ANNUAL 2009
OF THE CROATIAN ACADEMY
OF ENGINEERING

CROATIAN ACADEMY OF ENGINEERING

Annu. Croat. Acad. Eng.

ISSN 1332-3482

ANNUAL 2009 OF THE CROATIAN ACADEMY OF ENGINEERING

Editor-in-Chief

Stanko Tonković

Zagreb, 2009

Published by

Croatian Academy of Engineering,
28 Kačić St., 10000 Zagreb, Croatia

Editor-in-Chief

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President of the Croatian Academy of Engineering

Cover Design

Ivana Žiljak

ISSN 1332-3482
Annual 2009 of the Croatian Academy of Engineering
Annu. Croat. Acad. Eng.

Prepress

Vladimir Pavlić, GRAPA, Zagreb

Printed by

Denona, Zagreb

Circullation

300

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Annual Report on the Activities of the Croatian Academy of Engineering in 2009

In the year 2009 a number of important events for the Academy occurred. More details about some of them can be found on our web site (http://www.hatz.hr). I will start with the fact that in recent years a lot has been made in creating the conditions for a quality work and increasing activities of the Academy. We have acquired new premises in Kačićeva 28. Excellent relations with CAETS and Euro-CASE have been established, as well as with Croatian Government institutions and representatives, the University of Zagreb, Croatian Academy of Sciences and Arts, a lot of vocational academies at home and abroad and a number of firms. That is the reason more for a responsible work and management of the Academy in the next period.

Founded in 1993 at the time of the establishment of the Republic of Croatia, the Croatian Academy of Engineering celebrated 15 years of successful activities in 2008. It has been founded as a non-governmental, independent, non-party and non-profit organization of notable, experienced and established scientists of engineering and biotechnological professions (an excellent short overview of the Croatian Academy of Engineering history and activities can be found in the Annual Report of Annual 2008 written by Prof. Emer. Zlatko Kniewald, Ph. D.).

Up to now four Presidents of the Academy have been elected, i.e. Academician Josip Božićević (1993 – 1997), Prof. Juraj Božićević, Ph. D. (1997 – 2003), Prof. emer. Zlatko Kniewald, Ph. D. (2003 – 2009) and Prof. Stanko Tonković, Ph. D. (July 1st, 2009 – 2013). Having sacrificed numerous obligations and own free time, each of the first three Presidents has given his immeasurable contribution in establishing the status and reputation of the Academy in the Republic of Croatia and throughout the world.

Basic activities of the Academy include research and development in engineering and technological sciences, technological test and analysis, promotion and organization of scientific work, drawing up of scientific studies, expertise, reports and projects, opening discussions and expressing opinions about current issues in science and economy, organization of scientific conferences, publishing, cooperation with academies at home and abroad, as well as the transfer of knowledge.

In October 2000 the Academy became member of the CAETS – International Council of Academies of Engineering and Technological Sciences with headquarters in Washington, USA and in January 2005 associate member of Euro-CASE – European Council of Applied Sciences and Engineering with headquarters in Paris, France.

Important Events in 2009

On March 14th, 2009 Croatian Academy of Engineering held its 24th Annual Elective Assembly. Apart from the members of the Academy, the Assembly was attended by several eminent representatives from the field of science, as well as high government officials. President of the Academy, Prof. emer. Zlatko Kniewald, Ph. D. submitted a report with special review on his mandate from 2003 to 2009. Thereby the mandate of Prof. emer. Zlatko Kniewald, Ph. D. as the head of this eminent and honorable Croatian institution ended. By a spontaneous applause the participants of the Assembly rewarded his successful management.

For the new mandate period from 2009 to 2013 (beginning with July 1st, 2009) Prof. Stanko Tonković, Ph. D. has been elected President, Prof. Miljenko Lapaine, Ph. D. and Prof. Vilko Žiljak, Ph. D. Vice-Presidents and Goran Granić, Ph. D. Secretary-General.

According to proposals of the Departments of the Academy, elections for the promotion or admission of new Collaborating Members of the Academy have been made. 31 members of the Academy have been unanimously voted for the promotion into Full or Associate Members, and 22 new Collaborating Members, as well as 2 Correspondent Members elected. The new membership list – WHO is WHO – is included in this Annual.

On September 11th, 2009 Ministry of Science, Education and Sports of the Republic of Croatia awarded the status of **scientific organization** to the Academy, a great recognition to the work of the Academy in the past mandate and a large commitment for the new Governing Board.

At the Euro-CASE Board Meeting in Paris in May 2009 the Academy became **Full Member** of Euro-CASE. We consider it a special recognition to the work of the Academy since Croatia is the first **non**-member country of the EU admitted into Euro-CASE on account of which even an article of the Euro-CASE Statute has had to be altered.

Signing of the third international agreement on cooperation (the two previous ones with the Academies of China and Hungary) with Austrian Academy of Sciences is also considered an important accomplishment.

As the President of the Academy I have participated (as well as former Presidents every two years) in the largest annual international conference of the academies of engineering – 18th Convocation of CAETS 2009 Calgary (more details in this Annual).

The Academy has to remain the first "technologically oriented" scientific and professional organization in Croatia. I accentuate scientific and professional because in a small country like Croatia progress could only be made by synergy and collective efforts. And our mission is making progress in engineering and biotechnological sciences. Recognition of the status of scientific organization is the major event in the history of the Academy. We should bear in mind that the Academy is composed today of over two hundred members who are all first-rate experts with experience from almost every field of technical and biotechnical sciences. It is an enormous asset for such a small country as Croatia. We, engineers with experience, are deemed accountable for and have to take important part in the adoption, growth and breakthrough of the new technologies the coming of which we witness every day. Cooperation with all interested parties on the design of vision, objectives and strategies of the development of Croatia should be the duty and obligation of every member of the Academy. Not only deliberation, but also proposals of activities and work on joint, multidisciplinary and interdisciplinary projects should be the goals of the Academy and its members in the future. In Croatia we are confronted with a serious lack of proposals and work on development projects, especially complex projects, in the moment of "knocking on the door" of the European Union and its access funds. Changes in the method of education should also be considered starting with a serious and thorough analysis of the efficiency of the Bologna Process up to the need for a life-long education, vocational retraining etc. Being the witnesses of striking and rapid changes in all branches of our lives, and due to our professional consciousness, we may not stay behind.

Everything that has been achieved in last couple of years **has to be** preserved, but also improved. Croatian Academy of Engineering has to become partner to government institutions and economy. It is the **obligation** and **duty** of the new Governing Board, Presidency, all other organizational units of the Academy, but also of **all** its members. Members have to become aware that membership in the Academy is **not** only an item in their CV, but that they have to be **active** participants in the activities of the Academy. It is the **duty** of the Academy (Governing Board and Presidency) to **serve** its members. Informing “from up downwards” and “from down upwards” plays an important role here. I myself have a great confidence in team work. As President of the Academy I will try to be only “the first among equals”. With Governing Board and Presidency I will share deliberations about all important decisions, but of course take greatest responsibility for their implementation.

In the end I would like to personally thank all members of the Governing Board, secretaries of Departments, chairpersons of the Standing Committees, heads of the Centers, business secretary and all friends of the Academy that, besides all their obligations and in these hard times, they have agreed to continue the work of their precursors.

President of the Academy
Prof. Stanko Tonković, Ph. D.

Editorial

Dear readers,

As you can see, the Annual 2009 of the Croatian Academy of Engineering has been actually divided into three parts.

Part I. **Papers**

As one of the differences or changes from the past Annuals, the authors of the Part I. – Papers in the ***Annual 2009*** are the members of the Croatian Academy of Engineering, participants of several conferences sponsored by our Academy, or members of some of the sponsor organizations. The arrangement of papers has been done following the contributions and contents of the papers, i.e. the first two of them are of the general interest, the next four are from the field of geoinformation, the next three deal with the issues from the scientific field of graphical engineering, and the last four papers are from different scientific fields.

Part II. **International Cooperation**

In this part we have presented the main news related to the international cooperation of the Academy, concerning the agreements and the news from the CAETS and the Euro-CASE.

Part III. **WHO IS WHO** in the Croatian Academy of Engineering

This part is issued regularly when some changes in the Academy's membership occur. The latest one is related to the 24th Annual (Elective) Assembly held on March 14th, 2009. According to proposals of the Departments of the Academy, the elections for the promotion of the existing Members, or the admission of new Collaborating Members of the Academy, have taken place. The new list of members and their status is presented herein.

At the end, I am very pleased to have the opportunity to extend my sincere thanks to all sponsors and to all who had contributed, by investing their time and efforts, in publishing of this Annual that we have in front of us.

All papers have been reviewed, but not English language edited.
Each author has provided for her or his paper's proof-reading.

Prof. Stanko Tonković, PhD.
Editor-in-Chief

Part I

Papers

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Importance of Intellectual Property Rights Protection in Croatia – Education and the Role of the Croatian Academy of Engineering

Abstract

A modern world history of productive forces belongs to the mutual promotion of scientific discoveries, technical innovations and industrial revolution as a result of their implementation. Engineering sciences and technology are the bridge linking science and the industry supporting development and production. Croatia's intellectual capital is an asset that needs to be better valorized to develop the country's economy and industry. A crucial part of this process is development of a strong national R&D infrastructure. This necessitates the forging of working links between public administration, research institutes and indigenous industries to facilitate the commercialization of intellectual property from the research sector to the industrial sector. Addressing this process, series of projects were facilitated awareness of IP issues by targeting scientists and researchers, students in law, business engineering and other disciplines as well as Croatian industries. It is important to develop curriculum for IP teaching at the universities and present a balanced view to students which could equally apply to the intellectual property. The role of engineering academies and Croatian Academy of Engineering as their part in the collaboration on the development and usage in IPPR is of great importance as well as its role in IP education in continuing professional development and lifelong learning.

Key words: CAETS, intellectual property (IP), life long learning, university, WIPO

Introduction

After the transition to a market economy, as in other transitional countries, economic growth of the Croatian economy depends on the successful transformation of research results and knowledge to commercially exploitable products or innovation. Innovation is a driving force for a new economy and the key factor of a country's ability to enter international markets and technology competition. Competition rules and Intellectual Property Rights (IPR) play a fundamental role in these new economic processes.

Standard science and higher education policy largely dominate over the innovation policy that is focused on incentive measures for economic exploitation of research, capitalization of knowledge and science-industry cooperation. Universities, public administration and the society as a whole do not seem to be highly aware of the importance and the role that IPR plays in modern industrialized and knowledge-based societies. The Ministry of Science, Education and Sports of the Republic of Croatia (MSES), has made significant efforts in modernizing the Research and Development (R&D) Sector and the higher education system in the past. A number of new regulations and acts produced to improve the research system in Croatia have been introduced. However, intellectual property issues have never been included as a part of these regulations nor have they been outlined or formulated separately. It is estimated that Croatia is losing significant economic gains that could have been reached if many excellent technically and scientifically advanced ideas being generated within the country have been exploited in a proper commercial way.

The R&D Sector is characterized by weak linkages between research, education and industrial institutes with much of the research undertaken without having clear relations to the needs of the economy. Research institutes also have little motivation or interest in commercialization of research results, whilst individual Croatian researchers and scientists lack strategic and legal support to market their inventions.

The scientific community is much more focused on publishing their research results in peer-reviewed journals than on exploiting them commercially. Since it has long been acknowledged that the primary functions of universities are education, research and public service, the problem of protecting research results by IPR has often been neglected. If academic researchers commercialize their inventions, it is usually done through secrecy, not through IPR. While this method seems to save costs in the first place, it has considerable disadvantage: neither the invention nor the product is safe from reinvention by a third party.

Subsequently, the strategic policy and management of IPR are now recognized as strategic tools for accelerating innovations and adjustment of the research system to the challenges of the new economy.

Intellectual Property (IP)

A modern world history of productive forces belongs to the mutual promotion of scientific discoveries, technical innovations and industrial revolution as a result of their implementation. Engineering sciences and technology are the bridge linking science and the industry. The development of engineering sciences and technology has penetrated into every aspect of human life deeper than at any period in history.

The scientists and engineers worldwide are a very important force in the world's engineering science and technology development and implementation. Today a rapid development of nanotechnology brings together entrepreneurial start-ups and innovative corporations, world-class science and representatives from government and funding bodies to advance such development. This opportunity has opened a dialogue between organizations and across industry boundaries, directing public and private sector investments to support innovation and management of complex industry needs.

Intellectual property (IP) refers to the creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. IP is divided into two categories: industrial property, which includes inventions (patents), trademarks, industrial designs and geographic indications of source; and copyright, which includes literary and artistic works.

A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. It provides protection for the invention to the owner of the patent and protection is granted for a limited period, generally 20 years. Patented inventions have, in fact, influenced every aspect of human life, from electric lighting, plastic materials to ballpoint pens, new drugs or microprocessors.

The innovations and creative expressions of indigenous and local communities are also IP, yet because they are "traditional" they may not be fully protected by existing IP systems. Access to, and equitable benefit-sharing in, genetic resources also raise IP questions. Normative and capacity-building programs are underway at WIPO to develop balanced and appropriate legal and practical responses to these issues.

Protection of Intellectual Property

At present, no "world patents" or "international patents" exist. In general, an application for a patent must be filed, and a patent shall be granted and enforced, in each country in which someone seek patent protection for his invention, in accordance with the law of that country. In some regions, a regional patent office, for example the European Patent Office (EPO) or the African Regional Intellectual Property Organization (ARIPO), accepts regional patent applications, or grants patents, which have the same effect as applications filed, or patents granted, in the member states of that region.

Procedural and substantive requirements for the grant of patents as well as the amount of fees required are different from one country/region to the other. It is therefore recommend consulting a practicing lawyer who is specialized in intellectual property or the intellectual property offices of those countries in which you are interested to get protection.

Intellectual property protection in the Republic of Croatia is in the authority of the State Intellectual Property Office (SIPO). In 1991

Croatia has become a member of the World Intellectual Property Organization (WIPO) as well as a member (contracting state) of the PCT International Patent Convention in July 1998. Since April 1, 2004 Croatia can be designated in a European patent Office application as one of the extension states and it will be a full member in the near future. Thanks to significant efforts of SIPO and the assistance provided by CARDS 2001 project "Support the Croatian IP System" legislation (harmonization with EU legislation), institutional arrangements are now largely in place. This forms an excellent basis for developing and improving the seriously neglected IPR system related to exploitation of research and new technologies. Another CARDS 2002 IPR Regional Project of Support provided assistance to the countries of the region (Albania, Bosnia and Herzegovina, Croatia, Macedonia and Serbia & Montenegro). The objectives of this project have been the improvement of IPR institutions in beneficiary countries, regional cooperation among the institutions, adaptation of national legislation in line with the TRIPS agreement and creating general awareness of IPR. CARDS 2003 project "Strengthening the System of IP Protection" was about improving internal capacities of SIPO on granting industrial property rights and processing industrial property applications.

Croatia is characterized by a high degree of publicly funded R&D and high percentage of scientists employed by the public academic and R&D institutions. An important part of further development of the national R&D infrastructure is to implement processes and methods for exploiting its vast potential for development of IP such as patents, trade marks, copyrights and trade secrets.

Organizational Prerequisites within Croatia

Within the national technological network the following institutions have been established so far:

1. Business Innovation Centre of Croatia – BICRO Ltd.
2. Croatian Institute of Technology – HIT Ltd.
3. Centre for Karst
4. Technology and Innovation Centre Osijek Ltd.
5. Centre for Innovative Technology Rijeka Ltd.
6. Technology Centre Split
7. Centre for Technology Transfer
8. Research and Development Centre for Mariculture (1).

In April 1998, within the incentive measures, the Government of the Republic of Croatia adopted the Program for Increasing and Starting Production Based on New Technologies, proposal for which had been made by the Ministry of Science and Technology (1). In 1998 the Business and Innovation Centre of Croatia (BICRO) was set up as a state agency to act as an umbrella organization in the creation of an overall Croatian technology infrastructure. The real need for establishing an IPR system in the R&D Sector and respective management policy was initiated by the Croatian Program for Innovative Technological Development created by the Ministry and approved by the Croatian Government in April 2001. HITRA was the first innovation program in Croatia that paved the way for establishing a national innovation system and clearly pointed out the lack of a systematic approach to develop an IPR management policy related to R&D and technology. HITRA was especially targeted to encourage cooperation between the field of science and industry and provided a framework for direct cooperation between entrepreneurs/industry and Croatian universities and research institutes and was implemented through two complementary programs:

1. Program TEST – Technology Projects aimed at pre-commercial development of new technologies;

2. Program RAZUM – Development of Knowledge-Based Companies aimed at commercial entrepreneurial projects (set-up, development and expansion of a company) based on new technologies, i.e. products with higher added value.

On September 1, 2006 MSES completed the acceptance of technology project proposals (the TEST sub-program) within the Croatian Program for Innovative Technological Development (HITRA). The new Croatian Government Decree as of July 12, 2006 and Guidelines for Fostering Innovative Technological Development as of July 17, 2006 announced the transfer of the TEST program – technology R&D projects from the MSES to the Croatian Institute of Technology (HIT Ltd.). In March 2006 the Government of the Republic of Croatia established the Croatian Institute of Technology – HIT Ltd., with the aim to make it the central institution of the Croatian technological network (1). The HIT supports and guides Croatian researches aimed at development and technology, monitors and anticipates global technological movements, provides advice and support in matters such as intellectual property and technology transfer, gives support and promotes participation in European research and development projects, as well as promotes Croatian technological production, research and development potential worldwide. Integrating contributions of various participants in the area of education, research and innovations, the Croatian Institute of Technology will provide the basis for the so called “knowledge triangle”, which will form a unique structure – “knowledge community”. Considering this, the HIT activities include:

- supporting and guiding Croatian researches aimed at development and technology
- monitoring, analyzing and anticipating the effect of global technological movements in the Republic of Croatia
- giving advice and support in the area of intellectual property and technology transfer
- promoting participation in European research and development projects
- promoting Croatian technological production and research and development potential in the EU and other countries.

In January 2008, the Technology Transfer Office (TTO) of the University of Zagreb was established with a mission to ensure the implementation and functioning of an effective infrastructure for technology transfer within the University of Zagreb in order to successfully transfer technologies to the market so as to generate benefits for the inventor, the Faculty, the University and the Croatian economy.

These aims are accomplished through three main types of activities:

- Commercialization of research results
- Management of intellectual property in research projects
- Awareness raising and training on intellectual property and technology transfer.

Technology Transfer Office (TTO) supports the researchers by evaluating the technical and commercial potentials of innovations. The TTO determines the appropriate way to protect the intellectual property and identifies the route to the market for the innovation. It is our goal to successfully connect researchers and their research results with partners from industry and to ultimately capitalize the commercial potential of research. In order to ensure that researchers have necessary knowledge about intellectual property in research and commercialization the TTO is regularly organizing workshops and seminars. Subjects such as intellectual property basics, management of intellectual property in research projects, technology transfer and commercialization of innovations are covered by our training sessions (2).

Education for IP – Developing the Curriculum

Recent progress in technology and engineering has been accelerated by high-tech solutions such as Information Technology and Internet. The acceleration would be increased in the 21st century, since the informatization of society has been progressing. The role of universities should change in the information era. Since the knowledge obtained at the university becomes outdated very rapidly especially in the field of engineering, engineers are required to obtain new knowledge and to keep the quality and productivity throughout their lifetime. Some engineers would like to learn just for updating their knowledge day by day. Other engineers might want to obtain higher degrees in engineering, such as M.Sc. and Ph.D. and some would like to obtain professional qualifications. In these situations, some engineers are returning to the university with these objectives to obtain new knowledge continuously after joining the high-tech enterprises.

Students would benefit from the awareness of intellectual property concepts, combined with basic competences in recognizing, protecting, exploiting and enforcing intellectual property rights. In addition, professional bodies, governmental and international institutions have recognized the importance of developing intellectual property learning opportunities in the work place, as a part of lifelong learning and continuous professional development. The university's role is to present a balanced view to students which could equally apply to the intellectual property (3).

Contents of the graduate engineers' curriculum for IP protection:

- Broad, rather than deep, understanding of intellectual property
- Awareness of implications surrounding disclosure and confidentiality
- Linkages between IP, innovation and business development
- Where to find and how to use patent information
- What goes into a patent application and why
- Time scale and costs of patent protection
- Implications of steps to be taken, or avoided, in the patent process
- Relevance of patents
- IP is more than just patents-trade marks, copyright, design
- Intellectual property ownership
- Non disclosure agreements

- National and international intellectual property issues
- IP valuation
- IP commercialization and exploitation.

Intellectual property studies should involve students in a critical evaluation of intellectual property and an appraisal of the stages of intellectual property management:

- how intellectual property rights are first recognized
- how they can be protected in law
- how they are commercially exploited
- how they are legally enforced (4).

University and the Role of Intellectual Property Rights Protection – Education in the Past and at the Bologna Curriculum

Development of information technology opened also a broader insight at different patent databases. Translation of the International Patent Classification (6th Edition with the participation of more than 260 Croatian scientists out of which more than 60 from the Croatian Academy of Engineering) performed under the leadership of the SIPO from English to Croatian gave the students, experts and employed engineers the opportunity for searching enormous databases with more scientific information than in the scientific journals. After analyzing literature citations presented at diploma, M.Sc. and Ph.D. works at the University of Zagreb for technical disciplines, we have concluded that the students and their professors are still not being oriented to use available data from the patent sources, because during the study, environment within the technical courses is organized more on the reproduction of existing knowledge and know-how, without enough implementation of personal creativity. It means that we have to educate students how to apply already published and available information from patents and how to find out which discovery can be later on protected by the patent.

The Faculty of Science (FS) and Faculty of Food Technology and Biotechnology (FTBT) within the University of Zagreb already started with the course Introduction to Scientific Work at the academic year 1980/81. During that time the curriculum was of course mostly oriented on what was scientific research work and how to prepare and publish scientific work.

After the formation of SIPO at Zagreb (Director N. Kopčić), collaboration was established between the Faculty of Food Technology and Biotechnology and SIPO for several years where the SIPO was the education place for undergraduate and postgraduate students from the Faculty of Mining and FTBT (Head of courses J. Kniewald). The first project was supported by the Ministry of Science and Technology of the Republic of Croatia at 1997 (P.N. 058409) and was granted to the FTBT – "Intellectual and Industrial Property in Croatian Science" (Project leader Z. Kniewald). Research team consisted of the scientists from the FTBT, but also from the SIPO. At the time the first young researcher was also employed on the project and got her M.Sc. (A. Jeličić). In order to achieve a broader support for this important field the paper "Intellectual Property and the Role of University" (5) was published. After the introduction of the new Bologna Curriculum from the academic year 2008/2009 at the FTBT, the course "Methodology of Scientific Work and Intellectual Property Protection" was introduced for diploma students in all studies: Bioprocess Engineering, Molecular Biotechnology, Food Technology, Nutrition and Food Safety Management. The course "Methodology of Project Planning and Intellectual Property Protection" has been held in the doctoral study "Biotechnology – Bioprocess Engineering" since the academic year 2006/2007 as a continuation from the previous master study "Biotechnology – Bioprocess Engineering".

The projects aimed at Strengthening IPR in Croatia

CARDS/WIPO University Research and Development Initiative

In order to develop a greater awareness of IP matters at the university level, WIPO has launched a program entitled the "WIPO University Initiative," aimed at encouraging universities in developing countries and countries in transition to establish "University IP Coordinators," the contact person or unit, where management, researchers, academic staff and students can inquire and receive information and advice on IP matters and have access to technological information contained in IP documents, in support of their R&D or teaching activities. Three institutions and persons nominated as IP Coordinators from Croatia have been included in this project: Brodarski Institute (M. Drakulić), Faculty of Food Technology and Biotechnology, University of Zagreb (V. Gaurina Srček) and Ruđer Bošković Institute (V. Kotarski) supported by focal point from SIPO (Lj. Kuterovac).

The main goals of this project would lead to greater use of the IP system and contribute to the transfer of technology and innovation to industry from the universities and R&D organizations and, eventually, help to:

- improve access to the wealth of technological information contained in patent documents; improve the capacity of the users (researchers and inventors at R&D organizations, universities, etc.) to analyze and use such information;
- encourage the establishment of IP policies by the universities;
- develop the capacity of extracting, analyzing and summarizing technological, legal and business information from IP documentation;
- assist universities/organizations in identifying their IP assets with a view to generating more benefits and income;
- improve the IP protection of research results and inventions generated by the universities and R&D organizations, as a first step towards successful commercialization;
- establish contacts with other specialists working in the field of IP both, national and international, from the universities, national IP offices or private sector professionals with a view to exchanging experience, information and related IP material.

In the initial phase, the main function of the IP Coordinator was to provide reference services and information on IP-related matters to the university management, R&D staff and students. Furthermore, the IP Coordinator established contacts and links with the national IP office and copyright administrations and IP professionals. The IP Coordinator should acquire basic knowledge of the IP system (in his/her country and some information on the international IP system) but, more importantly, know where to find the necessary information. To begin with, it is desirable, but not obligatory, that the IP Coordinator be knowledgeable in the field of IP; however, as the project develops, he/she will acquire the necessary knowledge to ensure a fully informative service. Each Coordinator should maintain a set of national IP-related documents, such as national IP laws (i.e. patents, trademarks, geographical indications, copyright and related rights, etc.) that can be obtained from the national IP office. A close link should be maintained with the national IP office. One of recommendations was that IP coordinator should follow the WIPO Academy Distance Learning Program (website: http://academy.wipo.int). WIPO provided the necessary information for registration. Initially, the Coordinator should publicize the service, among staff and students and organize at least two information sessions (1/2-day seminar, workshop) per semester. These information sessions should comprise a general presentation of the IP system, a presentation of the national IP system and services of the IP office, and either a presentation on IP information and its benefits for the universities and R&D organizations or a presentation on copyright and neighboring rights. This should be undertaken in close cooperation with the national IP office and IP specialists or professionals from the private sector who should also be invited to give presentations.

WIPO organized trainings, in due course, for the IP Coordinators. The first Regional Workshop on "Searching of IP information for University IP Coordinators" organized by CARDS Regional Program Industrial and Intellectual Property Rights in cooperation with the WIPO and State Intellectual Property Office (SIPO) of the Republic of Croatia was held in Zagreb, December 1-2, 2005. The second Regional Workshop on "Searching of IP Information for University IP Coordinators" organized by CARDS Regional Program Industrial and Intellectual Property Rights funded by the European Commission (EC) and implemented by the European Patent Office (EPO) and the Office for Harmonization in the Internal Market (OHIM) was organized in cooperation with World Intellectual Property Organization (WIPO), the State Office of Intellectual Property in Skopje (SOIP) and Faculty of Mechanical Engineering, Ss. Cyril and Methodius University Skopje in Skopje, June 7 – 9, 2006. IP Coordinators from Croatia (M. Drakulić, V. Gaurina Srček and V. Kotarski) participated in this workshop and established links with IP Coordinators from other countries (Albania, Bosnia and Herzegovina, Bulgaria, Macedonia, Romania, Serbia and Turkey). The main workshop's topics included Electronic and Online IP resources, Electronic and Online IP resources (follow up), Role of National Offices, IP documentation network and Universities, IP management in Universities. Workshop "Intellectual Property Protection at the Higher Education", organized by State Office for Inventions and Trademarks Romania, University of Medicine and Pharmacy "Carol Davila" in cooperation with WIPO and Cedars Sinai Medical Center, Los Angeles, USA was held in Bucharest, Romania, March 2-3, 2007 in order to promote IP teaching at the Universities. IP Coordinator from FTBT V. Gaurina Srček attended this workshop and continued her education and networking with other IP Coordinators.

CARDS 2003 Intellectual Property Rights Infrastructure for the Research and Development Sector in Croatia

The project is aimed at increasing the commercial exploitation of the Croatian Research and Development sector, by developing an intellectual property system in line with the EU acquis and EU models, by supporting the institutions responsible for intellectual property issues, as well as by carrying-out trainings and awareness-raising activities. Croatia's intellectual capital is clearly an asset that needs to be better valorized to develop the country's economy and industry. A crucial part of this process is development of a strong national R&D infrastructure. This necessitates the forging of working links between public administration, research institutes and indigenous industries to facilitate the commercialization of intellectual property from the research sector to the industrial sector. Addressing this process, this CARDS IP rights program facilitated awareness of IP issues by targeting scientists and researchers as well as students in law, business engineering and other disciplines as well as Croatian industries and potential investors in the IP that result from the work of the Croatian R&D sector. Expected longer-term economic impact should be realized by many stakeholders. Some of the measurable economic impacts included the following:

- improved efficiency of the research process by being more market-driven
- enhanced scientific capabilities by more closely correlating research activities to market opportunities, thus fostering new collaborative funding relationships between academia, R&D institutes and industry
- by focusing more on market opportunities, the R&D sector will be making more contributions to regional and global science and technology initiatives, thereby making it more credible and competitive
- these accomplishments and motivations will provide more opportunities for students and researchers of high calibers to target careers in science and technology, thus strengthening Croatia's overall base of human and intellectual capital
- above conditions make for a higher quality of life and living standards, which in turn will make Croatia a more attractive location in which to live and invest.

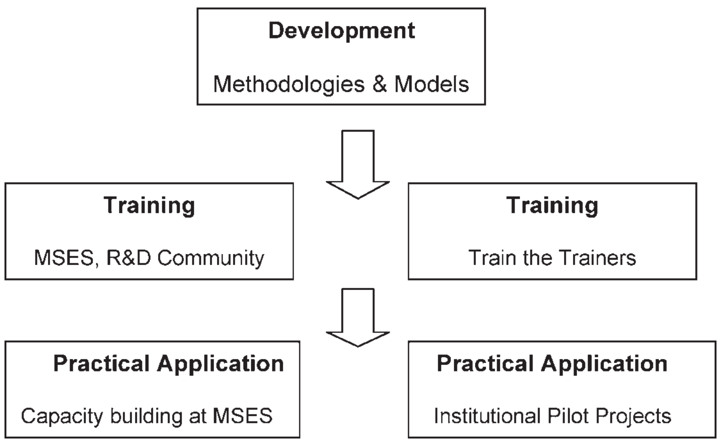
The CARDS Program "Intellectual Property Rights Infrastructure for the Research and Development Sector in Croatia" was comprised of three main components:

- **Component 1 – Institutional and legal framework**
    - generic procedures for IP protection, valuation of commercial potential prior to publication and technology transfer options are developed;
    - the specialized-central support unit on IP rights and R&D sector operates efficiently;

- the established network between government bodies and R&D institutions actively supports functional links between stakeholders national/local level

- **Component 2 – Targeted training and public awareness**
  - critical mass of key actors improved their knowledge, skills and attitudes to effectively enforce and foster innovative capacities in the field of IP protection and commercialization;
  - strategic elements for extensive application of new IPR concepts among the wider public are reinforced
- **Component 3 – Implementation in the R&D institutions-pilot project**
  - the basis for a sustainable and self supporting system of IP protection and exploitations established

General structure of project



In order to facilitate this comprehensive technical assistance program, a series of six 3-day workshops was held around Croatia on the subject of IP rights, the first of which was held from September 26-28, 2006. These workshops focused on the business aspects of IP rights. Overall of 142 attendees were from academia, the R&D sector of industry, research institutes, government offices and other sources. 36 attendees continued their education on to a much more intensive Train the Trainers event that was held over a total 9-day period (three training modules of three days each spread over November 2006, February 2007 and March 2007). The graduates from that event returned to their workplaces to facilitate additional training amongst colleagues and to implement technology commercialization and IP protection activities to valorize any valuable existing and future IP from their respective organizations. Among the key R&D institutes that have been identified to be involved in CARDS pilot project were the Brodarski Institute, The Ruđer Bošković Institute and the Faculty of Food Technology and Biotechnology of the University of Zagreb. During the project, 9 pilot locations have received a practical tailor-made assistance in establishing and maintaining their IPR issues:

1. Ruđer Bošković Institute/ Rudjer Innovations (www.irb.hr)
2. Faculty for Food Technology and Biotechnology (www.pbf.hr)
3. Faculty of Electrical Engineering and Computing, FER, (www.fer.hr)
4. Faculty of Mechanical Engineering and Naval Architecture, Center for Technology Transfer (www.ctt.hr)
5. Brodarski Institute (www.hrbi.hr)
6. University of Split + TEMPUS CREATE (www.create-project.info)
7. University of Rijeka + STeP (www.uniri.hr/step-ri)
8. Technology Development Center University of Osijek TERA (www.tera.hr)
9. The University of Zagreb (http://www.unizg.hr)

Manual "A Practical Guide to the Models, Processes and Procedures of Technology and Knowledge Transfer from Universities and Public Research Institutes" has been published and distributed to pilot locations for the further use (6).

PHARE 2006 CROATIA "Capacity Building in Technology Transfer Institutions in Order to Enhance Research Commercialization Activities"

The PHARE 2006 Croatia Project "Capacity Building in Technology Transfer Institutions in Order to Enhance Research Commercialization Activities" was established with the wider objective of strengthening the cooperation between science and industry and fostering commercialization of research results. This objective was to be achieved by building the capacity of technological development institutions and technology transfer centers which are part of the institutional framework of the Croatian innovation system. Specifically, it was envisaged to support emerging technology transfer activities across Croatia by providing assistance to the process of Continuing professional development (CPD) for some 20 Technology Professionals (TP) who were developing a career in the technology transfer area in Croatia and who could demonstrate that intellectual property or technology transfer would form part of their main job description. Capacity building can take many forms and typically includes workshops, lectures, individual consulting sessions and study tours. This project encompassed all these formats over an eight month period.

During the course of this PHARE project the 3 person expert team (Lisa Cowey, MBA-Team Leader, Lidija Stopfer from Rudjer Innovations Ltd. and Sarah McNaughton from ISIS Innovation, Oxford University) worked with participants to monitor their development against a need analysis and a personal learning plan. This Plan was specifically designed to help participants to measure the results of their commitment to the Continuing Professional Development course. To capture the results of this project, a series of Case Studies have been developed as followed:

- Intellectual property rights curriculum
- Intellectual property policy development
- Piloting processes-disclosure/due diligence/evaluation
- Marketing your innovations
- Engaging with potential licensees
- Adding value-leveraging new skills
- Study tour-transferring good practice and fostering networking (7).

The Role of Croatian Academy of Engineering as a Member of CAETS and EuroCASE in IPR Promotion

To meet the need of the times, the Croatian Academy of Engineering was established in 1993. The Academy is a national, independent non-profit research organization composed of elected members with the highest honor in the community of engineering and technological sciences of the nation. Its missions are to initiate and conduct strategic studies, provide consultancy services for decision-making of nation's key issues in engineering and technological sciences promoting the development of intellectual property rights protection of foreign and of course own new technological knowledge in Croatia. As the prestigious advisory institution in Croatia's engineering science and technology, the academy also boasts with groups of members with outstanding international references and contributions to engineering and technological sciences including biosciences, which can also serve within other academies making an enormous team of experts with over 11,000 participants. Members of the Academy will strengthen ties with international organizations such as the International Council of Academies of Engineering and Technological Sciences (CAETS) and EuroCASE to carry out exchanges and cooperation with engineering science and technology teams of all countries in the world, but also through the United Nations Economic Commission for Europe (UNECE) which was set up in 1947. It is one of five regional commissions of the United Nations. Its major aim is to promote pan-European economic integration. To do so, UNECE brings together 56 countries (including Croatia from 22 May 1992, represented by Mirjana Mladineo) located in the European Union, non-EU Western and Eastern Europe, South-East Europe and Commonwealth of Independent States (CIS) and North America. All these countries dialogue and cooperate under the aegis of the UNECE on economic and sectoral issues. It provides analysis, policy advice and assistance to governments, it gives focus to the United Nations global mandates in the economic field, in cooperation with other global players and key stakeholders, notably the business community. The UNECE also sets out norms, standards and conventions to facilitate international cooperation within and outside the region.

In 2007 UNECE was hosting in Geneva an International Conference on "Intellectual Property Rights Protection and Transforming Research and Development Outputs into Intangible Assets in Economies in Transition", followed by the annual meeting of the UNECE Team of Specialists on Intellectual Property.

Experts from national IP offices and ministries, international organizations, research institutions and the business community will meet to discuss good practices and policies in intellectual property commercialization, and protection and rights enforcement in the UNECE region, with a special focus on countries with economies in transition.

A well-designed intellectual property regime increases national wealth and benefits consumers by stimulating research and investment into new technologies and innovative products, and by enabling the transfer of technology between countries at different stages of economic development. Innovative industries are key drivers of economic growth and key providers of well-paying jobs, thus contributing to the achievement of broad development objectives.

However, these benefits are not automatic. Inadequate legal, regulatory and policy frameworks underpinning IP can hold back economic development. They can undermine the incentives to invest in research and development, impede the diffusion of technology, contribute to economic losses from IP-related crime, and add to public health and safety hazards from unsafe counterfeit goods.

The role of engineering academies in the international collaboration on the development and usage of Internet-based communication for the transfer of knowledge and experience in IPPR is very important. The collaboration academies from Austria, Slovenia, Croatia, and Hungary might be a good base of the international collaboration since these four countries have a long history of collaboration with similar cultures and closer location.

IP Education in Continuing Professional Development and Lifelong Learning

Once at work, the student (engineer or scientist) is more likely to be drawn more towards "vocational" or "pragmatic" training outcomes rather than "academic" consideration of the subject. Nevertheless, the range of intellectual property education topics in the work context can be wide. Interests will include the practical aspects of recognition, protection, exploitation and enforcement of rights: human resource issues; strategic issues; national and international issues. There have been responses from industry to the needs of people already in work wanting to understand more about intellectual property. This activity is under the scope of the Center of Lifelong Learning of the Croatian Academy of Engineering.

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Biomedical Engineering Worldwide – Celebrating the 50th Anniversary of the IFMBE

Abstract

In the past few decades, medicine and health care have changed dramatically and became dependent on high technology in prevention, diagnosis and treatment of diseases as well as in patient rehabilitation. Modern biomedical research and health care depend on multidisciplinary teams in which biomedical engineers equally contribute to the advancement of knowledge. Biomedical engineering research and development represent (in addition to sustainable power sources) the most rapidly growing branch of industry in the developed world. The new knowledge won through the research in basic biomedical engineering (at gene, molecular, cellular, organ and system level) influences applied research and boosts new industries, including small and medium size enterprises which bring to the market new products and services for health care delivery. Health is the major theme of the specific Programme on Cooperation under the European Seventh Framework Programme, with a total budget of € 6.1 billion over the duration of FP7. The objective of health research under FP7 is to improve the health of European citizens and stir up the competitiveness of health-related industries and businesses, while addressing global health issues. Growing technological participation in health services has also pointed out the need of hospitals and other medical institutions for support of technologically specialized personnel trained specially for use of all kinds of high technology devices including the hospital information systems, networks and their safety and security. These professionals are trained clinical engineers. Therefore, in Europe and worldwide the educational system has not only adopted the curricula for biomedical engineering as well as for clinical engineering but is also building certification system for biomedical and clinical engineers and the continuous education (life long learning) structures. The development of biomedical engineering and its affirmation has mainly appeared in the latest 50 years, first as a result of development in electronic industry while later it started developing at its own pace. The first part of this paper is devoted to the International Federation for Medical and Biological Engineering (IFMBE), the largest organization of biomedical engineers in the world. The IFMBE celebrated its 50th anniversary in 2009. In the second part we would like to review the background and the state of art of biomedical engineering research and education in Croatia.

Key words: Biomedical engineering, International Federation for Medical and Biological Engineering, Croatian Medical and Biological Engineering Society, Health Care

Introduction

Biomedical Engineering is an interdisciplinary field of engineering which integrates physical, chemical, mathematical, and computational sciences and engineering principles with the study of biology, medicine, behavior and health. The fundamentals of biomedical engineering lie in engineering, biology and medicine, and its aim is to improve human health and quality of life. It is important to notice that biomedical engineering advances fundamental concepts and creates knowledge from molecular and cellular level to the level of organs and the body as a system. Research in biomedical engineering brought new devices, materials, processes and implants as well as new algorithms in signal and information processing and contributed significantly to the transformation of biology into a numerical science. New technologies are implemented in prevention, prediction, diagnostics and treatment of disease, patient care and rehabilitation and in improving health care and medical practice (Tonkovic, 2004).

Though evidence of engineering efforts to improve human health can be found very early in human history (like limb prostheses, canes, crutches, wooden teeth) in this paper the emphasis is given to the development of biomedical engineering during the last half century, the social impact of biomedical engineering worldwide with a look forward into the future and into human expectations.

This modern history of biomedical engineering is mainly founded on the invention of the silicon transistor in 1947. The transistor, a small and reliable device as compared to the electronic tubes, enabled development of a large number of electronic medical devices for hospitals and outdoor medical facilities. First medical electronic devices were perhaps simple, but with years they have turned into a complicated equipment like dialysis machines, different equipment for medical imaging, artificial organs and active implants. An example of fast growing complexity of medical devices are implantable cardiac pacemakers. Pacemakers were the first electronic device ever implanted into a human body and are considered the most successful therapeutic device ever invented for saving human life and improving the quality of life of patients. When the first cardiac pacemaker was implanted in October 1958, it was a hockey puck size device, it had only one silicon transistor and it was powered by two rechargeable batteries. Though the first model of pacemaker failed after only a few hours (the patient survived and lived for another 43 years after a series of pacemaker re-implantations), already in 1960, serial production of pacemakers started. During the last 50 years, the implantable cardiac pacemakers have dramatically changed its design and became sophisticated, automated machines consisting of a computer with computational power of a contemporary personal computer; sensors for acquisition of signals from the patient body and its surrounding; communication circuits that enable exchange of information between the pacemaker and the physician, and finally, an output amplifier that generates pulses to stimulate the heart. Implantable pacemakers developed in the last decade enable the adopting of the rate of generated heart stimuli to the needs of the activity of the patient, i.e. device controlled, but physiological paced heart rate. Furthermore, the batteries developed in the last decade have the capacity to work properly without recharging for nearly 20 years, implanted in a hermetically sealed casing together with the electronic circuits into the human body (Magjarevic and Ferek-Petric, 2010).

Pacemakers can also serve as an example how biomedical engineering and other engineering fields supplement each other (Fig. 1).

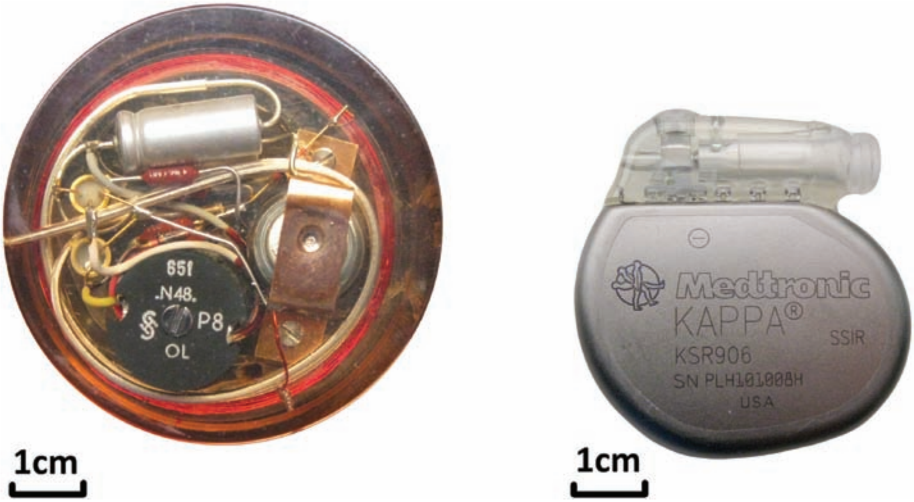

Figure 1. Implantable cardiac pacemakers. A replica of an implantable pacemaker from the early generation, Siemens-Elema, (1960) (left) and a modern implantable pacemaker, Medtronic Kappa KSR 906, (2002) (right).

The titanium technology used today for hermetic encapsulation of the electronic parts of the pacemaker and of the battery came from the NASA space program, while the lithium battery technology developed for pacemakers is the best candidate for powering electrical cars of the future.

It is however difficult to enumerate all the successful implementations of biomedical engineering achievements for health care in such a short article, but the technologies will continue to develop and change due to the exchanged needs of the health care (Andrade, 1994), (Madhavan et al, 2008). With the aging society, the health care will transit to patients home, patients will use e-health and m-health services more (Istepanian and Pattichis, 2006), and it is expected that e-health will empower the patients due to information present in the Internet. However, the idea of enhanced use of e-health raises also the questions of safety of the patients and security of the data (Higson, 2002). A new type of technologies is being developed, in order to support extended life expectancy and extended expectancy for prolonged life quality (Dorf, 2006). In such a constantly and rapidly changing environment, it is obvious that an international support and collaboration platform for biomedical engineers and other scientists and professionals in health care is a must.

1. International Federation for Medical and Biological Engineering

The International Federation for Medical and Biological Engineering (IFMBE) (www.ifmbe.org), is primarily a federation of national and transnational organizations (Fig 2.). These organizations represent national interests in medical and biological engineering: building up biomedical engineering and health research and professional networks, exchange of knowledge, fostering international mobility of researchers and students, making medical and engineering knowledge and health care available to all. The objectives of the IFMBE are scientific, technological, literary, and educational. Within the field of medical, biological and clinical engineering, the aims of IFMBE are to encourage research and the application of knowledge, to disseminate information and to promote collaboration.

Figure 2. IFMBE logo

1.1. 50th Anniversary of the IFMBE

The International Federation was founded in 1959 in Paris in the UNESCO building during the 2nd International Meeting of engineers, physicians and physicists who were mainly researching and developing in the field of Medical Electronics, therefore also the initial name International Federation for Medical Electronics and Biological Engineering. At that time there were few national biomedical engineering societies. For this reason researchers and professionals in the discipline joined the Federation as Associates. Later, as national societies were formed, these societies became affiliates of the Federation. In the mid-sixties, the name was then changed to International Federation for Medical and Biological Engineering.

As the Federation grew, its constituency and objectives changed. In the early days of the Federation, clinical engineering already developed as a sub-discipline, and their number in membership became significant. Therefore also the aims of the IFMBE had to be adopting and besides research and development, clinical engineering was included (David et al, 2003).

In April 2010, the Federation has an estimated number of 120,000 members in 60 affiliated national or transnational BME organizations.

1.2. International Liaisons

The IFMBE has also achieved a close association with the International Organization of Medical Physics (IOMP) (www.iomp.org). Since 1976, the two organisations have been jointly organizing international conferences every three years. The two international bodies have established the International Union for Physical and Engineering Sciences in Medicine (IUPESM) (www.iupesm.org) and they act together on international scene in matters related to health and patients. IUPESM is recognized by the International Council of Scientific Unions (ICSU) (www.icsu.org), representing a global membership that includes both national scientific bodies (106 members and associates) and international scientific unions (30 members). The membership of IUPESM in the ICSU is important because it gives visibility and legitimacy to the profession of biomedical engineers and medical physicists. The ICSU starts global projects such as the inter-union initiative on Science for Health and Well Being which in different time periods deal with specific topics, e.g. *Science and Technology in the Care of Patients and Persons with Disabilities* or *The Impact of Technology on Hypercommunicable Disease Processes*.

During the last decade the IFMBE has successfully promoted biomedical engineering at conferences and meetings, visited not only by scientists, but also by political decision makers, representatives of the health care systems and the medical device industry. Active cooperation of IFMBE with the World Health Organization (WHO), where IFMBE acst as the only accredited non-governmental organization (NGO) from the field of biomedical engineering, enabled the Federation to present several resolutions which are important for biomedical engineering as a profession and for technology in medicine in general (WHA, 2007). IFMBE is involved in a number of global initiatives that promote health: the World Alliance for Patient Safety, the Global Health Workforce Alliance, the Health Actions in Crises Initiative and the Global Health Professions Network. It is present in the World Standards Cooperation as the representative of the users – patients in matters of medical equipment and technology safety and security matters.

1.3. Research and Publications

IFMBE is primarily a learned society and its aim is to encourage BME research and application of knowledge for the benefit of science and patients. However, it does not fund scientific research projects. In order to contribute to the exchange of knowledge, the Federation has been publishing since 1962 the peer reviewed journal Medical and Biological Engineering and Computing (MBEC), and the electronic version of the Journal is available on-line (MBEC, 2010). Though MBEC is a “general” biomedical engineering journal, the editors foster publishing of special thematic issues, e.g. on Simulation and Modelling (Magjarevic, 2004), Microbubbles (Cosgrove and Harvey, 2009), Shoulder Biomechanics (Giovanni Cutti and Veeger, 2009) or Arterial Hemodynamics (Avolio et al, 2009). On yearly basis, the Journal awards the best paper published in MBEC the Nightingale Prize (Spaan, 2007), (Huang et al, 2008). Since 2006, the IFMBE Proceedings Series which covers publication of papers from IFMBE sponsored conferences and some of the IFMBE endorsed conferences is also available at the same web site.

2. Biomedical Engineering in Croatia

2.1. Croatian Medical and Biological Engineering Society – a Short History

The Croatian Medical and Biological Engineering Society (CROMBES) (CROMBES, 2010) was founded in 1992, continuing the tradition of the Croatian Section of the former Yugoslav BME Society (founded in 1984). The pioneer of biomedical engineering in Croatia is Prof. Ante Šantić. Prof. Šantić received his D.Sc. degree in 1966 in electrical engineering from the University of Zagreb, Faculty of Electrical Engineering. The application of the parametric amplifiers that Prof. Šantić elaborated in his thesis was in recording of bioelectric potentials, in particular in recording of the potentials of the brain (EEG) (Šantić, 1974). As the head of Electronics Laboratory at the Institute of Electrical Engineering in Zagreb, he worked on the research and development of special electronic instrumentation and started developing medical electronic instrumentation, particularly electroencephalographs (EEG), in which the Institute became the leading manufacturer in Central Europe. In 1970, he joined the Faculty of Electrical Engineering University of Zagreb as a Professor. From 1971, he started a new course in Biomedical Electronics and founded the Biomedical Electronics Laboratory. His research activities were in the field of special measurement instrumentation and biomedical electronics and in the latest years of his activity in infrared biotelemetry, non-invasive measurements (blood pressure measurement), gait analysis and pulse plethysmography (Šantić and Neuman, 1977), (Šantić, 1991), (Šantić et al, 2002). He is the author of two textbooks: “Electronic instrumentation” and “Biomedical Electronics” (Šantić, 1995). For his research, Prof. Šantić was recognized internationally and at the national level. He was the first European BME researcher to receive the IEEE EMBS Career Achievement Award for his "*fundamental and pioneering contributions to the development and construction of EEG, EMG and ENG Instrumentation and for his leadership in creating biomedical engineering courses in Europe*" in 2003. The EMBS Career Achievement Award is presented annually to an individual who has made significant contributions through a distinguished career of twenty years or more in the field of Biomedical Engineering, as an educator, researcher, developer or administrator.

2.2. Croatian Medical and Biological Engineering Society – today

CROMBES has over 100 members – scientists and experts involved in different scientific fields of biomedical engineering and medical physics (Fig 3.). This is rather unusual for most European countries, but it is not an exception (for example, Institute of Physics and Engineering in Medicine in UK). The successful development of biomedical engineering in Croatia in the first decade of the 21st century was continued under the leadership of Prof. Stanko Tonković (Fig 4.). At the international scene, the key role in develop-

HDMBT CROMBES

Figure 3. The logo of the Croatian Medical and Biological Engineering Society

Figure 4. Prof. Tonković awarded Honorary President of the Croatian Medical and Biological Engineering Society (Zagreb, February 2010)

Figure 5. New members of the Administrative Council of the IFMBE
(Munich, September 2009)

ing collaboration and research has been played by Prof. Ratko Magjarević who held the office of the Secretary General of the IFMBE from 2003-2009 and was elected IFMBE President-Elect in 2009 (Fig. 5).

Dr. Velimir Išgum, Mr. Petar Miličić and Dr. Mario Medvedec have made a major contribution to the development of Clinical Engineering in Croatia and started building up the conditions for recognizing the profession of clinical engineer in Croatia. Dr. Medvedec serves also in the Clinical Engineering Division of the IFMBE. Dr. Igor Lacković has joined the Young Professionals and Career Development Committee of the IFMBE in order to enable the affirmation of young Croatian experts in the field also internationally. In medical physics, Prof. Mladen Vrtar, Mr. Nenad Kovačević and Mr. Tomislav Viculin built the foundations of the profession, which resulted in the recognition of specialist postgraduate studies in medical physics and inclusion of Croatian language in the EMITEL Dictionary of Medical Physics, published on Internet (EMITEL, 2010) and to be published from Wiley as well.

CROMBES is active in promoting clinical engineering and in cooperation with IFMBE it has been working on projects for registering and certifying clinical engineers as well as on preparing a program for their continuous education. Within CROMBES, there are three professional sections: Clinical Engineering, Medical Physics, and Biomechanics Section, respectively. They are especially active within the clinical environment. The Society collaborates very closely with the State Office for Standardisation and Metrology, particularly with the Technical Committee TC-62, on the harmonisation of Croatian Standards relevant for medical equipment with European and International Standards. Since 2002, CROMBES has annually presented award for the best diploma paper in the interdisciplinary field of biomedical engineering to students of the University of Zagreb.

2.3. International Liaisons

Since 1993, the Society has been a full member of the International Federation for Medical and Biological Engineering (IFMBE) and the European Federation for Medical Physics (EFOMP, 2010). Later the Society affiliated also to the International Organisation for Medical Physics (IOMP, 2010) and the European Alliance for Biomedical Engineering and Science (EAMBES, 2010). CROMBES has been the platform for interdisciplinary cooperation in biomedical engineering in Croatia and internationally. In the previous decade, CROMBES has significantly improved international cooperation with foreign universities through research projects. We have also organized several international scientific meetings like: 8th International IMEKO Conference on Measurement in Clinical Medicine, Dubrovnik 1998; 9th Mediterranean Conference on Medical and Biological Engineering and Computing-MEDICON 2001, Pula 2001; 1st International Summer School: Applications of ICT in Biomedicine, Dubrovnik 2002; and in cooperation with medical physicists 2nd Austrian, Italian, Slovenian and Croatian Medical Physics Meeting-AISCMP, in Opatija 2006. In 2010, we supported the 17th International Conference on Biomagnetism organized in Dubrovnik.

2.4. BME Research in Croatia

Members of CROMBES participate in various Croatian and international research projects and programs. Among these different projects, we especially emphasize national scientific research projects “Non invasive measurements and methods in biomedicine” and “Intelligent Image Processing and Analysis Methods” endorsed by the Ministry of Science, Education, and Sports of the Republic of Croatia. The projects are based on modern technologies and have the potential not just for further research and development but for the implementation of achievements in clinical practice and by industry.

The main research activities in biomedical engineering in Croatia are carried out at the University of Zagreb Faculty of Electrical Engineering and Computing. Research of the Electronic and Biomedical Instrumentation Group is devoted to biosignal measurement and processing methods (Alić et al. 2006), in particular of the heart (surface and esophageal ECG) (Sovilj et al. 2009), muscle (Cifrek et al. 2009), (Medved and Tonković, 2004) and the brain, as well as bioimpedance measurement methods (Lacković and Stare, 2007), (Tonković, 2001) and instrumentation including characterization of bioelectrodes (Paćelat et al., 2000). The research of computational modelling of electric (Pavlin et al., 2005) and thermal effects in tissue during electroporation-based treatments (Lacković et al., 2009) is aimed to develop devices for minimally invasive therapeutic procedures in cancer treatment and for heart therapy (Ferek et al, 1984) (Fig. 6).

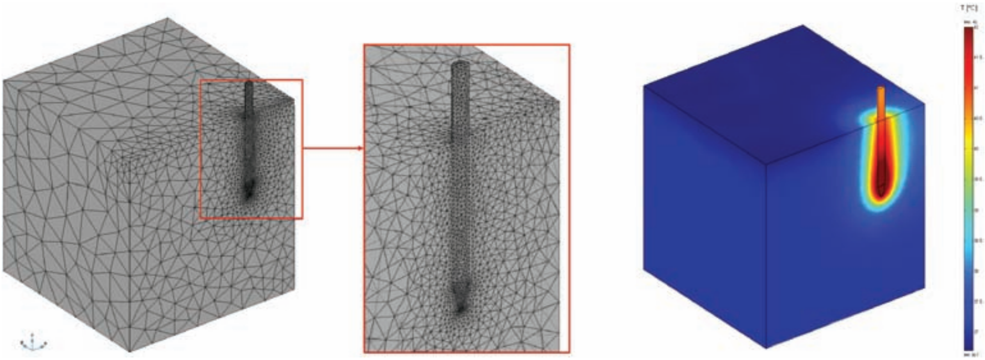

Figure 6. New drug delivery technology based on electropermeabilisation. The figure shows a computer simulation of the increase of temperature around a needle electrode used for electrochemotherapy (ECT) during the standard ECT protocol. Mesh generation (left), temperature distribution (right).

Networked sensor systems for physiological parameters monitoring and processing of extracted information in order to build up personalised intelligent mobile health systems for health care support represent a new field of research and development. Research in the Sensors and Electronic Instrumentation Group includes a number of biomedical topics such as mathematical modeling for extraction of 3-D content from images (Pribanić et al. 2010) and methods, algorithms, and software packages that best implement these models, camera (self) calibration, 3D structured

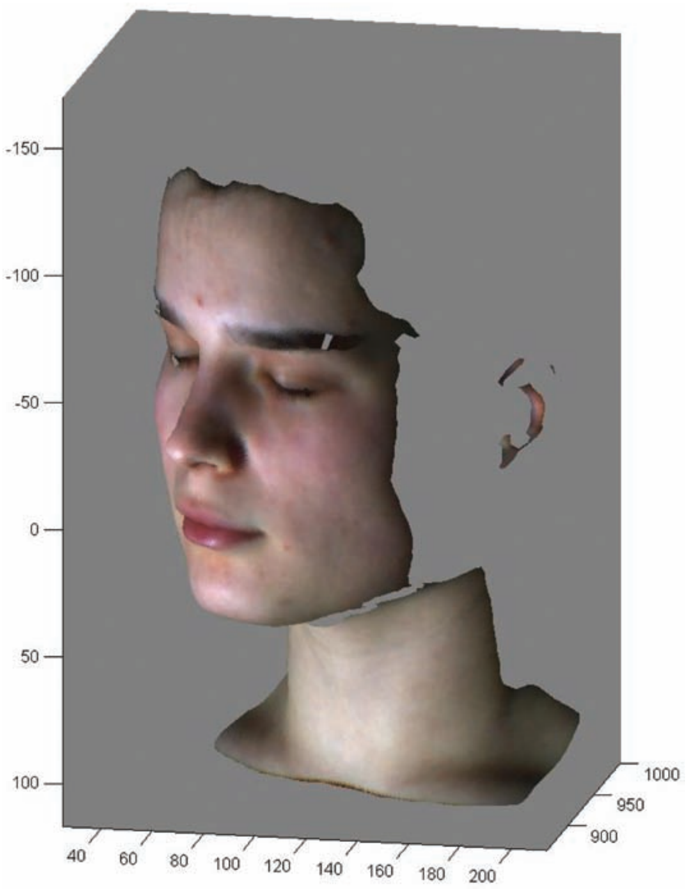

Figure 7. Three dimensional reconstruction using structured light constitutes an active topic in computer vision, having different applications such as range sensing, biometrics, object recognition, industrial inspection, reverse engineering, 3D map building and others.

light scanning, image feature extraction, marker tracking, surface registration, computer vision theory and methods for human motion analysis (Fig. 7).

Image Processing Group conducts research in theory and applications for intelligent image processing, pattern recognition and computer vision methods with applications in medical image analysis and biomedical imaging (Lončarić, 2005), (Subašić et al, 2005). The main research problems include image feature extraction, image segmentation, image registration, and motion analysis. Research has been conducted for real-time intravascular catheter tracking from X-ray image sequences and 3-D reconstruction of catheter tip, and in cardiac applications, methods for atlas-based image analysis of aortic outflow velocity profile from ultrasound Doppler images have been developed (Čikeš et al, 2009). Methods for 3D CT image analysis of abdominal aortic aneurysm have been investigated, as well as segmentation methods for nuclear medicine image analysis, and methodology for quantitative analysis of intracerebral brain hemorrhage from CT images (Lončarić and Dhawan, 1995).

2.5. BME Education in Croatia

Education in the field of biomedical engineering started in Croatia in the early 1970s, as a part of biomedical electronics teaching at the University of Zagreb Faculty of Electrical Engineering and Computing. Today, courses in biomedical engineering are offered by two Croatian universities. At the University of Zagreb, biomedical engineering is taught at several constituent institutions, while at the University of Split, BME courses are offered at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture. Within higher education reform in Croatia, we plan to establish a biomedical engineering programme at a master level in such a way that teaching of different courses is performed at different constituent university institutions and also at other universities from the region. One of our objectives is also to increase the mobility of teachers and students. These efforts are also supported by the international Tempus project “Curricula Reformation and Harmonization in the field of Biomedical Engineering” in which 23 higher education or research institutions are partners.

Conclusion

Biomedical engineers, as all other engineers, have the ability to design and produce, in their case medical products, devices and systems. BME is small compared to the traditional engineering fields, like electrical or mechanical engineering, but the number of BM engineers working in research and development is rapidly growing. Most of the BM industry still relays on electrical and electronic engineering including the currently fastest developing industries of active implants and mobile health services. New opportunities open in engineering the organisation of large datasets from biology combining computer based approaches. On this edge between engineering sciences and biology, an opportunity for new studies and applications open. Research in general is so complex today that hardly any research institution can cover all knowledge and skills necessary for successful outcome of the research goals alone. After 50 years of well institutionalized development of biomedical engineering at international level, and a little bit shorter development in Croatia, the Croatian engineers and scientists in the field contribute to the growing knowledge in the field of biomedical engineering.

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Geomathematics Between Mathematics and Geosciences

Abstract

The term geomathematics is nowadays often recognized in many geosciences and even in titles of societies, books and journals. Although most engineers and scientists know the term's root and fields in which it can be applied, there is an issue of *whether it is a group of mathematical methods mostly applied in geosciences* or *an individual geoscience*. Several texts about geomathematics are already published in Croatian scientific literature, and one thematic paper was published in "Vijesti" of the Croatian Geological Society in 2007. Geomathematics has since then been extensively applied in Croatian geosciences and a significant number of papers and books have also been published in individual fields belonging to geomathematics. We wish to determine the term in Croatian scientific terminology through extensive description and discussion.

Key words: mathematics, geomathematics, geosciences, Earth sciences

1. Geosciences or Earth Sciences

When we say the word *geosciences*, apparently everybody know what we are talking about, but defining the term is not easy.

Geosciences are also known as geoscience, Earth science or Earth sciences. It is a term for all sciences related to the planet Earth. Geosciences study atmosphere, oceans, and biosphere, land and planet structure. Geosciences, using knowledge from physics, chemistry, geology, biology and mathematics, try to understand how the Earth system works and how it has evolved. Generally, following scientific fields are included in geosciences (mostly according to URL 1):

- Geology describes rocky parts of the Earth lithosphere and their (geological) history, but also interaction with astenosphere and core. Main disciplines of geology are: geochemistry, geology of mineral ore deposits, geomorphology, hydrogeology, engineering geology, mathematical geology, mineralogy, palaeontology, petrology, stratigraphy, structural geology, sedimentology, and tectonics.
- Geophysics and geodesy explore the shape of the Earth, its relation to different physical forces, magnetic and gravitational fields. Geophysicists explore Earth's structure (from lithosphere to inner core), as well as tectonic and seismic activities.
- Pedology (soil science) studies Earth's surface, where soil is formed.
- Oceanography and hydrography (including limnology) describe Earth's parts covered with water (or hydrosphere). Main subdisciplines are physical, chemical and biological oceanography.
- Glaciology includes studying icy parts of the Earth or cryosphere.
- Atmosphere sciences include research of gaseous parts of the Earth or atmosphere between the Earth's surface and the exosphere (about 1000 km). Main subdisciplines are meteorology, climatology, atmospheric chemistry and atmospheric physics.
- A very important connecting sphere is biosphere, which is the subject of biological research. Biosphere is composed of all life forms, from one-cell organisms, plants to humans. Interactions with other Earth's spheres create conditions which make life possible.

The above list (URL 1) is obviously incomplete, because it is missing geotechnics, geomechanics, geography, etc. In addition, it is very interesting how sciences are classified (areas, fields, branches) in Croatia. In accordance with the *Regulation on Scientific and Artistic Areas, Fields and*

Branches (National Council for Science, 2008), field 1.03. Geosciences were in the area of natural sciences and were divided into following branches:

1.03.01 Geography
1.03.02 Geophysics
1.03.03 Geology
1.03.04 Mineralogy
1.03.05 Science about sea
1.03.06 Science about environment

It is interesting geodesy was not classified as a geoscience, but as a special field in area of technical sciences. Geography was only partially described as a geoscience, because social geography with demography was a special field in the area of interdisciplinary sciences. Geophysics, as an applied part of physics, was not in the field of physics, but in the field of geosciences. At the same time, physics was described as a special field in the area of natural sciences. According to the new *Regulation about Scientific and Artistic Areas, Fields and Branches* (National Council for Science, 2009), the field of geosciences do not exist any more. New fields of geology and geophysics were formed. The field 1.03 Geology is divided into two branches:

1.03.0. Geology and Palaeontology
1.03.02 Mineralogy and Petrology
The new field 1.06 Geophysics has four branches:
1.06.01 Meteorology with Climatology
1.06.02 Physical oceanography
1.06.03 Seismology and physics of the Earth interior
1.06.04 Other geophysical disciplines

Thus, geophysics is not a part of physics but a special field, like physics. Geography was previously divided between geosciences (physical geography) and social geography plus demography (which was a field in the area of interdisciplinary sciences). According to the new Regulation, geography is a special field in the area of interdisciplinary sciences. The last article of the Regulation reads: "*... these Regulations can be changed or extended depending on needs in particular scientific areas, fields and branches.*" It seems reasonable, regarding all mentioned, for informal events and occasions, to accept the definition of the term geosciences which includes all scientific disciplines about the Earth, regardless of fields and branches in the official classification of sciences in Croatia.

2. What is Geomathematics?

If we accept that *geophysics* is a scientific discipline which studies physical phenomena on the Earth and that *geochemistry* is a scientific discipline which studies the chemical composition of the Earth, the question is – what is *geomathematics*?

The Croatian Geological Society has recently published the *Geomathematical Dictionary* in Croatian (MALVIĆ et al. 2008). The term geomathematics is not explicitly defined in the dictionary. However, the first author also published a special paper about geomathematics in the "Vijesti" *of the Croatian Geological Society* (MALVIĆ, 2007). According to the paper, geomathematics is a set of mathematical methods applied in geology, and can be divided in three subdisciplines: "classical" statistics, geostatistics and neural networks.

Similar thoughts can be read in the paper titled *Geomathematics in Hungarian geology* written by Academician György Bárdossy of the Hungarian Academic of Sciences (URL 2):

"*The application of mathematical methods has a long tradition in Hungary. The main bases of geomathematics are the universities of the country, more closely the departments related to geology, such as general geology, stratigraphy, paleontology, structural geology, mineralogy, petrography, geochemistry, hydrogeology and applied geology. The Hungarian Geological Survey, the Geological Institute of Hungary and the Geochemical Research Laboratory of the Hungarian Academy of Sciences are institutions where geomathematical methods found broad applications. Finally, some mining and exploration companies, like the Hungarian Oil Company (MOL), the Bakony Bauxite Mining Company and others are regularly using geomathematical methods, mainly for the evaluation of exploration results, for deposit and reservoir modelling and for the estimation of resources.*"

In dictionaries, including Internet sources, it is quite difficult to find the term geomathematics. According to URL 3, geomathematics is the application of mathematics and computer techniques in geology, and is alternatively named *mathematical geology*. Some questions logically arise, such as:

a) Can geomathematics be considered a geoscience?
b) Is geomathematics a part of mathematics?
c) Is it valid to relate the term geomathematics exclusively to geology?

We are going to try to answer these questions in following chapters.

3. Geophysics and Geomathematics

Geophysics belongs to geosciences and physics at the same time. *Mathematical geophysics* is the development and application of mathematical methods and techniques in solving geophysical problems (URL 4). The term is analogous to, for example, mathematical geology. However, one may ask why these fields are not named geophysical mathematics and geological mathematics?

The paper titled *Geophysics and Geomathematics in Hungary* by Laszlo Cserepes from the Geophysical Department of the Eötvös Loránd University in Budapest (URL 5) states:

"*Geomathematics, a special application of mathematical statistics to Earth science problems, aims in general at the extraction of geological objects from "noisy" data sets (data including random errors). In a broad sense, this is also the basic goal of field geophysics, and this fact suggests a very close relationship between geophysics and geomathematics.*

Geophysicists have long been using various mathematical methods based on probability theory, information theory and mathematical statistics in order to evaluate their field measurements. Traditionally they use the term "geophysical data processing" for this collection of data evaluation methods, but it would not be a big mistake to say "geomathematics" instead.

Notwithstanding, geophysical data processing has its own specialities, and not just because the objects of geophysical prospecting are different from, say, those of mineralogy or petrology. There are some specialities *related to the methodological approach. In most geophysical data processing problems, the physical field of the geological object, which is investigated by a particular kind of geophysical measurements, is calculated from a deterministic physical theory, and these deterministically obtained theoretical values are contrasted with the stochastic data obtained in the field measurement. In this way, geophysical data processing mostly aims at an explicit physical model fitting, and the mathematical methods used in this process are selected according to this basic goal.*

Data processing in the above sense is now an everyday routine in most Hungarian institutions where geophysics is pursued, including university departments, reserach institutes, industrial laboratories and private geophysical companies.".

The paper continues with brief descriptions of application areas of mathematics in geophysics in Hungary. They include the modelling theory, i.e. fitting models to measurements and modelling error distributions, estimation of statistical parameters, filtering and processing images.

According to the presented material, it can be concluded that geophysics is a scientific discipline which studies physical phenomena on the Earth. Mathematical geophysics is a (science) scientific discipline which connects mathematics and geophysics. It is the application of mathematics in geophysical problems and development of mathematical methods appropriate for such applications and defining geophysical theories.

By analogy, it can be concluded that geology is a scientific discipline which studies rocky parts of the Earth lithosphere and their geological history, but also their interaction with astenosphere and core. Mathematical geology is a (science) scientific discipline engaged in connecting mathematics and geology. It is the application of mathematics in geological problems and development of mathematical methods appropriate for such applications and defining geological theories.

Geodesy is a technique and science engaged in measuring and mapping the Earth surface, determination of the Earth shape and its gravitational field. Mathematical geodesy is a (science) scientific discipline applied in connecting mathematics and geodesy. It is the application of mathematics in geodetic problems and development of mathematical methods appropriate for such application and formulating geodetic theories.

We could continue using analogies for pairs geography – mathematical geography, cartography – mathematical cartography, etc.

In short, this means that geomathematics for geologists represents the application of mathematics in geology, for geophysicists it is the application of mathematics in geophysics, etc. (Figure 1).

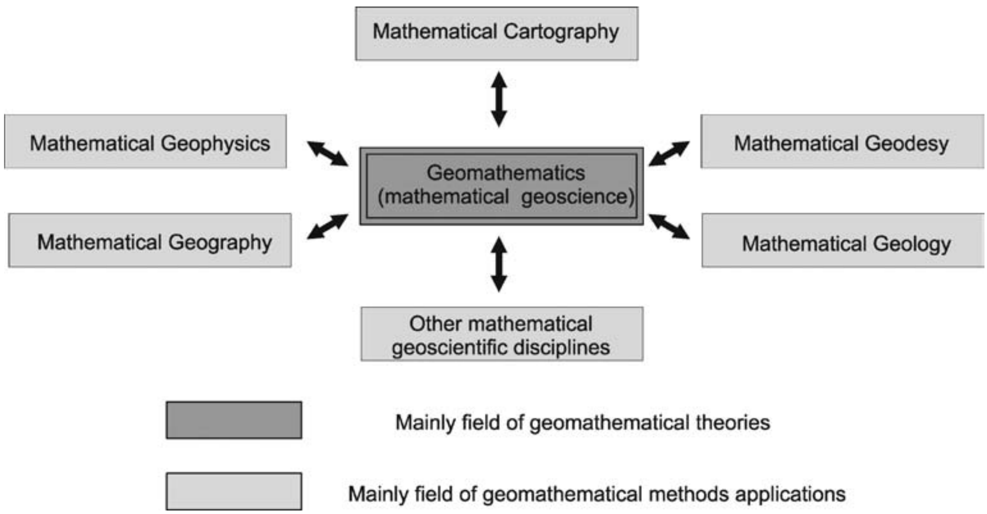


Figure 1. Relation between geomathematics and mathematical geodisciplines

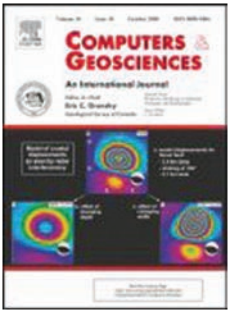
4. Geomathematics and Geomathematicians in Societies and Groups

Following subchapters present some societies involved with the application of geomathematical methods, their popularization, organization of thematic congresses and publishing. All of them can be found on the Internet easily. Most of them had influence on Croatian geomathematics.

4.1. International Association for Mathematical Geosciences

International Association for Mathematical Geosciences (IAMG) is a professional, multidisciplinary society with about 600 members from more than 40 countries. Its mission is to promote development in mathematics, statistics and informatics in geosciences in the world. In order to reach the goal, IAMG has following activities:

- Organizing meetings with brief seminars, field trips and other activities
- Publishing books and journals about application of mathematics in geology (emphasis on geology was significantly greater in the past, when the Society was mostly oriented toward geology)
- Cooperating with other professional societies involved with the application of mathematics and statistics in science and engineering.



IAMG was established at the 23rd International Geological Congress in Prague in 1968. Its first title was the International Association for Mathematical Geology. IAMG publishes a newsletter twice a year and organizes annual conferences. The society web site is http://www.iamg.org (URL 6). The next international IAMG conference is going to be held from August 29 to September 2, 2010 in the facilities of Eötvös Lóránd University in Budapest (URL 7). The Society publishes three international journals: "Mathematical Geosciences" (previously "Mathematical Geology"), "Computers & Geosciences" and "Natural Resources Research". All journals are cited in the Current Contents database.

It is interesting to analyse the Society's name. Translated to Croatian, the term "mathematical geosciences" is very interesting. What are mathematical geosciences?

4.2. Working Group for Geomathematics in Kaiserslautern, Germany

The Working Group for Geomathematics (in German "Die Arbeitsgruppe Geomathematik der Technischen Universität Kaiserslautern", abbr. "TU Kaiserslautern – AG Geomathematik") was established in response to many applications caused by the technological progress. It resulted in changes of observational and measurement methods in all areas of engineering in geosciences. Contemporary computers and satellite techniques have had an increasing significance in geosciences. Accuracy of observations is greater, which means processing requires appropriate mathematical models, approximation techniques, analytical and numerical methods. This gives greater significance to geomathematics, i.e. application of mathematics in geosciences. The work group for geomathematics set themselves a task of building a bridge between mathematical theories and geotechnical applications. Special emphasis was put on exchange of thoughts between mathematicians involved in mathematics applications and more interested in modelling, theory and approximations, i.e. numerical problems on one side and on the other, engineers more involved in measurement techniques, data processing methods and application of methods and software. Research of the work group is presented in Figure 2.

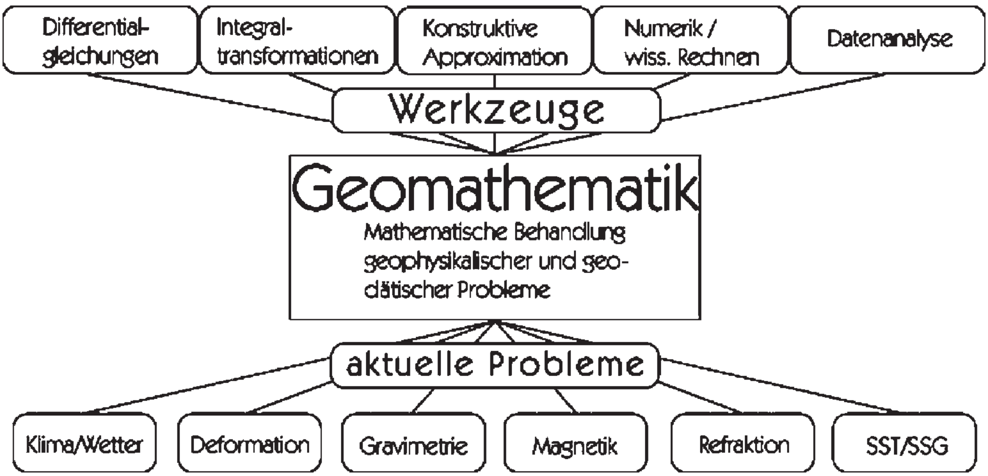


Figure 2. Schematic review of geomathematical tools and problems (taken from URL 7)

According to Figure 2, geomathematics encompasses mathematical approach to problems of geophysics and geodesy. The work group researches following areas in particular:

- Special function of mathematical physics
- Partial differential equations
- Constructive approximations
- Regularization of inversion problems
- Numerical method (development and application)
- Scientific computing

The Working Group for Geomathematics also organizes workshops at the University of Kaiserslautern. For example, a workshop in celebration of the 60th birthday of Prof. Dr. Willi Freeden was held from July 2 to 4, 2008. More information about the Group's activities can be found at URL 7.

4.3. Geomathematical Section of the Hungarian Geological Society

The Geomathematical Section of the Hungarian Geological Society has a long tradition and very strong international activities. Its membership is international, and one member of the Managing Board is from Croatia. Activities of the section, as well efforts of the Section's chairman, Prof. Dr. János Geiger initiated the establishment of the Croatian Geomathematical Section in 2007.

Probably greatest activities of the Hungarian Geomathematical Section are related to organization of congresses of Hungarian geomathematics traditionally held as activities of the Geological Department of the University of Szeged in the town of Mórahalom. The 13th congress of Hungarian geomathematics was already held in 2009, as well as the 2nd Croatian-Hungarian Geomathematical Congress.

Activities of the Society are the best illustrated with congress subjects, including: (1) applied geomathematics, geostatistics and integrated geoscience models, (2) geophysical applications, (3) theoretical approaches of geomathematics and geostatistics, (4) hydrological and hydrogeological applications, (5) environmental protection and nuclear waste disposal, (6) petrology, (7) meteorological, climatologic and landscape ecological models, (8) stratigraphical applications, basin analysis and correlation, (9) hydrocarbon geology and engineering, (10) GIS applications.

4.4. Geomathematical Section of the Croatian Geological Society

The Geomathematical Section was established within the Croatian Geological Society (CGS) in the 2007. This was institutionalization of activities stimulated by development of geomathematics within Croatian geology. In addition, it was a result of several years of cooperation with the Geomathematical Section of the Hungarian Geological Society. Geology was considered a dominantly natural science, and geomathematics can connect it to "the queen" of natural sciences – mathematics, making the geological view of the world and events in subsurface more exact (URL 8). It was the main incentive for geologists to establish the mentioned Section, who wished to practice mathematical methods in their work more. They also issued three books about geomathematics (two of them were published by the Section) and organized two Croatian-Hungarian geomathematical congresses in the town of Mórahalom in the south of Hungary.

The Geomathematical Section also gives two types of awards. One of them is the Annual Award (in the form of a diploma) for the best paper, thesis or book published by section member(s) in the last year. The second is the Section Medal, which is given for extraordinary achievement in Croatian geomathematics.

5. Geomathematical Publications

Geomathematical literature is very comprehensive if we count publications published in one of its disciplines such as geostatistics or neural networks. Publications with the word "geomathematics" in the title are less frequent, and here are publications more popular or read in Croatia.

5.1. International Journal on Geomathematics

The International Journal on Geomathematics (GEM) is published by Springer, ISSN 1869-2672 (printed version) and ISSN 1869-2680 (electronic version). Willi Freeden is the Editor-in-Chief. The journal presents papers related to mathematics applied in geoscience problems, i.e. field of geomathematics, which is becoming increasingly important. Two reasons can be outlined. The first is contemporary fast computers and satellite techniques, becoming increasingly incorporated into all geosciences. The second is the increasing public interest for the future of the Earth, its climate, environment and lack of natural resources. Efficient strategies for planet protection change the way new data are received from land masses, oceans, atmosphere and the Space. It also explains the need for new mathematical tools, methods and approaches. Generally, the GEM journal publishes mathematical papers about:

- Modelling of the Earth's system (geosphere, cryosphere, hydrosphere, atmosphere, biosphere),
- Analytical, algebraic and operator-theoretical methods and
- Calculation methods and numerical analysis necessary for mathematical processing of geoscience problems.

5.2. Journal of Hungarian Geomathematics

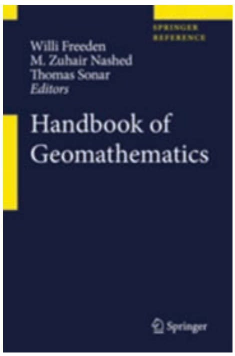
The Journal of Hungarian Geomathematics (abbr. JHG) is dedicated to gathering researchers in geosciences using geomathematical tools. JHG is available on the Internet with free access. The main idea is a journal with flexible and simple access and quick publishing possibilities.

The term "geosciences" is used in the broadest sense, including everything focused at Earth processes. According to this, published papers come from fields of geology, geophysics, geomorphology, hydrology, pedology, remote sensing and GIS. The term "geomathematics" suggested authors that only application of mathematics and/or geostatistics was expected. Prof. Dr. János Geiger was Editor-in-Chief (URL 10), and since 2009, the journal has been associated with another Hungarian journal named "Central European Geology" published by Akadémiai Kiadó, while it was known as "Acta Geologica Hungarica" before January 1, 2007. Papers in "Central European Geology" are published in English and bibliographic signs are ISSN 1788-2281 (printed version) and ISSN 1789-3348 (electronic version). Prof. Dr. János Haas is Editor-in-Chief.

5.3. Monograph "Progress in Geomathematics"

The monograph "Progress in Geomathematics" was published by Springer (Springer News, 2008), and it includes 28 papers dedicated to the 50th anniversary of publishing in geomathematics by Prof. Dr. Frits Agterberg. Prof. Agterberg published his first paper in 1958, and continuously works and publishes papers in a wide range of subjects particularly important to practitioners in geomathematics. He was the president of IAMG between 2004 and 2008. The following fields are included in the monograph: (1) spatial analysis in estimation of mineral ores, (2) quantitative stratigraphy, (3) non-linear multi-fractal models, (4) complex data analyses, (5) time-series analyses, (6) image analyses and (7) geostatistics.

5.4. "Handbook of Geomathematics"



The "Handbook of Geomathematics" was announced to be published in August 2010. It is edited by W. Freeden, M. Z. Nashed and Th. Sonar. The publication intends to fulfil emptiness in the area of basic literature in this field, putting together contemporary geomathematical knowledge and giving a review of concepts and theories, term definitions, biographical reminders and a general review of geomathematics.

The handbook was created as an answer to events from the last three decades, when geosciences were influenced by two important scenarios.

First, the technological progress completely changed techniques of observation and measurement. Contemporary, very fast computers and techniques based on satellite data are being increasingly incorporated. Second, public concern for the planet's future, climate, environment and expected lack of natural resources has increased. Obviously, both aspects ask for efficient strategies of protection against the Earth's changes. Also, obtaining better data from the Earth's land, oceans, atmosphere and the Space explains needs for new mathematical structures, tools and methods. Mathematics applied in geoscience problems, i.e. geomathematics, has become increasingly important. The "Handbook of Geomathematics" is going to be one of the central publications in that field and encompass 1000 pages in following chapters: (1) main techniques for observing and measurements, (2) modelling of the Earth system (geosphere, cryosphere, hydrosphere, atmosphere, biosphere), (3) analytical, algebraic and operator-theoretical methods, (4) statistical and stochastic methods, (5) methods of calculation and numerical analysis and (6) historical base and future perspectives. This book is intended for mathematicians and geoscientists (URL 11).

6. Geomathematics in the Teaching Process

Particular parts of geomathematics, e.g. geostatistics, are instructed in several faculties in Croatia, as well as abroad. Our intention is to give a brief review, so only subjects named exactly *Geomathematics* are mentioned.

The course GG/OCN 312 Geomathematics is registered (URL 12) at the University of Hawai'i at Manoa. In the autumn of 2009, the course included: introduction and review, regular differential equations, linear algebra and vector analysis. The goal was introduction of several mathematical subjects important in science and engineering with application to the Earth science and oceanography. Students were expected to have mathematical knowledge necessary for making scientific research in the areas of fluid dynamics, ecosystems, computer modelling, etc. In addition, the course included learning skills of numerical program packages such as Matlab(TM). The course is taught in 13 weeks, 3 hours per week.

The Faculty of Geodesy of the University of Zagreb has the course Geomathematics at the master level study. It is optional, i.e. a student can decide whether to enrol the course. The course includes: mathematics and GPS, networks, random variables and covariance's matrices, non-linear problems, linear algebra and least-square methods, problems with explicit solutions, GPS, data collection and GPS, Kalman filters. Students need to learn how to connect mathematical theory, geodesy and GPS. The entire course is presented in 15 weeks, including 2 hours of lectures and 2 hours of exercises per week.

The Department of Geography of the University of Zadar planned to start the course Geomathematics at the master study with the content: mathematical logic, probability, statistics, random variable, laws of distribution, planning of statistical research, collecting and processing statistical data, data distribution in classes and thematic cartography, frequency and relative frequency, arithmetic and other types of mean, standard deviation, review of statistical documentation, statistical information on the Internet, statistical software, statistical analysis of geospatial data, geostatistics, variogram, kriging, regularization of spatial variable applied to a digital relief model, analysis of trend, method of moving average, approximation with a polynomial, trigonometric functions and splines, correlation, regression analysis and linear regression. The course was planned to start in the academic year 2009/2010, but the educational plan was changed and it was not included in the graduate program of the Department for Geography any more.

7. Conclusion

Based on presented material, the following definition is proposed:

Geomathematics or mathematical geoscience is a (science) scientific discipline that connects mathematics and geosciences (Figure 3). It is the application of mathematics in geoscientific problems and development of mathematical methods appropriate for such applications and defining geoscientific theories. The scientific discipline studies the mathematical nature of events and processes on, in and around the Earth.

Maybe the statement that geomathematics is a geoscience can be unusual, but the fact is that geomathematics is not applied only by mathematicians, already mostly by geoscientists, i.e. professionals who do not use mathematics as the basic field of activities. Moreover, if geophysics and geochemistry can be separated as particular geosciences, the

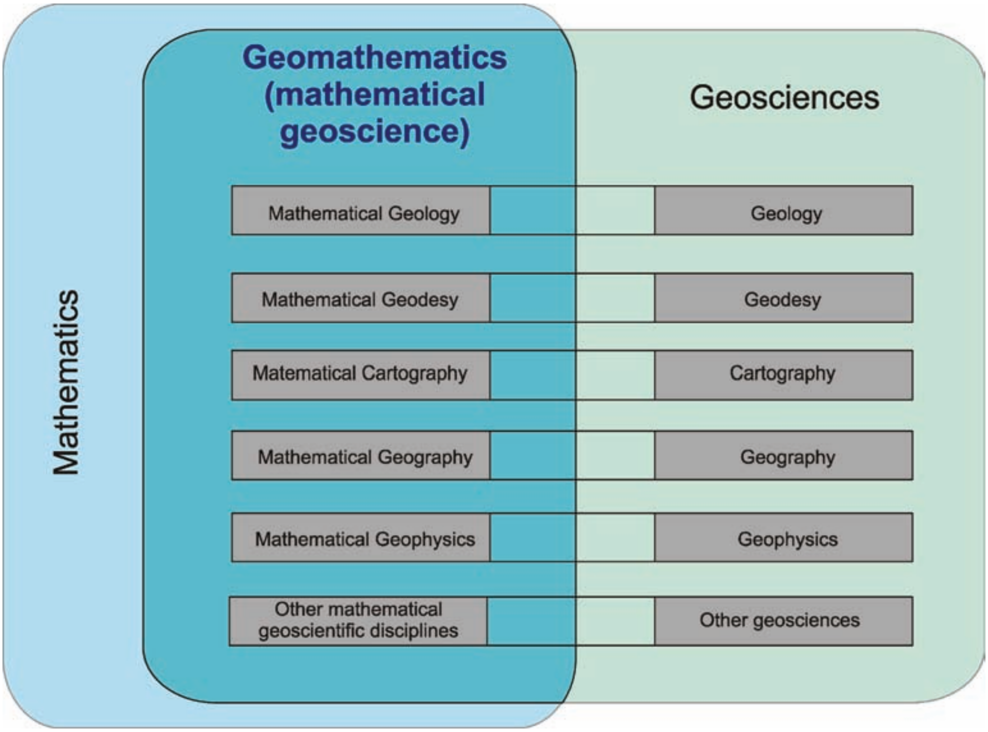


Figure 3. Relation between mathematics, geomathematics and geosciences

same rule can be also applied to geomathematics without a problem. It is probably not necessary to describe the fact that geomathematics is a part of mathematics. On the other side, mathematical geodesy, mathematical geology, mathematical cartography, mathematical geophysics, mathematical geography and other mathematical geosciences are a part of geomathematics. However, these disciplines emphasize the application of mathematical methods in geosciences, while geomathematics emphasizes application in addition to theoretical development of mathematical methods and techniques which can subsequently be applied in geosciences.

Finally, it bears repeating that geomathematics does not need to be connected only to geology or considered a synonym for mathematical geology. Many fields in mathematics are successfully applied in geosciences, e.g. geodesy, geophysics, oceanography, geography, geochemistry and others, making possible the acceptance of the term geomathematics in official classifications and nomenclatures.

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Note

A similar text in Croatian was submitted to the "Vijesti" of the Croatian Geological Society. It is going to be published in the June 2010 issue. This text is a partially different work, intended for a different type of journal and reader audience.

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Geostatistics as a Group of Methods for Advanced Mapping of Geological Variables in Hydrocarbon Reservoirs

Abstract

Geostatistics is a well-known and advanced mapping tool in geology of hydrocarbon reservoirs as well as in geosciences in general. It offers a lot of different methods and techniques for mapping of all geological variables that could define a subsurface volume with oil and gas reserves. These variables can be obtained from all types of measurements in petroleum industry, like seismic, well cores or well logs. In the last decade, many reservoirs of different lithologies (clastics, carbonate, metamorphic) had been mapped by kriging and cokriging (as deterministic methods) as well as by Sequential Gaussian Simulations (as a stochastic method) in the Croatian part of the Pannonian Basin System. The results gave more detailed insight in reservoir space, i.e. more precisely outlined petrophysical parameters of reservoirs, the role of faults and the borders of the field structures. It emphasised the recommendation for using geostatistics in reservoir analysis, especially in the development phase when more data are available, for all types of lithologies, but especially in sandstone and breccia-conglomerate reservoirs with dominant primary porosity. This set of mapping methods can be considered as an advanced mapping tool.

Key words: hydrocarbon reservoirs, geostatistics, kriging, stochastic simulations

1. Short Review of Geostatistics Hystory

In the world petroleum companies and in most of prominent universities with chairs for oil and gas, geostatistics is a standard tool implemented in hydrocarbon reservoir characterisation, i.e. for estimation and mapping of geological variables in the subsurface. Most geostatisticians use the basic division of geostatistical methods into the three groups: (a) methods for spatial analysis (with variogram as the most often such method), (b) interpolation methods (kriging and cokriging) and (c) stochastic simulations (conditional and unconditional, and sequential and indicator). Moreover, contemporary terminology distinguishes the terms “method” and “technique”, e.g. kriging is a method, but Simple Kriging is a technique. Also, the word “tool” often can be used as a synonym for method, stressing the fact that each geostatistical method is also an *engineering tool* for mapping.

Historically, the term “geostatistics” had been established by Prof. Georges Mathéron and his colleagues from the high school in Fontainebleau, France, describing methods developed for estimations of gold concentration in mines, and later for other ores. Such idea had been developed mostly independently from dominant works and papers in the field of *spatial statistics* in that time, using own, original terminology and style. Mathéron published the first results of his research in the doctoral thesis and several papers from the 1960s (Mathéron, 1962, 1963, 1965). These works are still considered as the milestones in geostatistics and are often cited. It was the first time that kriging was described as a mathematical method, which is still considered as the best tool for deterministic estimation of a variable in space. As it was mentioned, kriging (then still an unnamed method) had first been applied in mapping of gold ore in South African mines, for the problem of ore dispersed in nuggets. It had been done by Krige (1951), and in his honour the method had been called “kriging”. Mathéron was the first who showed kriging theory as an equivalent of the least squares method applied to a linear Gaussian model, which was later well explained in many books like Journel & Huijbregts (1978), because Journel was a Mathéron student and later the founder of geostatistics at Stanford University. Somewhat earlier, Davis & Sampson (1973) published one of the most famous works in the field of application of statistics and data analysis in geology. Authors presented most of statistical tools that geologists usually use, describing not only advanced analytical methods like multivariate analysis or time-series analysis, but also geostatistical tools like kriging. Furthermore, Brian Ripley in his first book about geostatistics (Ripley, 1981) explicitly showed a connection between the least squares method and the linear Gaussian model. Years later, Noël Cressie (Cressie, 1991) described geostatistics as one of the three main fields of spatial statistics. Other two are discrete spatial variation and spatial point processes. Here we also need to mention first geostatistical books in Croatia, as well as the first dissertation on the theory and application of variogram analysis in Croatian hydrocarbon reservoirs. In 2003 (Malvić, 2003) published his PhD thesis presenting one-dimensional variogram analysis of porosity and permeability data from cores taken from the sandstone reservoirs of Miocene age in the Bjelovar Subdepression.

It was followed by Andričević et al. (2007), which published a book at the Faculty of Civil Engineering and Architecture in Split titled "Geostatistics: skill of spatial analysis". They described the history of geostatistics as well as deterministic and stochastic modelling methods. The book includes a lot of nice examples, mostly calculated and interpolated from different measured data of parameters mostly for underground waters and aquifers. Very soon, it was followed by the book (Malvić, 2008) "Application of geostatistics in geological data analysis" where author gave reviews of the most often applied geostatistical theory in the analysis of oil and gas reservoirs as well as many examples. They included variograms, maps interpolated by kriging and cokriging methods and Sequential Gaussian Simulations. Results are given for different reservoir lithologies in the Croatian part of the Pannonian Basin System.

2. Geostatistics in Hydrocarbon Reservoir Characterisation

The beginning of the use of (geo)statistics is linked to the period of 'contemporary reservoir characterisation', which started in the early 1980s. Moreover, use of geostatistics and statistics in the exploration and development of hydrocarbon reservoirs is closely connected, which is normal because geostatistics is based on some basic statistical values and procedures of application of statistics in data processing for exploration and production of hydrocarbons (e.g. Jensen et al., 2000).

The need for new and improved characterisation methods arose as a result of very simplified figures of subsurface used in petroleum industry. It is very strange, because the field of hydrocarbon exploration and production attracted the high-level experts and huge financial funds. Disadvantages had been especially noticeable in describing reservoir characteristics in inter-well area. There interpolated values often were not confirmed, in acceptable ranges, with new wells, injected chemical fluids or water rose in unexpected locations or too early, and recovery was often less than expected. It is why geologists and petroleum engineers started to study some other scientific disciplines, primarily geostatistics and statistics, as tools for models improving, introducing uncertainties that could be described.

Furthermore, natural laws are mostly described purely deterministically, but then there exist huge limitations in their application in subsurface conditions, because engineer knowledge about reservoirs includes more or less unknown variables with stochastic properties. It is especially valid for clastic rocks as lithologies with the majority of reservoirs. Clastic sedimentation is the result of numerous processes that lasted for long periods and are responsible for the texture and structure of reservoir sediments (e.g. granulometry and sorting of clastics) as well as petrophysical properties. It was just this complexity of natural processes and their results in subsurface that pointed out geostatistics and statistics as disciplines that ‘make order’ in different measurements and datasets. Eventually such approach led to rules and regularities expressed through the values of variance, mean value, variograms etc. Using geostatistics, geological model can be upgraded in a detailed object-based model, describing reservoir architecture and/or distribution of reservoir variables. In fact, reservoir geostatistics had been developed in three directions, depending on the school and the country where it was studied. The first emphasised the importance of object modelling for describing reservoir facies, and the main work had been done in Norway. American school (Stanford) mainly worked at the development and application of different techniques of indicator and sequential simulations. The third initiative came from French Institute for Petroleum, abbr. IFP-a (in French *Institut français du pétrole*), where methods based on truncated random functions had been used. Through decades all three approaches have evolved to have very much in common, often representing alternatives for the same input dataset (from seismic, cores, logs, indicator transformed measurements etc.), with mutual goal, i.e. defining 3D geological model of a heterogeneous reservoir. Regarding modelling, two large, partially different, phases can be distinguished – exploration and developing. They are different by number, kind and quality of data, and consequently the way of using geostatistics.

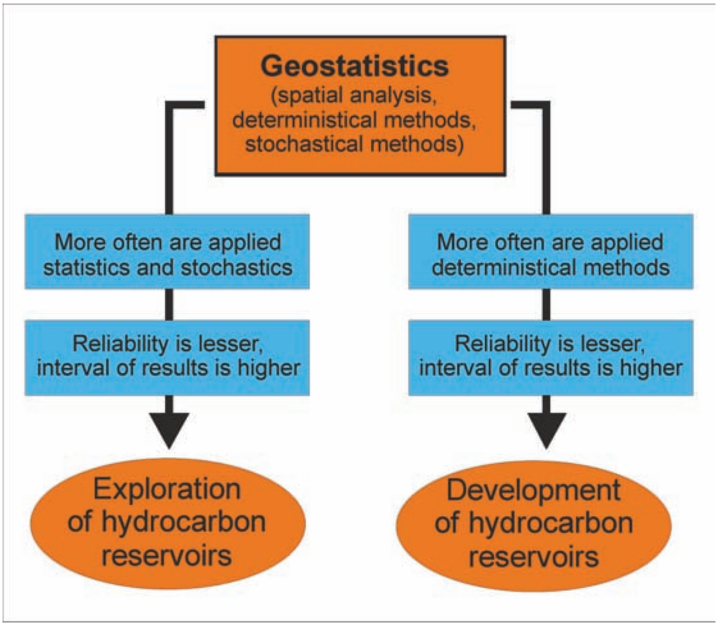

Figure 1. Use of geostatistics regarding the phases of exploration and development of hydrocarbon reservoirs

Figure 1 outlines two categories for reservoir variable prediction – determinism and stochastics. Any system is deterministic if for the same input it always gives the same output. For example, the porosity map interpolated for the same input dataset, using the same interpolation method, always results in the equal map. On the contrary, a completely random system would for the same input always give a different output. But creation of such geological model is completely meaningless, because there is no parameter for prediction. Stochastic system is a so called hybrid model somewhere between determinism and randomness, because in one part including uncertainties of reservoir variables, but also enough data for useful model creation. Stochastic models are very applicable in reservoir characterisation, also showing areas with higher or lesser uncertainties in reservoir prediction. Using such approach reservoirs can be classified into three categories (after Jensen et al., 2000):

1. Completely *deterministic reservoirs* where inter-well area is ambiguously determined, correlated in details, with well-known structural framework and lithologies. Such reservoirs are very rare and represented by small structures or mature fields at the end of production with large number of wells and there is no need for new drilling (or only control wells). Also, several sequential geological models are modelled and the last and most reliable one is set as the geological framework of the field.

2. *Stochastical reservoirs* are those where there are some uncertainties in our knowledge about the geological variables, but generally geological framework is well known and correlated. However, there are still some unknowns, especially in the inter-well area. Majority of reservoirs is just of such kind, and they are the main target for application of geostatistics.

3. *Reservoirs of mostly unpredictable parameters* are generally rare. Some prospects with assumed hydrocarbon reservoirs can be classified into this group. Such reservoirs are geologically modelled in the exploration phase when the field area includes few or no wells. This category also includes *possible reserves* described in regional studies, or reserves of P10 probability. Unfortunately, in such cases geostatistics, and even statistics, can not be applied due to lack of analytical data. Analogy is the most often used modelling method.

The critical moment in modelling of any reservoir is defining a typical reservoir, as a base for production prognosis with several scenarios. The reservoirs that are longer in production can be an easier target for revision or improving of the geological model. Deterministic modelling methods are more easily interpretable than stochastic, because theoretically results do not include uncertainties. But in reality, just a few geological variables are really deterministic. Sometimes these properties can be added for "classical" variables like porosity and reservoir thickness, with large number of data (wells), and can be considered as deterministic, i.e. variables appropriate for deterministic estimation (like regression, kriging etc.). If a secondary variable like seismic data is also available, deterministic estimation of the primary variable is even easier with another set of methods (like Kriging with External Drift, cokriging etc.). It is especially useful in the development phase when accuracy of the model at the small scale is particularly important.

But, most often the number of input data or the type of a variable favours application of stochastics, i.e. involving some kind of uncertainties in the model, defining ranges for variable values. Also, pure measurements can be weighted by systematic errors due to resolution of measuring tools or influence of surrounding rocks. It means that the analysis of observable uncertainties favours the use of geostatistical mapping methods.

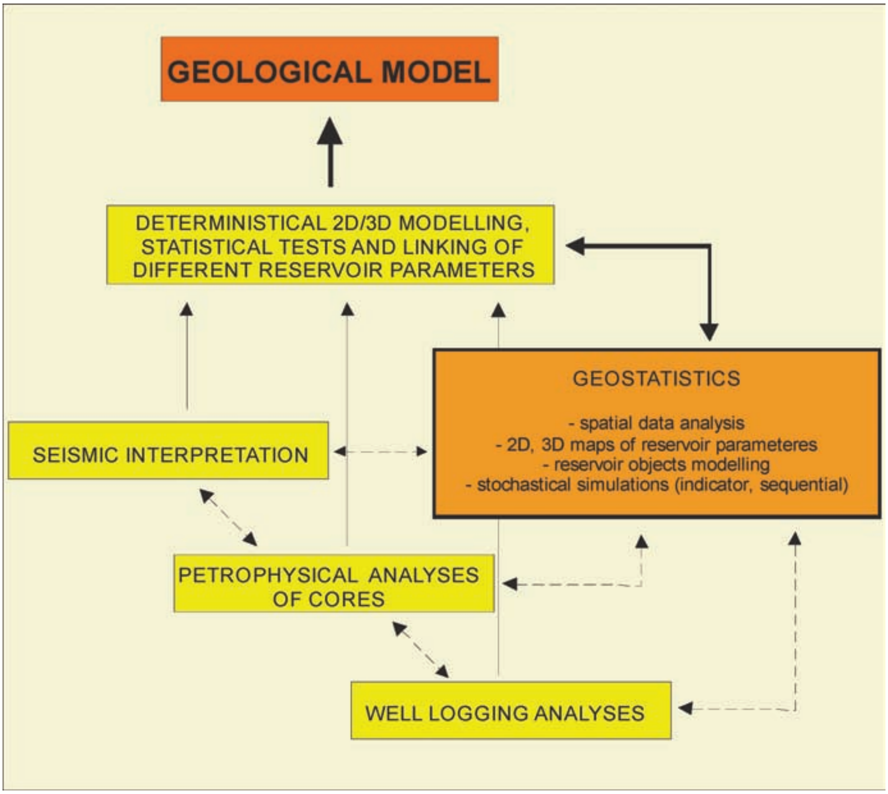

Figure 2: Application of geostatistics in different phases of geological model creation

Geostatistics has many desirable properties for the creation and improving of geological models in most hydrocarbon reservoirs. It is an extremely flexible tool, simple for using with different computer packages, which can be applied in the phases of exploration and development of reservoirs. It also gives some degree of quantification in reservoir geology, which is extremely important when geological models are input for calculation of hydrocarbon reserves of all kinds (proved, probable and possible). Eventually, a quantified geological model with geological variables expressed mostly numerically is a very good basis for dynamic reservoir models created by petroleum engineers, as a base for production prognosis.

3. Basic Geostatistical Methods (Tools)

There are many geostatistical methods, and even more techniques, for different purposes of mapping of hydrocarbon reservoirs. Many of them are used in very specific tasks, when some particular geological variables need to be outlined in reservoir space. Also, each of these methods includes more or less uncertainties in modelling, minimizing them as the number of data increases.

3.1. Variogram

This is the basic method for spatial analysis, often called semivariogram (because function can be displayed as '2γ' or 'γ'). Variogram summarizes all differences between estimation and measured points inside searching ellipsoid (1).

$$2\gamma(h) = \frac{1}{N(h)} \cdot \sum_{n=1}^{N(h)} [z(u_n) - z(u_n + h)]^2 \qquad (1)$$

Where:

$N(h)$ – number of data pairs compared at distance 'h'
$z(u_n)$ – values at location 'u_n'
$z(u_n + h)$ – values at location '$u_n + h$'

The first result of variogram analysis is an experimental variogram curve where five variables can be read: nugget (C_0), sill or variance (C), range (a), distance (h) and lag. Also, a variogram is characterised by several properties. Anisotropy is the most important and describes changes in the above-mentioned variables due to the variogram direction. Anisotropy in reservoirs is most often the result of the direction of structure and changes in reservoir lithology and stratigraphy. Eventually, variograms in anisotropic (heterogeneous) reservoirs are defined by two axes, i.e. axis of maximum continuity and of minimum continuity.

Moreover, if reservoir variograms have the same sill and different range it is geometric anisotropy. But if both variables change values with direction it is zonal anisotropy which is harder for modelling. The so called outliners, or extreme values have the greatest influence on the variogram curve. Sometimes, they can be removed from dataset if they represent untypical and rare measurements.

Almost all experimental models can be mathematically extrapolated by five theoretical models: spherical, exponential, Gaussian, linear and logarithmic (Hohn, 1988). The first three models are most often used for interpretation of geological variables, and, on the other hand, models without sill are very rare.

Approximation of experimental curves can be done by making also a complex model that is a summation of two or more theoretical models with different ranges and sills. It is *nested model* (2).

$$\gamma(h) = \gamma_1(h) + \gamma_2(h) + \gamma_3(h) + \dots \tag{2}$$

Variogram analysis is not limited by the scale of data sampling. It means that an experimental variogram can be calculated for, e.g. porosity values, averaged for wells distances in kilometres, but also for data on distances in meters or centimetres.

3.2. Kriging and cokriging

Kriging (and all extrapolated methods – cokriging and stochastic simulations) is considered as a statistical method for estimation. All techniques, except of Simple Kriging, are defined as *best linear unbiased estimators* (acronym BLUE). *Best* means that weighting coefficient calculated for each point included in estimation is calculated in the process of minimizing kriging variance. *Linear* means that estimation is done by linear combination of hard data. *Unbiased* indicates that the expectation of estimation is equal to the true expectation of the entire (possible) population. *Estimator* is a term for methodology.

Linearity of estimation makes all calculation significantly simpler (3). The values of a regionalized variable at a selected location (Z_k) are estimated based on surrounding hard-data (Z_i) to which the relevant weighting coefficient (λ_i) is added. Also, estimation assumes that Z_i values have normal (Gaussian) distribution, using the assumption of the Central Limit Theorem, i.e. distribution of a variable with assumed large number of measurements (without regarding probability distribution function of such events).

$$Z_k = \sum_{i=1}^{n} \lambda_i \cdot Z_i \tag{3}$$

Weighting coefficients are calculated from the system of kriging linear equations (e.g. Journel & Huijbregts, 1978; Hohn, 1988; Liebhold et al., 1993 etc.). Kriging very well interpolated data grouped in clusters also allows that some coefficients are negative. Moreover, it is a method where values of weighting coefficients depend only on distances among control points (hard-data), not on their values, what emphasises kriging as a 'spatial' estimator based on the so called 'statistical distances', i.e. autocorrelation of a mapped variable.

There are many kriging techniques developed for different purposes and variables in geology and geosciences in general. Those are *Simple Kriging*, *Ordinary Kriging* (Figure 3), *Indicator Kriging*, *Universal Kriging*, *Disjunctive Kriging* etc. The first two techniques are the most applied techniques in the mapping of hydrocarbon reservoirs.

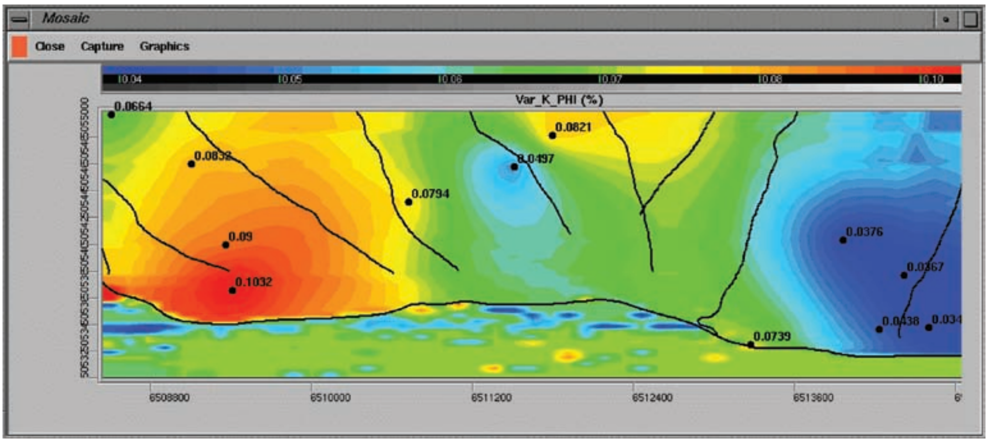

Figure 3: Porosity map interpolated by Ordinary Kriging in a clastic (breccia) oil reservoir. The age is Badenian and location is the eastern part of the Drava Depression. The porosity scale is in colour (blue is 4%, red is 10%).

Cokriging, like kriging, comprises similar techniques (Simple Cokriging, Ordinary Cokriging etc.). The necessary condition is introduction of a secondary variable that is: (a) in logical physical connection with the primary variable, (b) much dense sampled, (c) significantly correlated by the primary variable.

Special variant of cokriging is the so called Collocated Cokriging, where for each point there is the right equal number of the primary and secondary variable data. Then estimation is based on calculation of two sets of equal (in size) matrix equations. But, generally cokriging estimation can be shown as (4):

$$z_C = \sum_{i=1}^{n} \lambda_i \cdot z_i + \sum_{j=1}^{m} \chi_j \cdot s_j \tag{4}$$

Where:

$\sum_{i=1}^{n} \lambda_i \cdot z_i$ – identical to kriging equation

$\sum_{j=1}^{m} \chi_j \cdot s_j$ – identical to kriging matrices, but applied for secondary variable

3.3. Stochastic simulations

Stochastic simulations are a special set of geostatistical methods, serving a different purpose than interpolation methods. Sequential Gaussian Simulation (e.g. in Dubrule, 1998; Isaaks & Srivastava, 1989 and Kelkar & Perez, 2002) is one of the most used modelling tools in hydrocarbon reservoir modelling, which can be applied to reservoir data with normal distribution, originally or after transformation. Such data have known expectance and standard deviation (μ,σ^2).

In simulation, existing measurements (well hard-data) keep constant values in each realization, and this kind of simulation is called *conditional simulation*. Another type is *unconditional simulation* where also input hard-data can be changed in each realization. But, each type of simulation uses variogram and kriging as necessary inputs, where kriging is called *zero-realization* that is deterministic and gives information about (a) average value (expectance) for data (μ), (b) kriging variance (σ_K), (c) ranges for simulated values, most often as $\pm 3\sigma$ around μ, covering 99% of all possible results.

In all other 'empty' cells values are simulated; very often using Sequential Gaussian Simulation method. This procedure requires that data have properties of normal distribution originally or after transformation. Estimation is done in all 'empty' cells selected in random order (1st introduction of randomness). The value is estimated by kriging or cokriging from spatial ellipsoid, taking also into account earlier simulated values that could be in such ellipsoid. Each such point also has a defined uncertainty interval Ǐ3σ, where variance (σ) is calculated in zero-realization. Then any values from this interval could be selected as the final value (2nd introduction of randomness). When it is repeated for all cells on the map one realization is finished. Entire simulation includes so many realizations as it is defined in the calculation, and there are different methods how to select one or several which are the most appropriate for the geological model (Figure 4). Very often, the number of realizations done is 100, due to the statistical rule that such set comprises 95% of all possible realizations. But, selection of several realizations is again often done using statistics, selecting e.g. realization P10 (90% of all realizations have higher values of all summed cells for the mapped variable), P50 (50% realization is higher) or P90 (10% realization is higher).

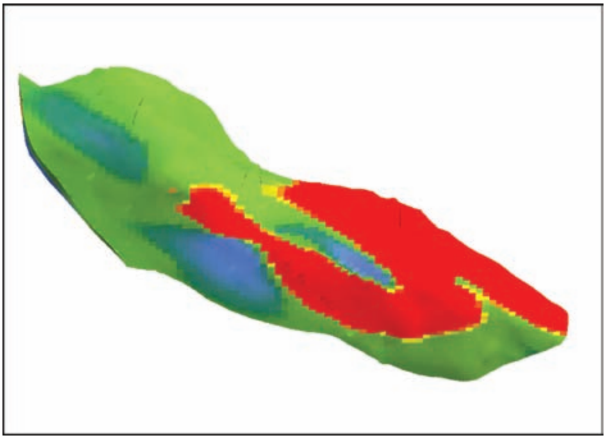

Figure 4: Porosity P50 realization estimated by Sequential Gaussian Simulations in a clastic (breccia) gas reservoir. The age is Badenian and location is the western part of the Drava Depression. The porosity scale is in colour (red is close to 0%, green to 2.5% and blue to 5%).

4. Conclusion

Geostatistics is one of standard geological tools that is applied in the exploration and development of hydrocarbon reservoirs. It is a part of applied statistics, which allows introducing mathematical exactness in geological maps and easier interpretation. There are also some other interpolation methods that are, with geostatistical ones, most often used in geological mapping of hydrocarbon reservoirs. Those are methods of linear regression, inverse distance weighting and, of course, previously mentioned kriging, cokriging and simulations.

Linearity is in the base of regression as well as of kriging. In simple linear regression equation $Y=bx+c$ the parameter 'c' is the value of intersection at axis Y, and 'b' is slope of line. Moreover, regression is a method for point estimation (not spatial) because all hard-data have the same importance (they are not weighted according to spatial location). It means that estimation is strictly linear, which means that estimated values at one margin (of map or regression line) are underestimated and at another overestimated.

In kriging and cokriging the parameter 'b' from regression equation is changed by kriging matrices (of variograms or covariances) where distances from control points (hard-data) to estimated cell are counted. In this way, geostatistical methods are unbiased for data clustering, and, in addition, varying of weighting coefficient can minimize estimation variance. Geostatistical simulations are based on geostatistical deterministic method, but also incorporate uncertainties linked with each estimated cell. Uncertainties are always connected with the number of data from which we assume true behaviour and statistical parameters for theoretical (infinity) population. These properties make possible that one simulation contains many possible and mathematically equally probable realizations, which is a unique mapping property of this set of simulations.

Disadvantages of geomathematical methods (as mathematically advanced tools) are mostly connected with lack of data, due to the fact that all datasets need to be approximated with normal distribution and some statistical properties. It is almost a rule that in datasets smaller than 10 values geostatistics use is not recommended. Firstly, experimental variograms then can be modelled only with extremely numerous assumptions, and deterministic maps are characterised with 'bull-eyes' effect in almost the entire area. It is why 20 hard-data is considered as some kind of minimum for mapping of geological variables of hydrocarbon reservoirs in the Croatian part of the Pannonian Basin System. In strongly anisotropic reservoirs this limit can be even higher (25-30 hard-data). However, if some reliable, strongly correlated secondary variable like seismic attributes is available, this number can also be decreased to 15 values. In any case, each geostatistical results can be validated visually compared with geological maps interpolated with other types of methods or with numerical results of cross-validation.

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Physical Planning Information System of the Republic of Croatia and National Spatial Data Infrastructure (NSDI)

Abstract

The preconditions necessary for the development of the Physical Plan Geoinformation System (GIS) as an important part of a more complex Physical Planning Information System of Croatia were created in 1998 with the adoption of the Physical Planning Act and the Ordinance on the Content, Scales of Cartographic Presentations, Mandatory Spatial Indicators and Standards of Physical Plan Studies. These regulations have obliged physical plan purchasers and suppliers to develop the plans in digital format through GIS computer program packages. This is how, in terms of both technology and content, the process of developing a completely new generation of physical planning documents started from regional to local and urban levels. On the basis of thus created digital physical planning documentation, in 2004 the Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC) started developing the GIS of physical plans of Adriatic Croatia. This system contains, among other parts, the adopted physical and urban development plans, mapping and other data sets, photo documentation, statistical data, etc. Since 2008, MEPPPC has also been developing the GIS of physical plans of Pannonian Croatia with a content structure similar to that of the GIS of Adriatic Croatia. Both systems are based on a single database of geopositioned spatial, planning and statistical data, which are going to become essential components of the GIS of physical plans of the Republic of Croatia during the course of 2010. The new Physical Planning and Building Act (2007) defines in detail the Physical Planning Information System of Croatia (PPIS). The development, maintenance and management of the PPIS from the national level to levels of counties and local self-government units, i.e., cities/municipalities, is conducted according to the PPIS Development Programme proposed by MEPPPC and passed by the Government of the Republic of Croatia. Through continuous development of the PPIS of the Republic of Croatia, MEPPPC is going to create a high quality base of physical-planning georeferenced data with which it is going to be significantly involved in the exchange, access and use of spatial data among numerous entities of the National Spatial Data Infrastructure (NSDI) in the Republic of Croatia.

Key words: physical plan GIS, physical planning information system, physical planning documents, Adriatic and Pannonian Croatia, physical-planning data

In the Republic of Croatia, the crucial moment when the necessary preconditions were created for the development of the Physical Planning Geoinformation System as an important part of a more complex Physical Planning Information System was the passing of the Physical Planning Act (NN no. 30/1994, 68/1998) and Rules and Regulations on the Contents, Mapping Scales, Compulsory Spatial Indicators and Physical Plan Report Standards (NN no. 106/1998). These regulations have obliged the physical plan purchasers and suppliers to develop plans in digital format through GIS computer program packages.

Physical planning is a system which includes:

- Monitoring the situation and processes in space (reports)
- Preparation of physical planning document development (plans)
- Physical planning document development (plans)
- Implementation of physical plans (location permit)
- Supervision (inspections)

Box 1. Physical planning system

This is how the process of developing a completely new generation of physical planning documents started (technologically and content-wise) more than ten years ago, from regional to local and urban level. More than 1600 documents have been produced so far. 21 Physical Plans of Counties have been passed, many of which have already been amended several times.

About 550 Physical Plans of Development (PPD) for Local Governmental Units (LGU) like cities and municipalities were produced (for almost all LGU; many of them were amended several times), development or passing of Physical Plans for the Areas with Special Features (for 8 National Parks and 11 Parks of Nature) is underway. Several hundreds of all types of Urban Plans were developed (General Urban Plans, Urban Plans of Development and Detailed Plans of Development) in cities and larger settlements.

On the basis of thus created digital spatial plan documentation of the Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC), in 2004 the development of GIS of the Adriatic Croatia Physical Plans started in cooperation with the Adriatic County Institutes for Physical Planning and the geoinformation company GISDATA Ltd. Zagreb. The area of Adriatic Croatia made up of 7 Adriatic Counties was selected, because it is undoubtedly the most valuable potential of the Republic of Croatia (particularly the protected coastal area of the sea). This is already the most interesting entrepreneurial and construction area in the country, and will continue to be so in the upcoming decades. The value of this area will particularly grow after Croatia joins the European Union. A large part of spatial data and information in the stated GIS is crucial for an efficient and accountable management of this valuable area, and its basic purpose was to create a high-quality database for the development of the Physical Plan of Areas with Special Features for the Croatian Adriatic.

System of physical planning documents

Strategic documents:

1. Physical planning documents at the national level are the following:
   - 1.1. **Physical development strategy of the** Republic of Croatia
   - 1.2. **Physical planning program of the** Republic of Croatia
   - 1.3. **Physical plans of areas with specific features** (national parks, parks of nature and other specified by the Strategy)
2. Physical planning documents at the **regional** level are the following:
   - 2.1. **Physical plan of the County** and the City of Zagreb
   - 2.2. **Physical plan of areas with specific features** (specified by PPC)
3. Physical planning documents at the **local** level are the following:
   - 3.1. **Physical plan of** LGU (large city, town or municipality)

Implementation documents:

- 3.2. **Urban plan** of development
- 3.3. **Detailed plan** of development

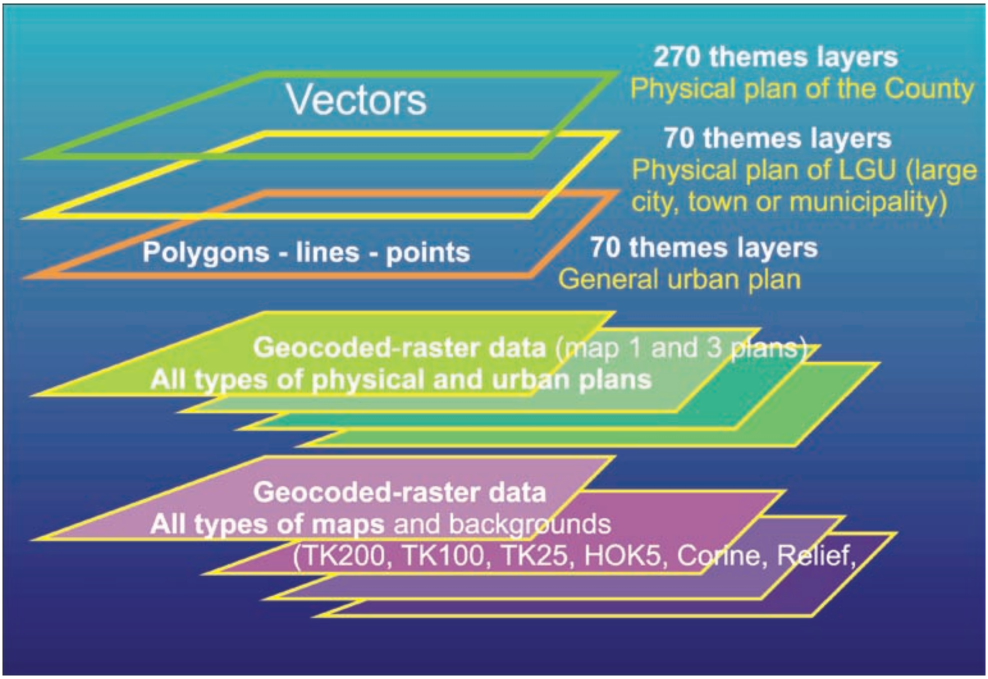
Box 2. System of physical planning documents (NN 2007, 2009)

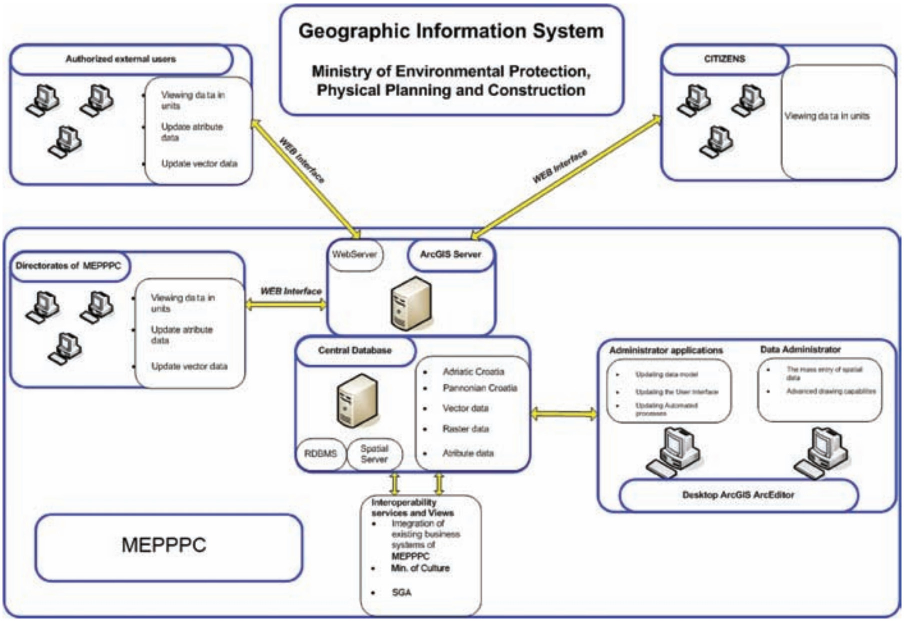
GIS of the Adriatic Croatia Physical Plans (ACPP) has been established gradually during the 2004 – 2009 period, therefore the content system structure has mostly been completed. Via a specially designed user interface, the system is internally available to MEPPPC employees who use it on a daily basis. ACPP GIS has particularly improved the work of three structural units so far: Administration for Physical Planning, Administration for Inspection Works and Institute for Physical Planning. The following planning documentation is incorporated in ACPP GIS: database on physical plans, county physical plans, development physical plans of LGU (cities and municipalities), physical plans of national parks and parks of nature, urban plans of development (and GUPs) of larger cities, mapping and other data sets, photo documentation, census statistics, apartment statistics, etc. By 2010, the system will be available to a number of other users (ministries, public and scientific institutions and public companies).

GIS Spatial plans Adriatic Croatia (GIS Spatial plans Panonian Croatia – local community spatial plans)
Module 1: **General information on Spatial plans of GIS**
Spatial plans decision process
Spatial plans GIS make over
Spatial plans integrated
Module 2: **Counties spatial plans**
Vectors – selected topics (about 110)
Map 1 – Land use; Map 2 – Infrastructure; Map 3 – Protection
Raster – geopositioned
Map 1 – Land use; Map 3 – Protection
Spatial plans integrated – text and maps
Module 3: **Local community spatial plans** (town/municipality)
Vectors – selected topics (about 110)
Map 1 – Land use; Map 2 – Infrastructure; Map 3 – Protection
Raster – geopositioned
Map 1 – Land use; Map 3 – Protection
Spatial plans integrated – text and maps
Module 4: **Spatial plans for areas with special features** (national parks, nature parks)
Raster – geopositioned
Spatial plans integrated – text and maps
Module 5: **Urban plans** (general urban plan, urban development plan of larger settlements)
Raster – geopositioned
Spatial plans integrated – text and maps

Module 6: **Spatial layout – vectors**
Administrative and territorial constitution
ZOP – Protected coast area sea
Maps and undercoat
Roads
Module 7: **Maps and backgrounds – raster** geopositioned
Maps – TK200, TK100, TK25-new, and TK25-old, HOK5
Digital orthophoto
CORINE – Land cover (using) 2000 and 2006 years
Digital relief model (altitude zones)
Satellite images
Module 8: **Population census 2001 and statistical data**
Population (information-indicators)
Dwellings (information-indicators)
Tourism (information-indicators)
Module 9: **Multimedia** – raster, pictures, tables, etc.
Aerophotogrammetry images
Spatial statistical of physical plans (table)
Construction area of larger settlements from PPD LUG
Tourist zones – in Physical plan of the County (study)
Exploitation coast area in old Physical plans (1980-1990. year)
Project – Brijuni Riviera
Exploitation stones in Physical plans
Internet links – MEPPPC and Counties Institutes for Spatial Planning

Box 3. The content structure of the GIS physical plans (ZPP 2004-2009)


270 themes layers
Physical plan of the County
Vectors
70 themes layers
Physical plan of LGU (large city, town or municipality)
Polygons - lines - points
70 themes layers
General urban plan
Geocoded-raster data (map 1 and 3 plans)
All types of physical and urban plans
Geocoded-raster data
All types of maps and backgrounds
(TK200, TK100, TK25, HOK5, Corine, Relief,



Scheme 2. Organisational scheme of current GIS of Croatian Physical Plans

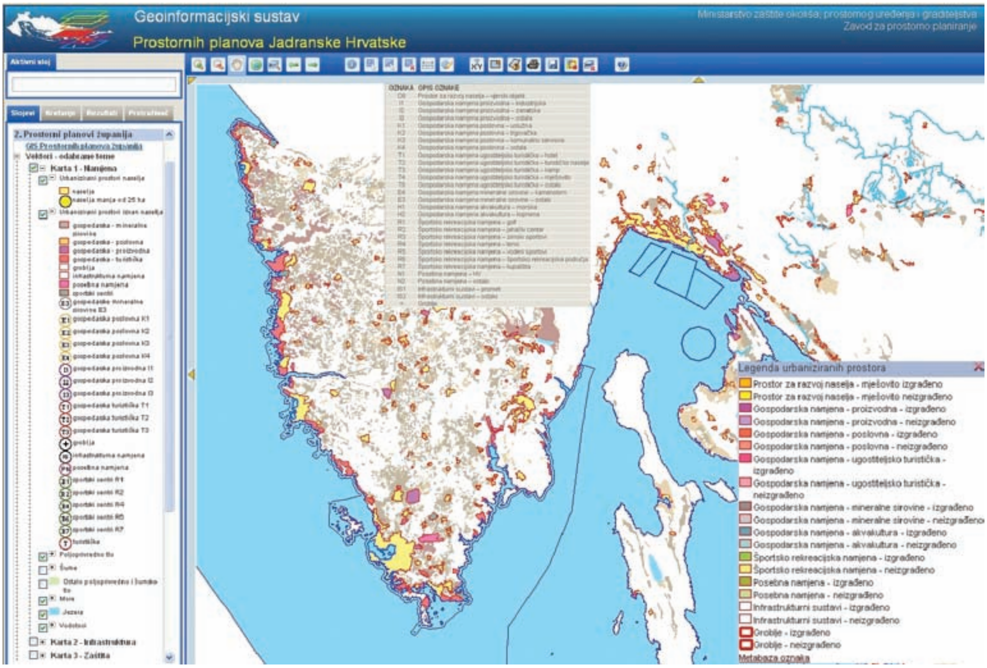


Figure 1. Urban and cultural areas in the Physical Plans of Development for LGU Cities and Municipalities

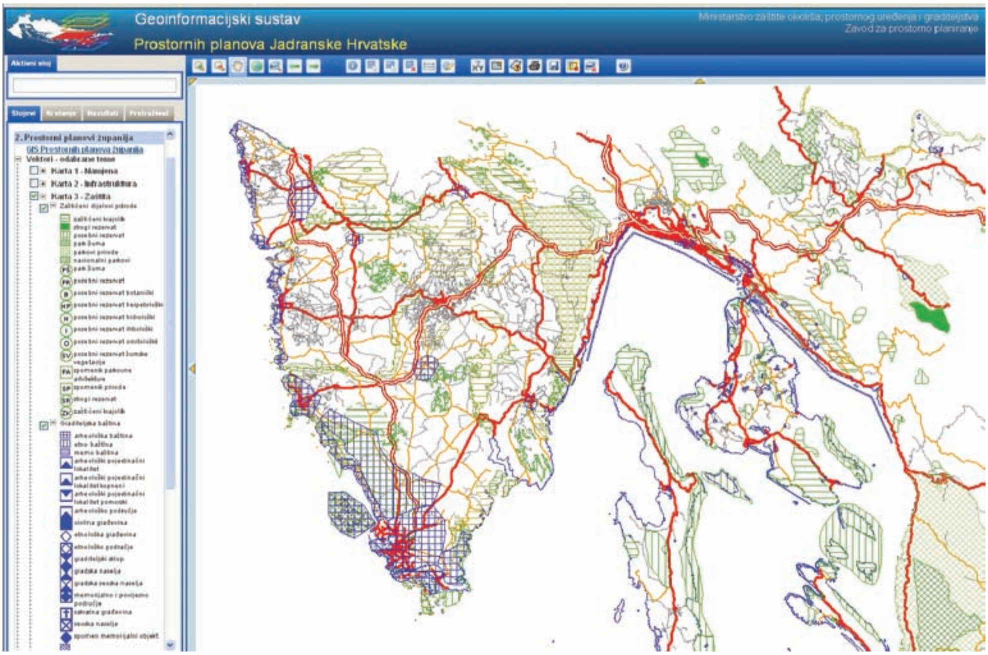


Figure 2. Natural and Architectural Heritage from the Physical Plans of Counties

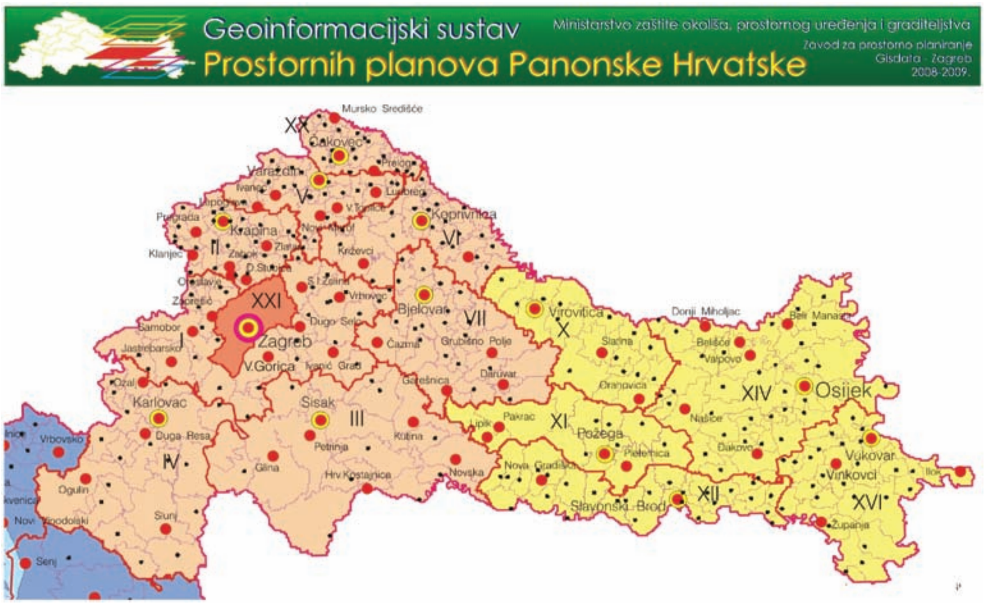


Figure 3. Geoinformation system of the Pannonian Croatia Physical Plans
(integral element of the Physical Planning Information System
of the Republic of Croatia)

With the passing of the Physical Planning and Construction Act (NN no. 76/2007 and 38/2008), new relations have been established between many partners from the physical planning and development domain. For the first time, the Act precisely stipulates what the physical planning information system is, its contents, steps of establishment, management and maintenance, the obligations related to the data and information delivery and the public access to that system. The Act clearly stipulates the responsibilities between the Physical Planning Institute (the future Croatian Institute for Physical Planning) which established the information system at the national level and the local government units which are

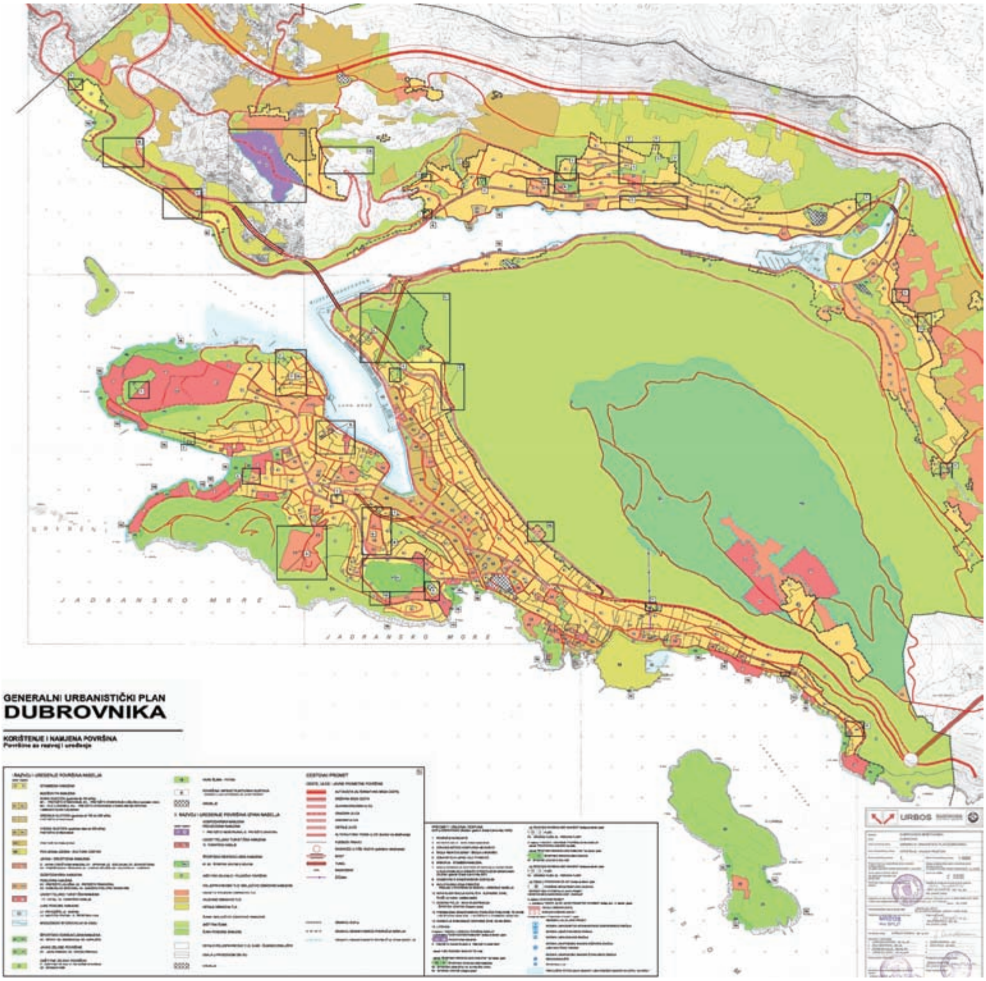


Figure 4. General Urban Plan of the City of Dubrovnik

obliged to develop the information system for their area and the determined level of data. The development, maintenance and management of the Physical Planning Information System (PPIS), from the national level to county and LGU cities/municipalities is conducted according to the PPIS Development Program proposed by MEPPPC (the Institute) and passed by the Republic of Croatia Government. The PPIS Development Program is in the process of being developed through cooperation between MEPPPC (the Institute) and geoinformation companies and information experts.

PPIS is being established in order to enable permanent monitoring of the situation in the area of physical planning and in order to develop reports on the situation in space, with the purpose of having comprehensive management of space protection, as well as to develop and monitor the implementation of the Physical Development Strategy, Physical Planning Program and other documents related to physical planning. Furthermore, PPIS contains spatial data registers, as well as other data registers related to physical planning. Particularly, it contains data and information on: (1) actual land use and a list of physical indicators, (2) basic use

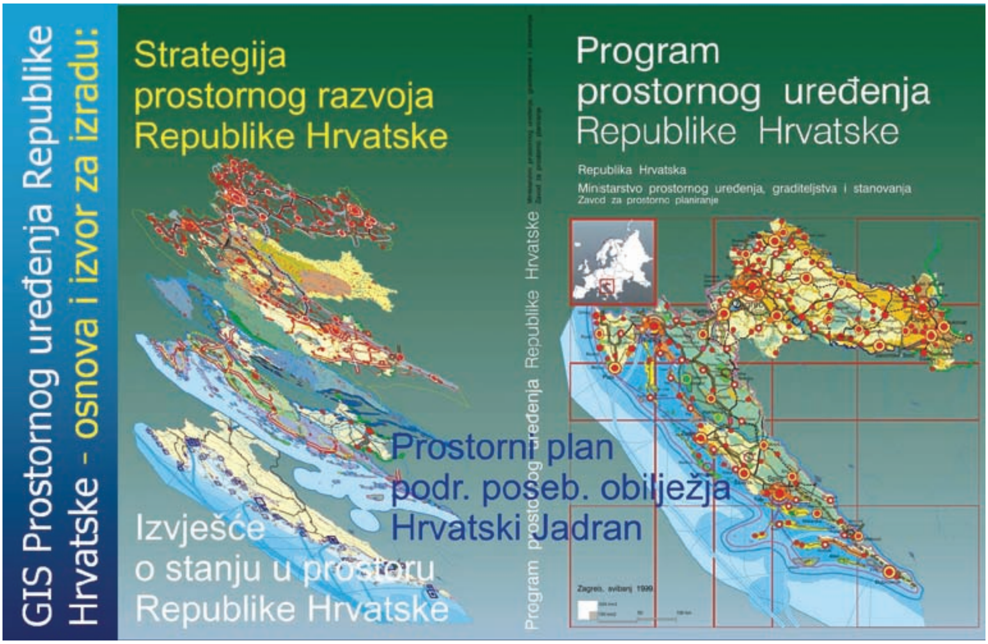


Figure 5. Implementations of the Physical Planning Information System of the Republic of Croatia (ZPP 2004-2009)

of space/surfaces defined in physical planning documents, (3) conditions and limitation of land use determined by physical plans, (4) public, communal and other infrastructure, (5) administrative and other acts passed by responsible bodies for the purpose of physical planning document implementation, (6) plans and programs in the development process or developed with the objective to protect space. PPIS is managed as a distribution information system made up of a number of remote but harmonized and linked information systems of various topics and sub-domains for which responsible reference centres are established.

Figure 6. System of Central Settlements (from the Physical Planning Plan of the Republic of Croatia)

All of the above mentioned is going to influence the new method of work employed by the MEPPP which is gradually going to transfer, among other things, the harmonized development of GIS of the Republic of Croatia Physical Plans to counties, cities and municipalities, and is going to retain, through the work of the Croatian Institute for Physical Development, the collection and processing of geoinformation physical planning data at the level of nation or region (Adriatic Croatia, Pannonian Croatia and other). Through the work of the future Croatian Institute for Physical Development and permanent development of the Physical Planning Information System Republic of Croatia, MEPPPC is going to create a quality database of physical planning georeferenced data for complete participation in the exchange, access and use of physical data between various subjects of the National Spatial Data Infrastructure (NSDI) in the Republic of Croatia.

1. Geoinformation system of the Adriatic and Pannonian Croatia Physical Plans
2. Physical Planning Information System of the Republic of Croatia
3. NSDI – National Spatial Data Infrastructure of the Republic of Croatia
4. INSPIRE – infrastructure for the spatial information system in Europe

Box 4. Physical Planning Information System of the Republic of Croatia in relation to the GIS environment (ZPP 2004-2009)

To conclude, the specific quality and uniqueness of physical planning data developed and maintained by MEPPPC in their Physical Planning Information System (PPIS) need to be pointed out, as compared to other parties involved in the National Spatial Data Infrastructure (DGU 2008). Physical (regional) and urban planning (NN 2007, 2009) as interdisciplinary activities are an institutional and technical form for managing space, by which designation of space/areas is determined on the basis of assessed development potentials while maintaining the distinctiveness of space, of requirements with regard to space preservation and conservation of environmental quality. Also determined are requirements for the development of activities and their distribution in space, requirements for improvement and urban renewal of constructed areas, and requirements for realisation of planned projects in space.

Only in physical planning documents at the strategic level, areas for future settlement development and for other activities in space outside of settlements are determined, as well as planned facilities and networks of various infrastructure systems (by choosing between variant or alternative study or plan solutions and by social verification through the adoption process), the spatial distribution of administrative and public functions in central settlements is proposed (including services, supply, education, social and health-care activities and sports and recreational areas), and cultivated landscapes generated through human activity in space are protected.

The indicated set of geolocated physical planning data, along with other geoinformation and indicators constituting the physical planning system (monitoring of the situation and processes in space, implementation of physical plans and inspectional supervision) will be an essential contribution to NSDI development by MEPPPC (DGU 2008) as well as to the exchange of harmonised data with neighbouring EU Member States.

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Development of Spatial Data Infrastructures in South East Europe

Abstract

This paper deals with capacity building for the implementation of Spatial Data Infrastructures (SDI) in South-East Europe. It provides some insight into the status of SDIs in the region and underlines problems and challenges for their further implementation. SDI projects are presented, along with examples of SDI development and good practice to show understanding the status of SDI implementation in the region. Several activities are described that aim at networking of stakeholders, at capacity building and training.

Two important current projects are expected to stimulate the development of SDIs in the region. First, the European project eSDI-NET+ builds a network of users and key European SDI stakeholders in Europe in order to share experiences and best practices. Second, in the area of nature conservation and protected areas, the project Nature-SDI+ builds a thematic SDI according to INSPIRE standards and guidelines. There are plans to extend the project to other countries in the region of South-East Europe. Last but not least, the paper points to the SDI conference in Skopje in September 2010 with the ambition to strongly influence SDI development in the region.

Introduction

The concept of Spatial Data Infrastructures (SDI) emerged in the early eighties of the twentieth century as a consequence of the use of geographic information systems and of spatial information in digital format in order to achieve interoperability and wide accessibility of digital spatial data. A Spatial Data Infrastructure supports ready access to geographic information and encompasses the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the national and regional scale are not impeded in meeting their objectives [Masser, I., 2005]. The World-Wide-Web had a major influence on the implementation of SDIs, data are now normally distributed via the Internet and accessible by Geo-Portals.

Much progress has been achieved in industrialized countries in developing SDIs on national, regional and local level. A major step forward was the definition of the European SDI, in the form of the INSPIRE directive that provides a legal framework for the implementation of SDIs in the European Union.

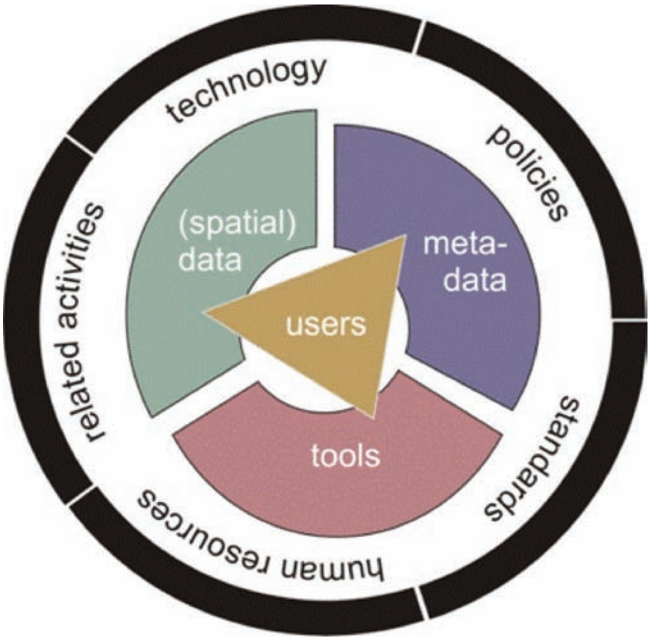

Figure 1. Components of an SDI: the users are in the centre; figure © S. Hennig, 2009.

The South-East European countries however lack behind in the development of SDIs, although they demonstrate strong interest in the area. This applies to the European member states Bulgaria and Romania as well as to the candidate countries Croatia, Republic of Macedonia, Turkey and to the remaining countries in the region. The importance of spatial data for the economic and social development makes it however essential to rapidly proceed in the area of geospatial data, being a process that is also important for the foreseen membership to the European Union.

This is linked to the need for more information and knowledge about spatial data infrastructures, about the use of GIS and about the European directive INSPIRE. Various activities are being carried out to transfer information and contribute to capacity building including learning from examples and bringing interested stakeholder together. This paper wants to contribute to such capacity building and networking in describing several actions that are relevant to the region including links and suggestions for further work in order to convince stakeholders of the necessity of spatial data infrastructures and to enable them to initiate and implement such infrastructures.

Spatial Data Infrastructures in Europe

Spatial Data Infrastructures have been implemented in many European countries. Further development is now driven by INSPIRE, the legal framework for SDIs in the European Union. INSPIRE, the Infrastructure for Spatial Information in the European Community, is defined by the Directive 2007/2/EC of the Council and the European Parliament. It entered into force on the 15th May 2007 and is a legal framework for setting up and operating Infrastructures for Spatial Information. A key milestone was 15th May 2009 when all Member States should have passed national legislation transposing the INSPIRE Directive.

INSPIRE intends to overcome barriers that inhibit the widespread use of spatial information, which are both technical and organizational. These barriers comprise lack of spatial data availability, lack of interoperability of data, lack of documentation and metadata, and issues of cost and distribution of data. INSPIRE is designed primarily for environmental policies, including those policies and activities that have an impact on the environment. INSPIRE is thus part of the environmental acquis, although INSPIRE would also support other policies in Europe (Annoni and Craglia, 2005; European Commission, 2002).

INSPIRE lays down general rules to establish an infrastructure for spatial information in Europe and should be based on the infrastructures for spatial information established and operated by the Member States. Therefore, INSPIRE is implemented as a distributed infrastructure. Also, it does not require collection of new spatial data and does not affect existing Intellectual Property Rights. INSPIRE obliges the member states of the European Union to make their data available and to implement the infrastructure necessary to access these data. The scope is spatial data held by or on behalf of a public authority operating down to the lowest level of government when laws or regulations require their collection or dissemination.

Data are an essential element of spatial data infrastructures. INSPIRE defines 33 data themes in 3 annexes to the directive. The three annexes correspond to different time scales for the transposition of these data themes into INSPIRE conformant formats and for the definition of meta data.

Table 1. Data themes of INSPIRE

Annex I data themes	**Annex II data themes**	**Annex III data themes**
Coordinate reference systems Geographical grid systems Geographical names Administrative units Addresses Cadastral parcels Transport networks Hydrography Protected sites	Elevation Land cover Ortho-imagery Geology	Statistical units; Buildings; Soil Land use; Human health and safety; Utility and governmental services; Environmental monitoring facilities; Production and industrial facilities; Agricultural and aquaculture facilities; Population distribution – demography; Area management/restriction/regulation zones & reporting units; Natural risk zones; Atmospheric conditions; Meteorological geographical features; Oceanographic geographical features; Sea regions; Bio-geographical regions; Habitats and biotopes; Species distribution; Energy Resources; Mineral resources

Since INSPIRE is based on existing infrastructures for access to data, it is important to understand the status of such infrastructures in Europe. Therefore, the European Union had launched the “State of Play” study, which resulted in the description of the status of SDI implementation in Europe.

The study monitored and analyzed activities related to national spatial data infrastructures in 32 European countries. These included the member states of the European Union, and also those that at the launch of the study were candidate countries, Bulgaria, Romania, Turkey. In addition, the SDIs of the EFTA countries Iceland, Liechtenstein, Norway and Switzerland were analysed and documented. The last version of the reports dates from 2007 and are available on the web site of the European Union on INSPIRE, http://inspire.jrc.ec.europa.eu/index.cfm/pageid/6/list/4.

32 indicators were used to assess SDIs, structured around seven main components: organisational issues, legal framework and funding, reference data and core thematic data, metadata, access and other services, standards, and thematic environmental data [Vandenbroucke, D., e.a., 2007].

The study showed that most countries have to a certain extent a coordinated SDI approach, and territorial coverage at the national level, and have also one or more of the SDI components operational: metadata, network services, and standards are very well developed particularly in the Western part of the European Union. Legal issues and funding are much more diverse across the European Union, because either no clear information is available or the legal basis for the national SDI has yet to be consolidated together with a sustainable funding regime. Discover and view services, and to a certain extent also download services are relatively well developed, but much progress has still to be made to set up services for transformation, and above all services chaining.

According to this survey, the SDIs of Germany, Belgium/Flanders and Spain are fully operational but not led by the national data provider. In contrast, both Hungary and Denmark are examples of well working SDIs with also users involved where the major initiative is done by the national data providers. Regional SDIs in Europe are particularly well developed, and could serve as example for building new SDIs.

The study also concludes that INSPIRE has stimulated the further development of SDIs: particular work has been done in the field of metadata and service development. Data harmonisation efforts or creation of new data sets seem to continue at a lower pace. More stakeholders, especially users, for example Ministries, are involved and take active part in the coordination. Data sharing as a concept is not yet daily practice; free services for discovery and viewing data are emerging everywhere, other types of services are still rare and the integration of the components of the infrastructures in the day-to-day work of the public actors is still weak.

There is not one single 'best approach' for developing a NSDI. Several organisational approaches are possible, but a good coordination and intense cooperation between the different stakeholders is a key element to success. In particular, the involvement of the private sector is very important. A need for awareness, education and training has been identified.

Meanwhile, a new study has been launched with the title "INSPIRE and NSDI implementation state of play". This study includes now 34 countries with Croatia and FYROM as new candidate countries to the European Union.

Developments in South-East Europe

Those countries in South-East Europe that are not yet European Union members states expect their integration into the European Union in the long term and as such, they will also be obliged to develop their spatial data infrastructures according to the rules of INSPIRE. However, so far, they have not been included in the INSPIRE state of play study and information about the status of their spatial data infrastructure development is difficult to obtain.

An early study to understand the status of the development in these countries has been carried out in 2002 by the project GISEE, "GIS Technology and Market in South-East Europe – a market study". The project was financed by the fifth RTD Framework Programme of the European Commission and coordinated by the Technical University of Sofia, in cooperation by EuroGeographics, the association of National Data Providers in Europe and the company URSIT Ltd., further with the support of experts in all countries considered. Using extensive questionnaires, the spatial data infrastructures were investigated in Albania, Bosnia-Herzegovina, Bulgaria, Croatia, FY Republic of Macedonia, Romania, Serbia-Montenegro[1]. and Turkey. The reports of Bulgaria, Romania and

[1] They study was carried out in 2002, before the independence of Montenegro

Figure 2. First South-East European SDI Conference 2003 in Sofia, Bulgaria

Turkey were then integrated into the INSPIRE state of play reports of these countries.

The project ended with the South-East European SDI Conference in Sofia, Bulgaria, on 23 and 24 October 2003 and its results were summarized at several occasions [Boes, Pavlova, 2004]. The study identified several problems: although spatial data exist throughout the region, they are not compatible and access to these data is difficult, data owners are often not known and access conditions are not made available. There is a lack of collaboration between data owners and providers, along with unclear procedures and planning and a lack of financing.

As one way forward to address and remedy these problems, the originators of the study created the association AGISEE, Association for Geospatial Information in South-East Europe in order to contribute to realizing the vision of enabling sharing of geospatial data for the benefit of the economic development of the region and with the goals to:

- Unite the GI community and interested parties in South-East Europe;
- Promote the use of GI and to contribute to building SDI in the region;
- Support and provide relevant information to its members;
- Act as enabler for new opportunities to members, and
- Represent the GI sector in South-East Europe and outside.

Interested stakeholders were and are still invited to become members of this association and membership registration can be done on its web site http://www.agisee.org.

Much has happened in the countries of South-East Europe since this study. In order to update the information, AGISEE had the opportunity to hold a "South-East European SDI Workshop" which was organized in collaboration with the South-East European Research Centre and took place in Thessaloniki, Greece on 5 – 6 February 2009. The goal of the workshop was to exchange, communicate and document the achievements of Spatial Data Infrastructures in South-East Europe, on national, regional and local level, with the further goal to select best practice cases of sub-national SDIs in the region.

Representatives from 12 countries from South-East Europe participated in this workshop and presented the status of SDIs on national and local level in their countries [Boes, Dimopoulos, 2009]. Some spatial data infrastructures were proposed as best practice cases for the region. The selection was based on Questionnaires collected from national and sub-national SDIs. Amongst the selected best practice cases are the Municipality of Tirana in Albania, the Municipality of Burgas in Bulgaria, the Municipalities of Zagreb, Rijeka, Varazdin in Croatia and the City of Skopje in the FY Republic of Macedonia. Slovenia contributed with thematic SDIs: a farm registry, used for farming subventions and all processes related to agriculture; and the web site geopedia.si, a web-based atlas of Slovenia, which can be edited and extended by its users. The selected best practice cases served as input to a European SDI best practice award conference that took place in November 2009 in Turin, Italy.

The workshop demonstrated, not surprisingly, that SDIs are not completely realized in these countries, only some of their elements exist. Data sharing is widely not realized. Many differences in the development of SDIs exist between the countries. It was said that problems are often influenced by the general political situation. Quoted was a lack of willingness of decision makers, the lack of a clear mandate and the lack of cooperation. Existing initiatives and projects are not coordinated, and the data are old and scattered. Further there is a lack of understanding and training.

There is however a good legislative basis for the development of SDIs, and users and applications act often as driving force for data sharing. Important are cadastre with land registration, and agriculture. Participants to the workshop defined the need for a clear mandate and vision for SDI development, as it had been done in an exemplary way in Croatia. There is a need for awareness creation, training, education and learning from others, and it would be necessary to be open to other approaches, as it is for example shown in Slovenia by the examples mentioned above. An independent civic committee or organization could be of great help to stimulate developments, and all countries should start implementing INSPIRE now.

The presentations given at this workshop are available from the workshop web site http://www.city.academic.gr/special/academix/events/gis/index.html; the final concluding report is made available by AGISEE on its web site [Boes, Dimopoulos, 2009].

Networking and Awareness Building

One of the needs as formulated at the Thessaloniki workshop is the need for awareness creation, training, education and learning from others. This requires stronger collaboration between actors and networking combined with actions that would eventually lead to creation of awareness for the understanding of the framework of INSPIRE and its components. To address this well-known need, the European Union had organized INSPIRE information days in the EU members states and candidate countries, and funds projects for collecting and disseminating information about European SDI development and of bringing stakeholders together.

One of these projects is ESDIN, European Spatial Data Infrastructure Network (http://www.esdin.eu/), which is coordinated by EuroGeographics and supported by the European Commission's eContent+ programme. Its goal is to help member states, candidate countries and EFTA States prepare their data for some of the data themes of the INSPIRE Annex I.

Another important project is eSDInet+, a Network for the promotion of a European wide dialogue and exchange of best practices on Spatial Data Infrastructures throughout Europe (http://www.esdinetplus.eu/). The project started on 1st of September 2007 for a duration of 3 Years. The objectives of eSDInet+ are to target users and key European SDI stakeholders, and to bring them together through a Thematic Network, which is built as a platform for communication and knowledge exchange. The project emphasizes in particular SDIs on sub-national level and collects from them lessons to be learnt for building up new SDIs. Through intensive dissemination campaigns, the network raises awareness of the important role SDIs play in the enrichment and reuse of spatial data.

A main task of the project was the study and evaluation of sub-national SDIs. The project has developed a comprehensive methodology and criteria in order to assess existing SDIs, which includes issues such as:

1. Level of technology and innovation and originality of the project;
2. Implementation and/or readiness for INSPIRE principles;
3. Level of fostering cooperation between different users (proof of visibility and/or user feedback);
4. Possibility of extension or transfer to other countries and regions.

Twelve national and regional SDI Best Practice workshops were held, where existing SDI solutions at the sub-national level were identified and analysed. These workshops also addressed promotion of the best practice and knowledge exchange between stakeholders involved in the creation and use of SDIs. One of these workshops is the one in Thessaloniki that was described before. In all these workshops and through thorough investigation throughout Europe, 135 SDIs from 26 countries in Europe could be collected and described.

Figure 3. Award Winners at the SDI Best Practice Award 2009

The project culminated in the International Conference "SDI Best Practice Award 2009" that took place on 26th and 27th November 2009 in Turin, Italy. The aim of the event was to highlight promising SDI solutions in Europe, to exchange experiences and to learn from each other. At this conference, twelve best practice SDIs had been selected and awarded as example SDIs in Europe. The selection had been done by an Award Jury consisting of 6 GI experts. The main message of the Award Jury was that "each Spatial Data Infrastructure is a special case" and the diversity of experiences made was a fundamental challenge for the selection. Next steps in the project will be to feed back the lessons learnt in the award procedure to all SDIs that have participated in the project, and to a wider audience as well.

SDI development needs the link to existing initiatives, needs collaboration and clustering with existing actors, locally and in other regions. One example of such an initiative that started locally and has now become international is the GIS cluster in the Municipality of Gävle, Sweden [Östman e.a., 2009]. The main organization of this cluster is the non-profit organization Future Position X (FPX – http://www.fpx.se/en), which is in fact a membership organization. The cluster was formed in 2004 by public and private actors; most of them are based in the Gävle region and work with Geodata and GIS. Goal is to build a closer cooperation in research, development, internationalization and marketing in order to promote growth and development within the GIS-field. In offering a service infrastructure as displayed in figure 4, the cluster is able to transfer research directly into products and bring thus research and business together.

The cluster enabled the creation of many new companies and new products and services partially with the support of seed financing and venture capital. The establishment of three foreign companies in the Gävle area within the GIS-field is now in progress. A GIS-Development lab has been set up that offers opportunities to test, develop and evaluate systems/services in a realistic multi-user environment, using the lab's GIS-competence as well as access to a test population where companies can test their products on the market. The lab also functions as a technical base for test, development, validation and demonstration of GIS-related applications and services. FPX is in fact approved by the Swedish government as the national geo-test centre for data quality and harmonization with the INSPIRE directive.

FPX has now moved into a next phase and extends the activities getting more participation regionally, nationally and also internationally. FPX has established businesses in Norway, Estonia and Finland and works to develop the Gävle region into an international GIS-centre. This GIS cluster is an example for network building that starts from one place and

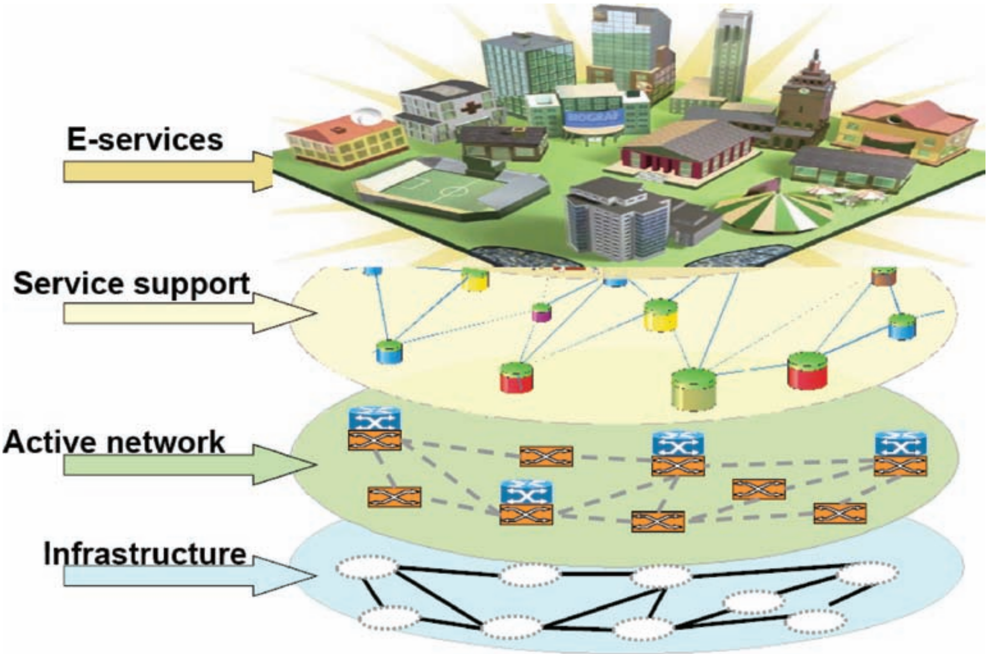

Figure 4. FPX: from Infrastructure to services and applications [Bang, J., 2009]

extends internationally. Further collaboration with other countries is a declared goal of this cluster.

Networking and clustering bring stakeholders together, may create awareness but do not necessarily lead to the right knowledge which is needed to implement GIS or spatial data infrastructures. There is a demand for training and training courses, possibly alongside or outside of normal university education. Many training and educational courses are available, but we may have difficulties to locate them. This problem is addressed by the project Vesta-GIS (http://www.vesta-gis.eu/), which is a broker of GIS and SDI training. Vesta-GIS is a Leonardo-da-Vinci network and funded by the Life Long Learning Programme of the European Commission. The project creates a framework or "clearing house" for the access to training courses, often throughout distant learning facilities and organizations.

The Training Course Catalogue on the web site includes information about relevant courses and other training content delivered by the network partners and accessible through an on-line searchable database. The catalogue consists of course metadata, but does not include the courses themselves, only references to them. The VESTA-GIS course catalogue represents a possibility for educational institutions to reuse specialized tailored courses, and make them visible to a pan-European GI-public. Users who search for vocational GI-education might find specialized offers that match their needs even better than they would expect.

An eLearning Platform is in development that allows the direct delivery of some courses of the catalogue in a customised and interactive way. The training framework can be used after registration to VESTA-GIS and it is then completely free. Workshops in the partner countries inform about the project and the training courses published on the web site and offer some of the courses as best practice examples. Courses about INSPIRE are part of the course programme published on the web site.

Training and participation in courses very often has to be complemented by certification. Certification is provided by the ECDL foundation which has endorsed a GIS certification [Salvemini, 2009]. The GIS certification (http://www.ecdlgis.com) aims at supporting capacity building for SDIs. Three different levels of certification are offered, which are for the basic user, the professional, and the specialized user. The course schedule includes examination questions for the certification. The ECDL GIS certification exists in a few countries only, and should be transferred to other European countries.

The GIS certificate has a EU perspective as well since it can be considered a facilitator for INSPIRE implementation and the distribution of its data and principles. VESTA-GIS endorses the ECDL-GIS Certification as a specific facilitator for INSPIRE data handling and sharing.

Thematic SDIs – Example Protected Areas

Spatial data infrastructures are normally provided by authorities and provide access to all kinds of public data. They can however also exist for certain themes such as nature conservation, disaster management, e-government or others. INSPIRE in fact allows for such thematic SDIs to happen. For instance, protection of our environment becomes more and more important and sustainable development is a keyword for preserving our nature for our descendants. Protected areas constitute an important element for human values and general public awareness will help to preserve these values. A thematic SDI can contribute much to the fulfillment of the goals of nature conservation and protection of the environment.

Public Administrations and Park Authorities in Europe have plenty of data and databases created for management needs at local, regional or national level that should be made available and re-usable at EU level through the use of common standards and interoperable services. For example, Environmental Assessment procedures imply the management of seamless geo-information in different application fields. The Habitats Directive requires in its Art. 6 that environmental impact assessments are carried out for projects that are related to protected areas as for example building a railway track. Such studies need a comparison of different datasets such as protected sites boundaries, habitats, species distribution, water bodies and the project data such as the designed railway track. INSPIRE provides the right framework for data accessibility and data sharing.

These issues are addressed by the project NATURE-SDI+, http://www.nature-sdi.eu/, a European Best Practice Network that focuses on nature conservation and protection and will end in 2011 [Boes, U., Pavlova, R., 2009]. The project contributes to the implementation of INSPIRE with the data themes for nature conservation, which are:

- Protected sites (INSPIRE Annex I);
- Biogeographical regions, Habitats and biotopes, Species distribution (INSPIRE Annex III).

The project develops a European metadata profile for the data sets of protected areas based on ISO and CEN standards (ISO 19115/119 and CEN/TC 287 Geographic information). The datasets are provided by the data providers participating in the project; they will be harmonized and converted to the INSPIRE specifications in order to make them better accessible and exploitable. The project will thus deliver interoperable and harmonized datasets for nature conservation all over Europe, with their metadata profile, a data model and thesaurus. All this will be accessible via the NATURE-SDI+ Geoportal.

Testing of datasets follows the INSPIRE Methodology that consists of seven steps or tasks:

Task 1. User requirements and use cases analysis;

Task 2. Analysis of the relevant reference materials;

Task 3. "As-is" analysis according to the methodology defined in INSPIRE document D2.6, Methodology for the Development of data Specifications;

Task 4. Gap analysis according to the methodology of D2.6;

Task 5. Drafting data specification of the data themes of the INSPIRE Annexes;

Task 6. Testing of draft data specifications for themes;

Task 7. Preparation and adoption of Implementing Rules for the interoperability and harmonisation of spatial data sets and services for the INSPIRE spatial data themes.

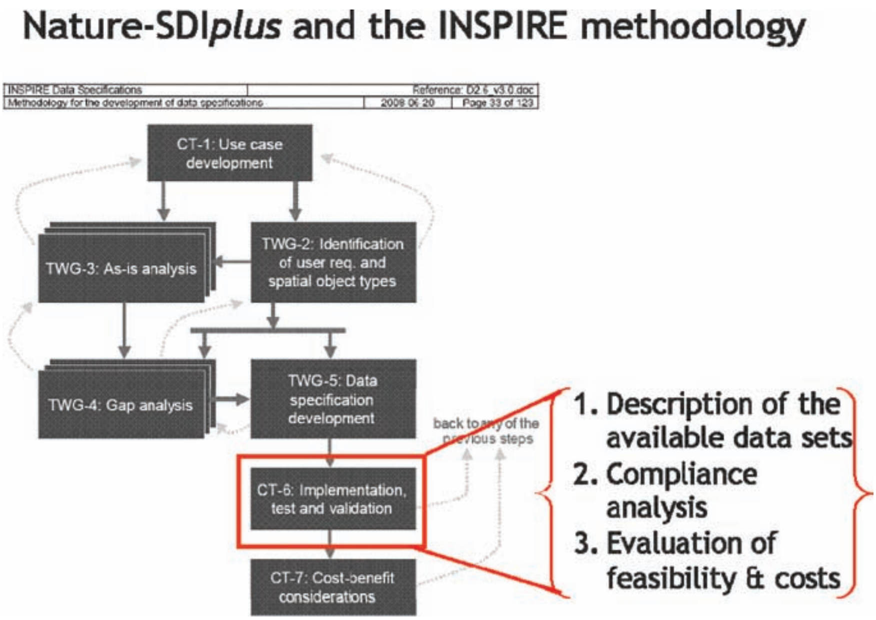

Figure 5. INSPIRE Data Specification Development Process

These seven tasks are inter-dependent and allow many interactions as it is depicted in the following figure.

Having identified and described the data sets available, they are checked for compliance. A matching table is used that is based on the attributes defined in the INSPIRE data specification. For each attribute and identified data sets, compliance, differences, gaps and critical points are defined. The matching table compares the INSPIRE attributes with those existing in the datasets of the protected areas, as shown in Figure 6. The NATURE-SDI+ data specification outcomes are then submitted to the INSPIRE drafting teams. The last step in data testing is evaluation of feasibility and costs, which is in progress.

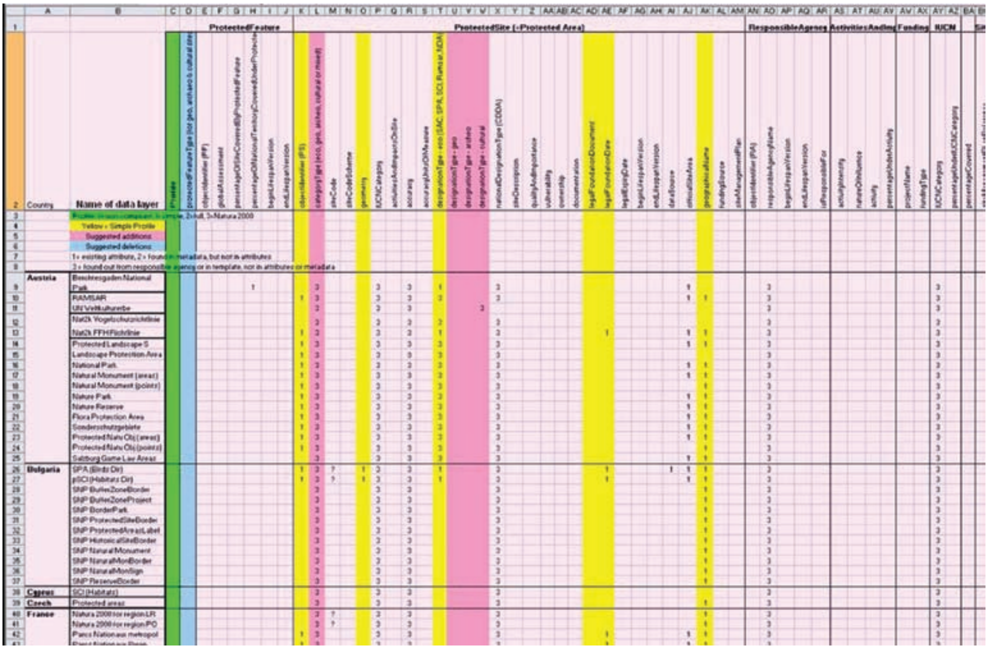

Figure 6. Example of a Matching Table

An important aspect of the project is networking to involve new stakeholders beyond the existing partnership of data providers, data users and service providers. Extension of this network is part of the project and networking activities and consensus building are considered a continuous process aimed at recruiting network members and at involving them in the project activities and their validation. A wider network creates more opportunities for sharing of data and best practices towards improving and stimulating exploitation and the re-use of information about nature conservation.

Two nature park directorates from Bulgaria participate in the project as data providers; these are Vitosha Park Directorate and Strandja Park Directorate, with the company URSIT Ltd (http://www.ursit.com) as the Bulgarian coordinator. They have held a Bulgarian Nature SDIplus workshop (http://www.ursit.com/all/nasdi/initiative.html) on 1st and 2nd of December 2009 with the goal to inform protected areas and other interested people about spatial data infrastructures, about related European legislation and about the use of open source software in this area. This workshop turned out to be very successful and demonstrated that there is a strong demand in this area for information about spatial data infrastructures and their implementation.

The organizers see the need for more such events, both in form of informing about INSPIRE and spatial data and in form of training in open source software and GIS. Another important conclusion is the requirement by the participants to work more closely with state organizations on issues related to INSPIRE, their wish to be better informed and to also contribute to the definition and implementation of INSPIRE in Bulgaria. Possibly, one or more working groups could be formed in certain areas such as nature conservation.

Conclusion: Challenges for the Future

The countries in South-East Europe are growing closer to the European Union. Some are already member states, others are candidate countries or are just waiting to become candidates to European Union membership. It is mostly the European Union that finances and supports adhesion to the European Union. Whereas member states receives financing nearly exclusively from the Union, for example via the structural funds, those countries that are not yet member countries, benefit from many international and bilateral donors. This has important consequences also in the sector of GI and SDI. There are opportunities that should be seized in order to create strategies, programmes and action plans to drive forward implementation of spatial data infrastructures and use of data.

Many SDI/GI organizations look today more closely at South-East Europe. Among them are EUROGI, EuroGeographics, the Open Geospatial Consortium (OGC), the International Federation of Surveyors (FIG), the International Society of Photogrammetry and Remote Sensing (ISPRS) and many others. Collaboration with such organizations also creates opportunities that cannot be neglected and can be used for the transfer of knowledge, for creation of awareness and for the development of programmes for SDI implementation. In Bulgaria, for example, the author works together with the Open Geospatial Consortium and has created an OGC interest group to inform interested organizations about the advantages of standardization and to encourage private and public sector to formulate their requirements to international standardization and have them included in current and forthcoming OGC standards.

Beyond the creation of national SDIs, it will be important to bring the stakeholders of one entire region together, as it is done by the GSDI association on world level. This is the goal of the International Conference on SDI 2010 that will take place from 15th to 17th September 2010 in Skopje, Republic of Macedonia (http://sdi2010.agisee.org). Its ambition is to become the major SDI conference in the region and be influential for SDI development. The main theme is the development and use of Spatial Data Infrastructures and all their aspects – technology, criteria and standards for organizing and sharing spatial data, with an emphasis on the realization of the European INSPIRE directive in South East Europe. Deadline for abstracts is the 15th of February 2010.

Many supplementary activities are necessary for the implementation of SDIs and INSPIRE. Such activities comprise awareness creation, training, networking, and furthermore business related activities such as market creation and business planning. They should be included in the strategies and action plans of government authorities or NGOs for the realization of SDIs, for the use of GIS and for sharing of data.

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Mutational Typography in Security Printing

Abstract

New digital digital letters are produced with the help of computer graphics. They set the basis for introducing mutational typography with emphasized use in designing documents and securities. This paper presents methods and commands for transforming letter shape that conventional graphic programs fail to provide. Deformation may be a stochastic one as well, but also a strictly defined one and subject to designer requirements. Mutation is achieved by transformation of texts through a program made in advance on basis of primitive postscript commands controlling memory stack addressing. This paper elaborates and explains the motivations for activating individualized mutant fonts as a routine in tool design. There is more interest in creating such typography if it is planned in advance to be used in the area of graphic product security. The same font used in producing one security document, but carried out in different transformations creates new designer solutions and contributes to greater protection in security printing.

Key words: mutational typography, security printing, stochastic transformation

1. Introduction

When designing securities, the choice of typography plays a significant role in the group of security elements that must be included as part of the document design. Typographic designs have a double role. Besides a document's graphic design, the typography itself must include a security function. Tools for designing font letters for PostScript systems are already successfully used in the past twenty years. The iterative phases of the process were: hand made collection of all letters on paper, determination of geometric system in typographic scale, scaning of letters, visual control of comforming letter face and generating the font for the computer use [1].

In the non-English areas, those tools were the main part of massive exploitation of new applications that had their superb original, but protected fonts [2]. Designers of individual letters were motivated differently to create their personal handwriting letter designs with extreme deviations from the typographic rules [3].

In order to determine shape of the graphical letter PostScript language is used to define "path" or route [11]. Letters are formed inside letter bounding bob. It is an imaginary square, containing a picture of a letter (glyph). Letter shape is most commonly presented as filled space framed by inner and outer path [4].

New fonts are made for each design. Digital handwriting fonts are presented and program codes have been applied for mutating letter shapes. Four new digital handwriting fonts have been designed (Fig. 1). Tools based on random sequences have been used for producing the fonts.

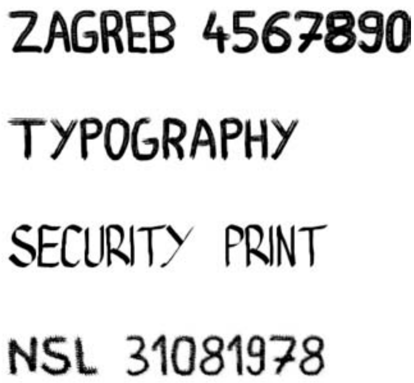


Figure 1. Digital handwriting fonts from GF database:
ZAG 456, Kist 15, Pero 12, Efekt 36

2. Random number generators

Letter shape mutations can be carried out in different ways [5]. The most complex and the most effective solutions are achieved by introducing random numbers [6]. Such generators determine the letter's deformation form depending on the seed set in the random number congruency. Each letter can have a different deformation independent of the neighboring letter.

Random sequences have been used as an artistic expression in typography [7, 9], to making individual works of art. As they contain an artist's individuality, such works are personal creations and as such they have been entered into museums of contemporary art. These graphics are unique and non-replicable.

They were made as unique pieces of art and this is something that is not typical in the field of graphics. Many of their algorithms cannot be repeated because there is no language or computer technique that could make such reproduction. Nowadays there are many experiments carried out with colors in the invisible part of the spectrum. Random choice of UV and IR intensities [8, 12] with precise algorithms has expanded typography into the security graphics area, as well as into a new manner of creating artistic canvases. Recently some individual raster elements have been developed [10] that can be placed quite freely into letter signs. Digital screening expands the area of security graphics because the parameters in screen equations are set as a separate information outside the task described by typographic values.

By using number congruency mutations in securities typography are determined stochastically [7] and this makes a product unique and impossible to repeat. This method provides strict control of sequence and repetition.

New ways to protect typographical elements in security graphics are introduced and proposed on basis of the executed examples. The proposed methods of protection are based on the uniqueness of the derived solutions by which mutational typography is made possible.

Through Postscript programming personal random numbers generators have been produced that create number sequences by using set values and they are given set functions in further programming. Random numbers generated in this manner may take over the values of many parameters belonging to program commands such as: color value, line thickness, font size, and especially accentuated here – the shape of certain letters.

The original Postscript generator is presented:

```
x srand
/m { 2 31 exp 1 sub } def % (1)
/rn { rand m div } def % (2)
```

The srand function sets the initial value for the random number generator that is implemented in the rand function. This initiator may have a positive value up to 2^{31}-1 and this is also the range of the module's width in congruency. Srand is set at random before the sequential loop, whereas the values of random numbers m are generated according to the relation (2). Division by the width module m provides the random number in the range from zero to one. The relation (1) represents the highest number in small computers and that is also the highest number with which the number of pseudo repetitions is achieved.

The algorithm for the rand function has never been openly published by Adobe, creator of Postscript, so it cannot be controlled in full. Another faulty characteristic of the random number generator is the necessity to introduce two or more generators within one and the same program in order for the produced typography's protection to be fully efficient. These are the very reasons for making personal random number generators. The manner of defining sequency is used by generating pseudo random numbers with the congruency method without the additional member.

The congruency has parameter (a) the multiplier, and the operator module.

$$r_i = a*r_{i-1} \bmod m$$

where the random number r_i is calculated as the module (m) resulting after multiplying the constant a and the preceding random number r_{i-1} from the same sequence. We set r_0 as the first number in the sequence and called it the seed.

3. Experimental work

The program solutions used in the presented experiments have been carried out following the listed routines:

```
/sjeme S0 def
/m M def
/a A def
/k {sjeme a mul m mod dup /sjeme exch def } def
/rn { k m div } def % random number 0. to 1.
```

Standard Postscript RAND (random number) routines are not used in the experiments for generating a random sequence because we plan two or more sources that are in parallel operation with the intention to control the stochastic graphic repetition. The manner of setting the algorithm in the experiments that have been carried out is by generating pseudo random numbers using the congruency method with its own parameters. Letter shape deformations have been achieved on basis of the following procedure:

$[f_1\ f_2\ f_3\ f_4\ f_5\ f_6]$ `makefont`

in which the horizontal deformation of the foursome is defined by parameter f_1, and the vertical deformation with parameter f_4:

$/f_4$ `{rn v1 mul v2 add} def`
$/f_1$ `{rn s1 mul s2 add} def.`

Parameters f_2,f_3,f_5 and f_6 have value zero in this experiment (Fig. 2).

Figure 2. Experiment 1; RD=rn; GR=rn; BL=0.1; A0=715; M=12345; S0=1405; N=5, za v1=40: i v2=10, za s1=120 i s2= 10

The random values used in the experiment have been set on basis of own routine. The random number generator was used. The text "Zagreb" is written an N number of times, and this is set with the repeat loop. The color change is set according to the relation

```
RD GR BL setrgbcolor
```

where the red and green color values are random numbers derived from the relations

```
/rn { k m div } def
```

where the k random number was derived form the relation

```
/k {sjeme a mul n mod dup /sjeme exch def } def.
```

This experiment was carried out in order to show the possibilities of letter shape deformation with the help of program tools.

Second experiment (Fig. 3.) is much more complex as to the program procedure. This is also why its security is more efficient and it is impossible to repeat the procedure and produce the same product.

It uses two independent random number generators:

```
/a A def % množitelj u kongruencijskom generatoru
/m M def
/Sjeme1 S1 def % generator br.1
/Sjeme2 S2 def % generator br.2
```

Figure 3. Experiment 2; A=123; M=1503951; S2=1405977; S1=3108978; RD=0,3; GR=bo; BL=bo; Min=0; Max=50; D_1=10

```
/S11 {a Sjeme1 mul Modul mod dup
    /Sjeme1 exch def Modul div } def

/S12 {a Sjeme2 mul Modul mod dup
    /Sjeme2 exch def Modul div } def
```

Parameters f_1 and f_4 that set the foursome deformation according to the *x* and *y* axis from the matrix

```
[f1 f2 f3 f4 f5 f6] makefont
```

change their value according to generator no 2. The role of generator no 1 is to carry out stochastic change of blue and green colors. Such generators that are completely independent generate totally different number sequences and enable double protection. Color change is independent in respect to the letter boundingbox change. Additional deformation is achieved by also introducing variable values for parameter f_3 from the transformational matrix. It is set by the “FOR loop” having a value in the range from *Min* to *Max* with the *D1* step. For this experiment parameters f_2, f_5 and f_6 have zero value.

Experiments No 3,4,5 and 6 (Fig. 4, 5, 6) show the capital letter "L" and several of its deformations. The letter used is not taken from some existing font, but was formed with the help of commands for lines and curves. In this manner each line and curve is independent and may be altered separately. Controlled letter mutants are produced by such programming of typography. The design is carried out with constant horizontal and vertical shifting of the whole letter.

The letter mutation, i.e. the letter L altering in respect to one of its lines only has been carried out by generating random numbers for the line length values.

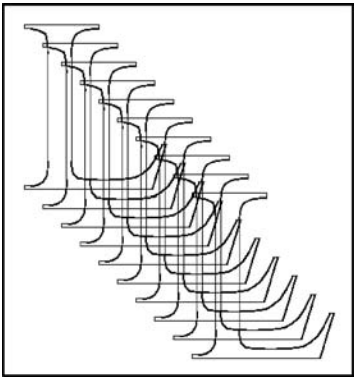


Figure 4. Experiment 3; N=10;

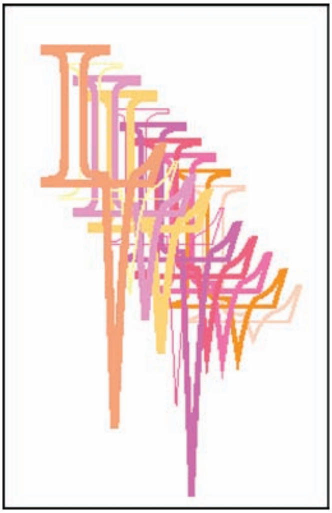
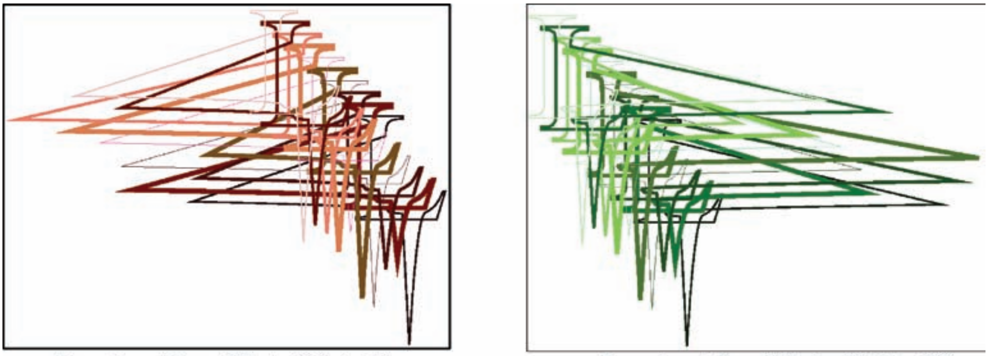


Figure 5. Experiment 4; A=715; M=12345; S0=1405; x=504; l_1=300; l_2=70



Experiment 5. $y=377$; $l_1=300$; $l_2=70$ Experiment 6. $y=377$; $l_4=625$; $l_3=400$

Figure 6. Experiments with mutations along the horizontal and vertical lines

By the relation

```
/y {rn l1 mul l2 add} def  %sluèajni broj između
                            l2 i l2+l1
```

the value of y is set that is used in the place of axis y value in the relation

```
x y lineto
```

for making one of the letter L lines. As y is variable, its value depends on the initiator value and varies throughout the program execution according to the relations set. Color change and line thickness are also used in the same example and they are also randomly set on basis of known relations and initiator values.

In experiments No 5 and No 6 the letter L is mutated along the horizontal and vertical lines. Shift values equal to the ones in experiment No 4, except that in experiment No 5 the values in the y relation are also introduced in the x axis value in the relation

```
x y lineto.
```

Experiment No 6 has a vertical line deformation to the right. This was achieved by introducing a new relation

```
/n {rn 400 mul 625 add} def  %sluèajni broj između
                              l4 i l3+l4
```

in the place of

n y L

when defining the line's image.

Experiments No. 7 and No. 8 (Fig. 7, 8) have been carried out applying the same program procedure. Also, a third random number generator was introduced. Two completely different image designs were the result. Such designs were carried out in order to stress the importance of knowing the initial parameters and their influence in carrying out program

Figure 7. Eksperiment 7; A=123; M=1503951; S1=3108978; S2=1405977; S3=2304978; RD=rn; GR=0.5; BL=rn; l_1=70; l_2=30;l_3=90;l_4=30;l_5=270; l_6=10;h=6; N=12; h=6

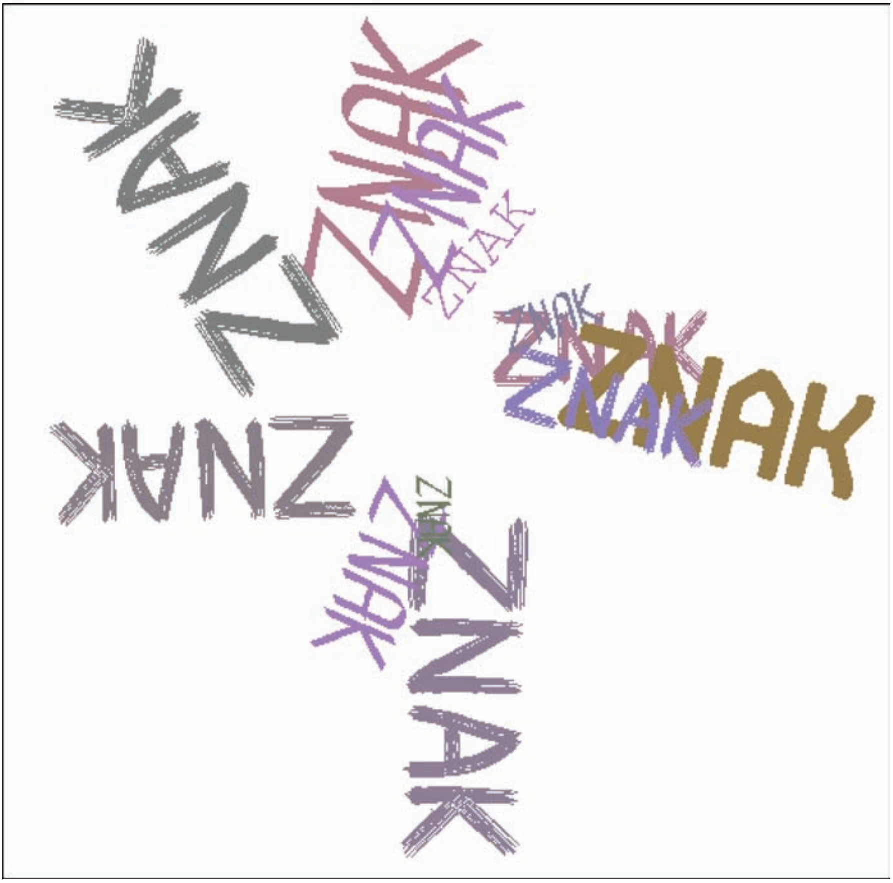


Figure 8. Eksperiment 8; A=71155; M=4659; S1=4782; S2=9257; S3=7803; RD=rn ;GR=0.5 ;BL=rn; l_1=70; l_2=30;l_3=90;l_4=30;l_5=270; l_6=10; N=12; h=6

procedures in case it is planned to repeat the experiment. Completely different solutions have resulted by changing the parameter values within the same program procedure. All of the parameters are given at the bottom of the pictures for each experiment. Seven different fonts were used among them Helvetica, the well-known font from the Windows fonts, whereas the other fonts come from our database and have been designed for the needs of this paper.

Set fonts are placed within the array relation, and all of the random numbers from 0 to 6 have been set with the help of:

```
/Jr rn h mul def /j Jr round cvi def.
```

In order to enable repetition of the experiment, the complete program procedure is attached to this paper. Random choices of FN fonts are shown set by the following relations:

```
/FN1 {/BRUSH21_.PFB} def
/FN2 {/Helvetica} def
/FN3 {/NEW_____} def
/FN4 {/BRUSH38_.PFB} def
/FN5 {/MAKISUPA.PFB} def
/FN6 {/BRUSH45_.PFB } def
/FN7 {/BRUSH49_.PFB} def

/s { mark pstack pop } def
/a A def %
/m M def
/Sjeme1 S1 def % generator br.1
/Sjeme2 S2 def % generator br.2
/Sjeme3 S3 def % generator br.3

/S11 {a Sjeme1 mul m mod dup
    /Sjeme1 exch def Modul div } def

/S12 {a Sjeme2 mul m mod dup
    /Sjeme2 exch def Modul div } def

/S13 {a Sjeme3 mul m mod dup
    /Sjeme3 exch def Modul div } def

/p {S12 l1 mul l2 add} def  %sluèajni broj izmeðu
                             l2 i l2+l1
/v {S12 l3 mul l4 add} def  %sluèajni broj izmeðu
                             l3 i l4+l3
/rot {S13 l5 mul l6 add} def  %sluèajni broj izmeðu
                               l6 i l6+l5
/rn {p 100 div} def  %sluèajni broj izmeðu 0 i 1
0.4 0.4 scale
400 400 translate
N {v 10 moveto
RD GR BL setrgbcolor
/Jr rn 6 mul def /j Jr round cvi def
[FN1 FN2 FN3 FN4 FN5 FN6 FN7] j get findfont
v scalefont setfont
(ZNAK)show rot rotate} repeat
showpage
```

The font to be displayed in the individual program printouts is chosen stochastically. In order for the overall experiment to have better security characteristics, random values of red and blue are used in the same manner as in the previously described cases. The vertical shift is constant, whereas the horizontal shift value is set with v variable. The font size in individual printouts is set with the same relation. It is set in the program and the word "Znak" is repeated N times. Three different generators were used in different parameters.

Generator No 1 is used for generating random numbers in the range from zero to one. The stochastic change of red and blue colors is set in this manner. The same generator is used for choosing the font types in individual printouts. Generator No 2 determines the horizontal shift of each printout and the font size. Generator No 3 sets the text rotation angle in each printout. The generators are independent of each other and each one of them provides a different sequence of random numbers. Owing to this it is impossible to repeat the designs without knowing the initial parameters.

The importance of knowing certain parameters is stressed because it is essential to know them in order to repeat the described security typographical designs. This is best seen in experiments No 7 and No 8. The introduction of the second and third random number generators and their application to various parameters in the program designs makes it impossible to repeat the experiment. These solutions are applied in making documents with security elements such as all types of security papers, diplomas, entrance tickets for all kinds of events, transportation tickets, etc. Besides the CMYK and RGB systems, the typographical solutions offered may also be carried out as UV colors or infrared colors [6]. With such application security elements become even more efficient. The security elements are observed only under devices that have the possibility of selecting wavelengths so that the graphic design of a document can also be carried out as a double design. One design is visible in the visible specter and the other design in the specter area invisible to the human eye [8].

4. Conclusion

The produced digital letters provide the foundation for introducing mutational typographies into the field of security graphics. The introduction of typography into program procedures results in creating unique designs such as presented in this paper. The stochastic approach enables the emerging of typographic transformations that are fully individual and unrepeatable without possessing known set parameters. It is not possible to carry out such deformation of letters by using conventional graphic programs. The purpose in carrying out the presented experiments is primarily to provide graphic product security and create interesting typographical solutions in documents and securities.

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12. Žiljak, Ivana, Pap, Klaudio, Žiljak, Vilko (2009) Double Separation Method for Translation of the Infrared Information into a Visible Area. // *Journal of Information and Organizational Sciences*. **33**, 1; 219-225

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Designer's Custom Screening Elements Development

Abstract

Screening in one of essentials procedures in graphic arts reproduction. Screening elements made possible to reproduce various tints, shades and colors on the printed image.

Standard elements shapes were associated with basic screening system, but informatics technology allows to achieve special purpose, custom designed elements for standard, but also wide range of elements and screening systems for various tasks and dedicated reproduction purposes.

Key words: Graphic reproduction, screening systems, programmed elements, designers applications

The timeline

We could say that the necessity to repeat or reproduce some sign or image goes far back into history. As long ago as in the Babylonian empire times cylinder seals existed and served as proof of certain documents' authenticity in those times.

Figure 1. Babylonian seal

As there was no other way to do it, reproducing any document or record was done by hand copying. The method of replicating certain drawings or signs with the help of xylography was taken over from Far East (T'ang Dynasty, Diamond Sutra; Yi Munsun, Korea's Koryo Dynasty) sources in more recent times (in the 11th century was introduced in Europe), and this means the carving of certain protruding forms in wood and their printing onto a suitable surface, the result of which were prints. (fig. 1, 2, 3)

Figure 2. Printing plate *(Worin ch'on-gang chi ko, Korea)*

Figure 3. Frontispiece of the earliest dated printed book, the Diamond Sutra, 868.

The medieval incunabula were sometimes a combination of texts and added images and this was used in the printed documents of those times. After a certain period of time instead of wood plate (fig. 4), a metal plate was introduced and used as the media for producing image information in the documents of the period in the form of a copperplate engraving and etching with concave elements (and this would correspond to today's intaglio). Gutenberg's movable types invention was suitable for promulgating a "written word" (fig. 5), but all possible changes application of the printing system allowed more extensive production and distribution of such printed images or drawings done by various masters.

Figure 4. Woodcut print (XVI century)

Such images (reproductions) were in fact drawings, and the possibility of shades (tones) was achieved by closer or further

Figure 5. Letterpress types

setting of elements that displayed a lighter or darker shade. This type of reproduction actually required as obligatory the craft and skill of an artist involved in making it, and also knowledge on the materials and technique used.

Lithography as a reproduction procedure became known of at the end of the 18th century (Alois Senefelder 1796). It was a reproduction technique using plates with crayon drawings, where the main principle overtaking of dyes from then plate to substrate was the effect of hydrophilic and hydrophobic properties, and in case of a multi-color reproduction (chromolithography, 1837), a special (extra) form had to be achieved for each printed color.

Corresponding photo systems were developed with the development of photography (Daguerre, Talbot), as well as photo material suitable for producing photographic images, that also rendered reprographic possibilities. The works of Newton (Seven Primary of Simple Colors, Opticks 1704) open the area of knowledge about light and colors, and this is continued by many, especially Maxwell (Experiments on Color 1855, on the Theory of Compound Colors, 1860), H. Von Helmholz (Manual of Psychological Optics Vol II 1860) where fresh knowledge is accepted allowing thereby the development of the manner of producing photographic color images based on the additive as well as subtractive color mixing principle.

As technology was able to make black and white reproductions (prints), desire for colored reproduction grew, so subtractive principles of achieving such reproductions had started to be used in graphic reproduction as well. Photographs were able to reproduce various tones , after colors also), but that due to the photographic system (silver halides, emulsion, exposition, etc). General printing systems can not show different shades (lightness), some have tried to overcome the problem of reproducing shades in the graphic systems (F. Talbot, M. Jaffe, C. Angerer, G. Meisenbach) by using nets and line systems trying to achieve various tones (shades) with various printing areas. Only after a screen system had been produced on basis of a glass screen (fig. 6) (Louis brothers at the same time as M. Levi in 1890), and by using the corresponding photo materials as well as printing form systems, it was made possible to have successful graphic reproduction and single multi-shade images as well as multi-color ones, with the principle on differing printing elements (dots) and their coverage, meaning a part covered with screening elements in a elementary screening cell. (Willkom, 1978)

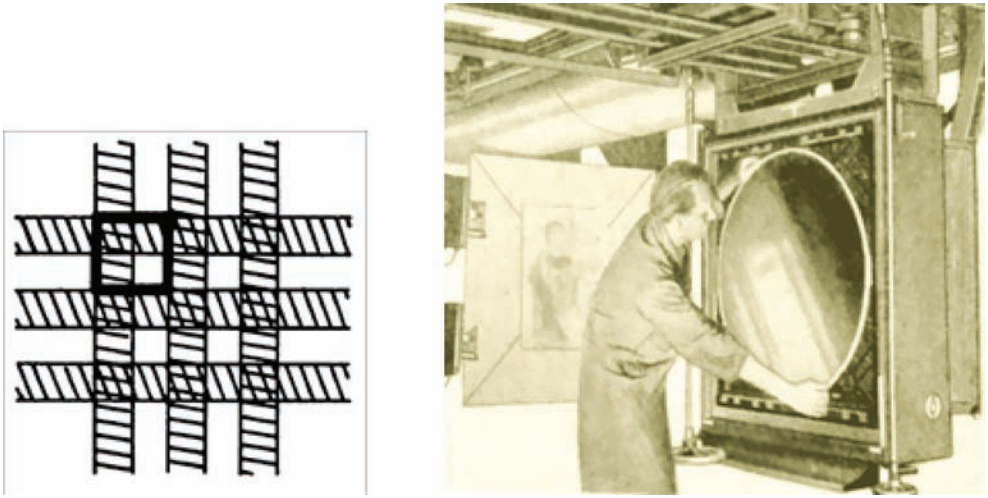


Figure 6. Principle of glass screen, elementary cell (left), position in camera back (right)

Due to the simplicity in photographic as well as film procedures, the dual tone manner of showing colors (Hernandez, around 1912) was used in printing for a certain period of time, before standard separation technique and subtractive colors plus black were widely used (fig 7.)

Glass screens were rather limited as to the possibilities of various screen rulings as well as screen element shapes, and their production was quite complicated. The possibilities of manipulating with shades (tints and colors) were quite modest taking into account that the process was generally non-direct and leaned upon the characteristics of the optical system, photographic material and the screen itself.

Certain adjusting of reproduction parameters (screen element form) was enabled by possible overlapping of (glass) screen lines at some other angle (different in respect to 90°) whereby the element form altered partly,

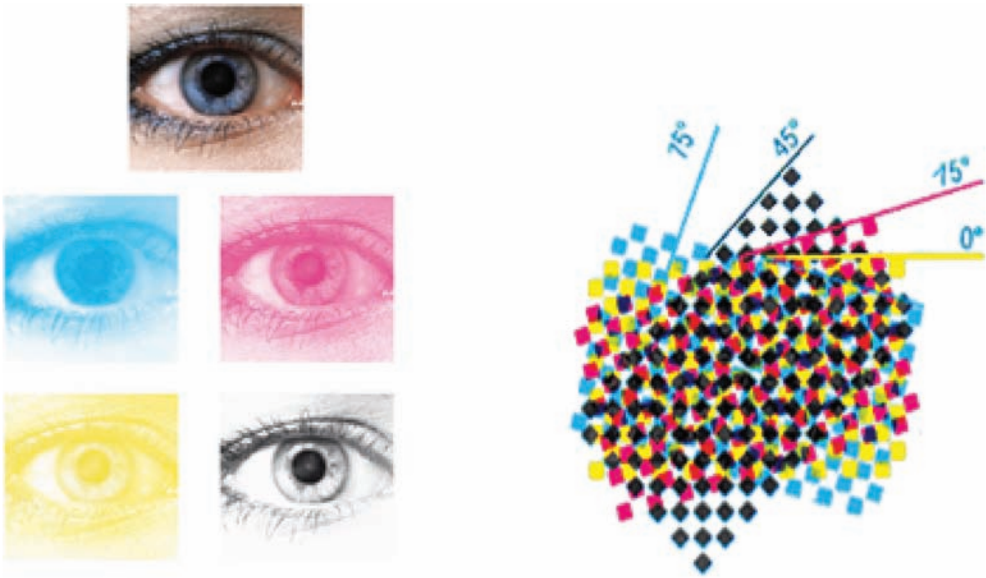


Figure 7. Separations (cyan, magenta, yellow, black, left), standard separation angles (right)

or with the use of special lens shades fig. 8, (Kraus) and this required additional attention. Contact screens (gray and magenta) are introduced in the twentieth century's Fifties (fig. 9) and they offer a somewhat wider choice of screen rulings and screen element forms, as well as the so-called screens for special effects. They allowed better quality reproduction, but any further altering of any parameter required physical altering of the screen system, i.e. the altering of the screen itself. That shortage of various element shapes and their missing in today's screening and reproduction possibilities of their development for various purposes and appliance becomes possible with the aim of information technology and programming. (Agić 2002, Žiljak, 2002)

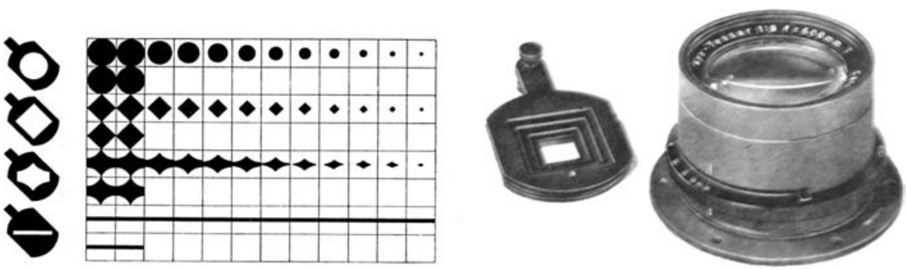


Figure 8. Special lens-objective masks used for changing screening element shape

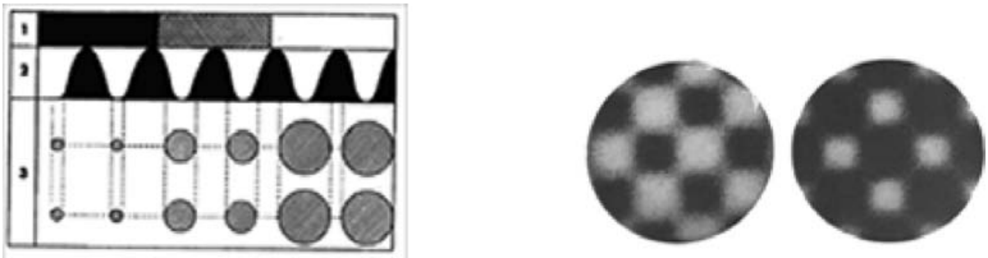


Figure 9. Contact screen (function) left, enlarged “dot” in the contact screens (right)

Scanners, the electronic reproduction devices, first appeared as analogue systems-analogue computers (fig. 10) with generally basic possibilities for color and tones correction, magnification and some other basic correction options for simultaneous (corrected) printout to film as a semi continuous image. They mostly were designed as drum scanners (Burden, 1980), afterward as flat bet devices. Later screening possibilities were added.

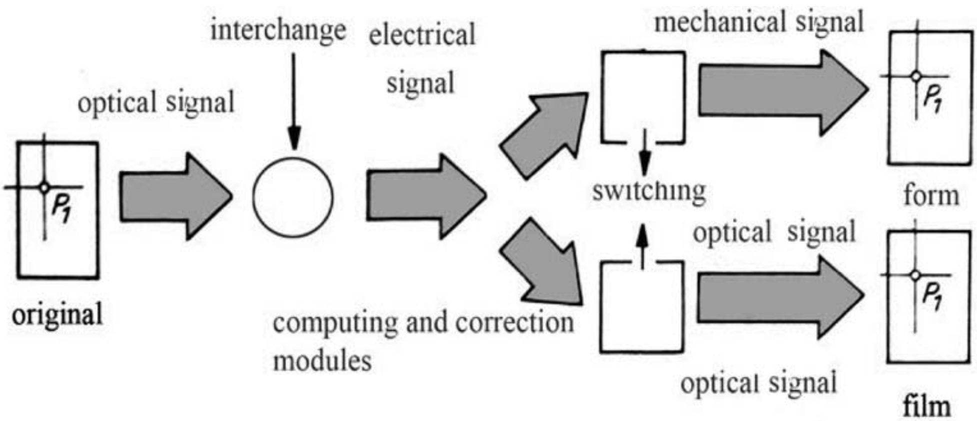


Figure 10. Schematic layout of a (simultaneous working) scanner

Recent accomplishment

Digital systems with program aimed control of reproduction are introduced in the twentieth century’s Seventies, and they take over the leading role in respect to analogue and indirect reproduction systems. They introduced a wider choice of various correction options, and were able to produce a “digital dot” as subcell (supercell) matrix (fig: 12),

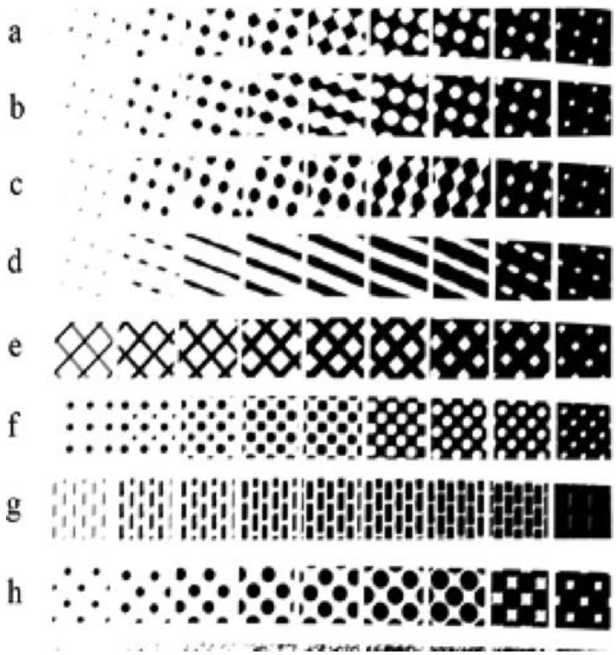


Figure 11. Some standard screen element shapes: a) square, b) chain, c) elliptic, d) lines, e) square lines, f) double dot, g) brick, h) round

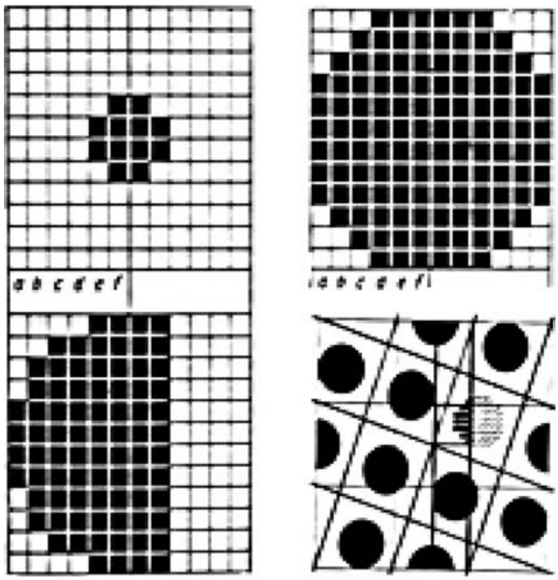


Figure 12. Forming supercell and "digital dot " (Screening Technology 05-2002, Freyer 2006)

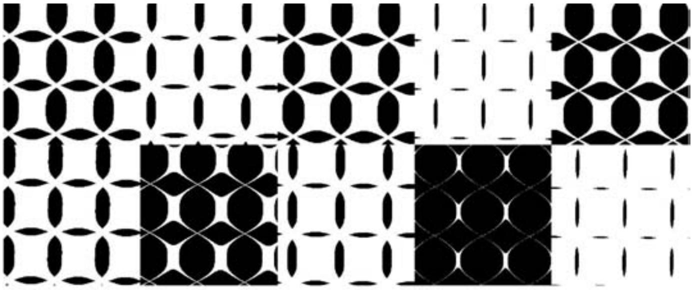
and screening systems with means of screening computer using tables. Separating functions in such system "scanner" overtook the function of a "input device", producing a digital image build of pixel matrix, recorder as a output device, and implementing screening functions, and after PS programming into a RIP, (raster image processor) first as hardware, later as software managed devices, the possibilities widened not only as AM also as FM screening systems producing "digital dot", meaning screening element. Producers of screening systems (RIPs and recorders) their products applied to various printing capabilities, but in applying various screening element shapes mostly used standard, conventional or well known ones, such as round, square, elliptical (chain), line, or similar ones. (Morgenstern, 1985)

All of them support parameters such as accurate of coverage, system structure (AM or FM), exact separation angles or any angle, shape of element in any combination, dot gain, dithering possibility RIPs are rather closed systems, but to days informatics support allows creating various shapes of elements using a PC and export it to establish a film or plate for reproduction.

Programmed shapes

This opens a practically unlimited possibilities of creating screening models and screening shapes that can be fixed on the image, but simultaneous variations of various parameters are possible. As in such combinations picture element becomes similar to screening element in function, this opens a wide range of possibilities and improvements in reproducing colors and tones on various printing systems. (Pap et al., 2008)

Such implementations lead to an interesting situation of creating custom designed screening elements and systems for dedicated reproduction purposes. This implies special (custom) shapes of elements, applications in valuables, very high individualization, control of various cmyk parameters such as dot gain, (Žiljak et al., 2009) special effects, special designers applications etc. (Žiljak et al., 2005, Datevernier, 2008)



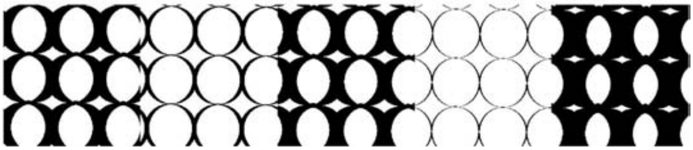


Figure 13. Layout of r52 and r53 elements shape (0 deg. screening angle)

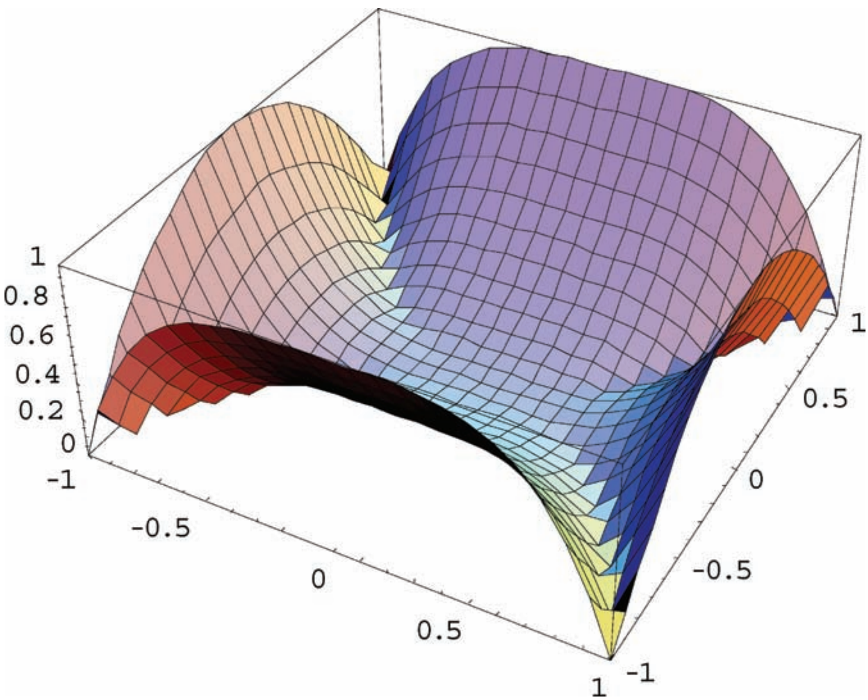


Figure 14. r 52 3D view

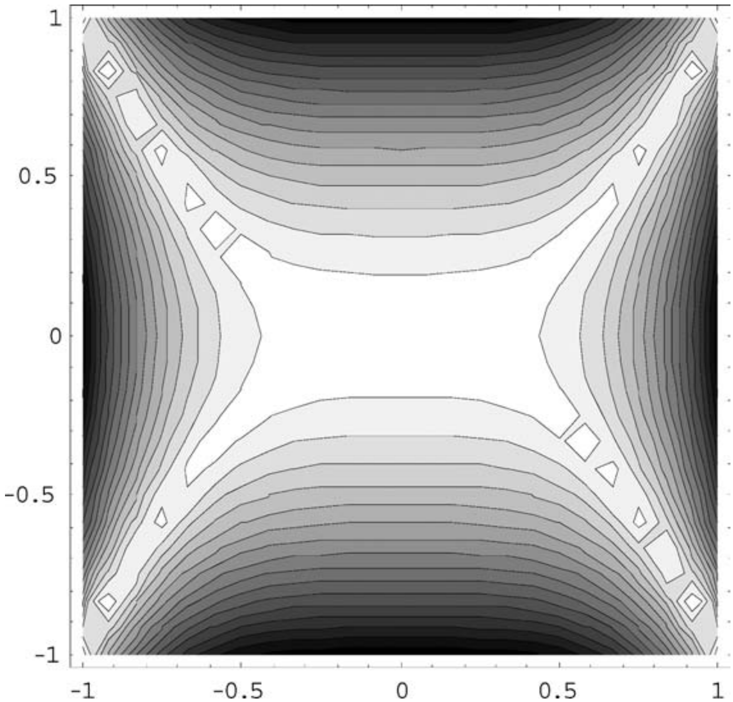


Figure 15. r52 topographic view

In this paper two new screening elements r52 and r53 are introduced. For each of them a detailed testing in whole range of coverages is made. Such detailed testing must be applied cause (Žiljak et al., 2003)

determining its decesion its decision algorithn, what is an lasting process that can discontinue craftsmanship of the printing form without declaration of the cause of suspense of the process.

```
Z= Abs[(Abs[x^4]-Abs[y^2]) ]
```

PS code:

```
/r52 {dup mul dup mul abs exch dup mul abs sub abs
} bind def
```

Pixel lightness is given with the vector lightness

```
5 2 8 [1 1 div 0 0 1 1 div neg 0 0 ]
{<80cc77ee44aa22cc06f0>}
```

Trigonometric individualisation for r53:

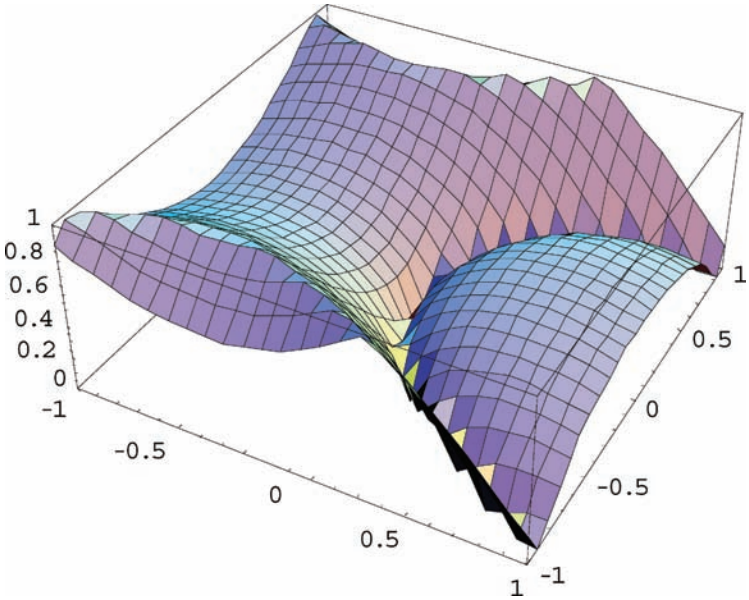


Figure 16. r 53 3D view

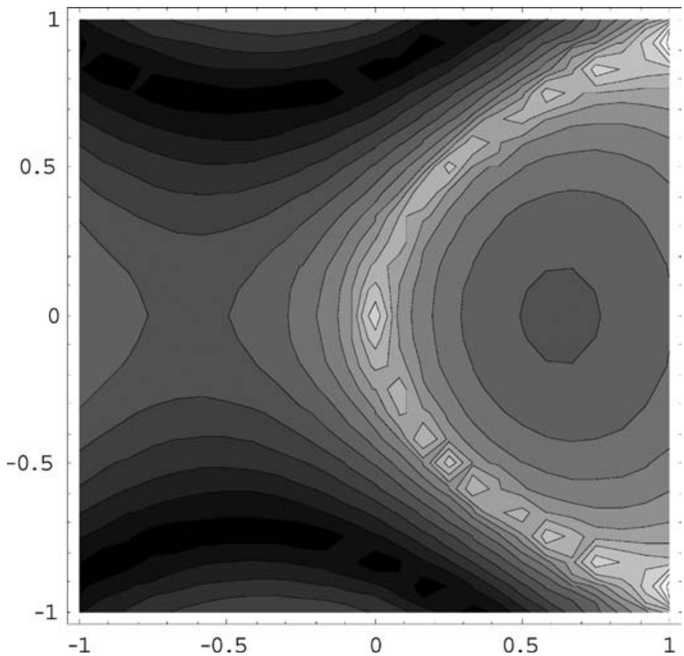


Figure 17. r 53 topographic view

```
z=1-Abs[ Sqrt[Abs[Sin[x]-y^2]]-Sqrt[Abs[Cos[y]+x^2]] ]
```

$$z = 1 - \mathrm{Abs}[-\sqrt{\mathrm{Abs}[x^2 + \mathrm{Cos}[y]]} + \sqrt{\mathrm{Abs}[-y^2 + \mathrm{Sin}\ [x]]}]$$

PS code:

```
/r53 {dup sin 2 index dup mul sub abs sqrt 3 1 roll
exch cos exch dup mul add abs sqrt sub abs 1 exch
sub } bind def/r54 {dup 2 index div abs 3 1 roll
mul add 20 div } bind def
```

Numerous programs (applications) are in integer range of parameter definitions and is possible to false determine and arrest the plotting of the CTP printing form for large formats, as for newspaper printing screening continuous values overall screening parameters. Caused of that (dis) continuous process, huge disservices in production are possible, so imminent and close collaboration between designer and programming engineer of dedicated screens and the printing plant that facilitates, numerous testing and experiments on production printing plates have to be performed.

In this work two new algorithm for screening shapes are proposed in respect that they can be processed and realized in current CTP systems. Permissions for maximal enlarging of the level of density definitions are allowed. The best example for such definition is for the element shape r52 where in analytical expression is appended a diminution of the function as proceeded in PS function to 20 *DIV.* Such adjusted value of the expression ensures access through the CTP system, although for visual screening it can be at the value of 10. For smaller values this screening

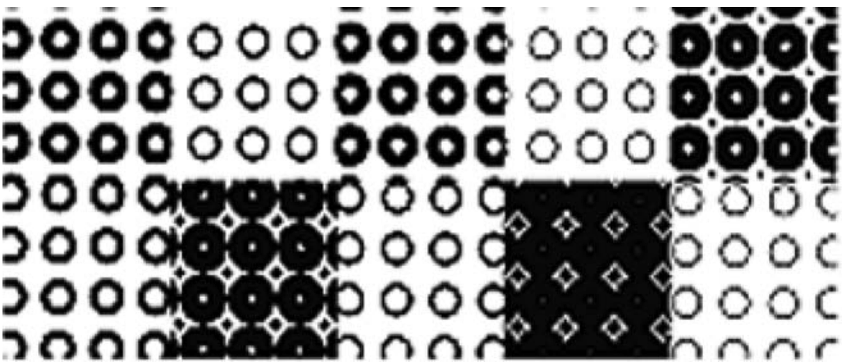


Figure 18. Screening element “ring” as reproduced (layout)

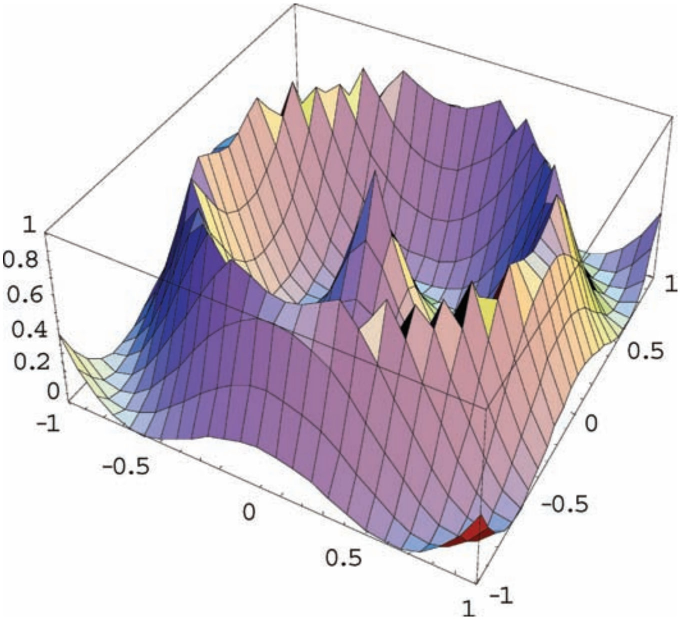


Figure 19. Element "ring" as 3D view

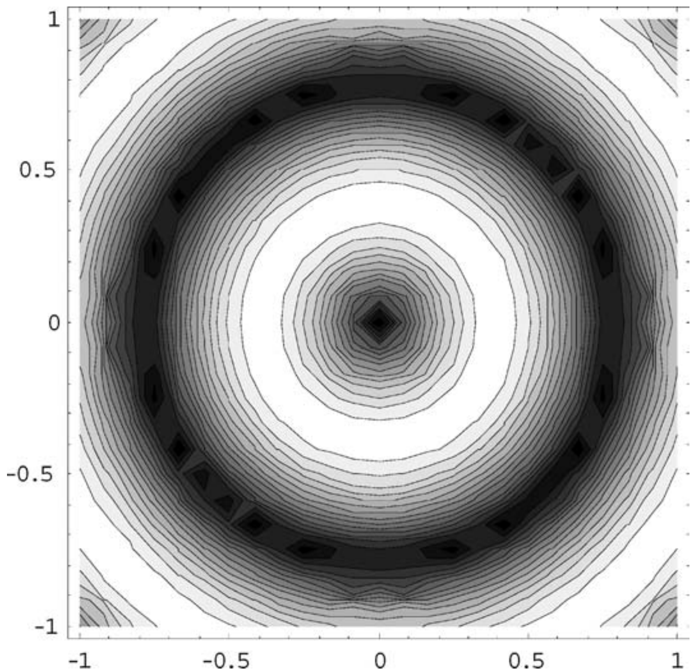


Figure 20. Element "ring" as topographic view

element shape suspends the procedure of bitmapping procedure, but that depends of the definition of certain pixel density. A very interesting element "ring "containing very extended characteristics was already introduced (Vujić et al., 2009.)

Ring:

$$z = 1 - \mathrm{Abs}[\mathrm{Sin}[4\sqrt{x^2 + y^2} * 16]]$$

```
z=1-Abs[Sin[Sqrt[(x^2+y^2)*16]]]
```

PS code:

```
/rP { dup mul exch dup mul add sqrt 160 mul sin abs
} bind def % prsten
```

Similar behavior with screens in the series of examined r95 and r73 shapes were found (Pap et al., 2009.)

As contemporary graphic arts activities are incorporated with color management and workflow , so all mentioned shapes and modifications of elements can be used and applied within that systems and support predicted conditions. Extended assignments with systems of non visible part of spectrum colors can be accessed too.

Conclusion

A continuous overview about rise and development of approach the reproduction possibilities is presented. It was a long way from first written ideograph, character, cave painting, seal as a clue of authority, to woodcut and metallic stencils, and possibilities of integrated script and picture reproduction. To days technology, informational supported widens limits of possibilities of all topics wanted to be reproduced or printed on various substrates or media. Reproducing facilities comprehend whole surrounding from materials, processing possibilities, ordering, belief supported by technical, programming, and all possible demands. For various reproduction and printing purposes where screening is used and special demands have to be implemented, including special inks and colors for dedicated purposes, (Žiljak-Vujic et al., 2008.) close coordination between reproduction and printing technologist, designer and programming developer is a necessity. Special shapes and functions by screening technology are not only designers ways of expression, they are present in numerous graphic arts products, as custom designed effects, valuables, personalization, etc. (Pap et al. 2009, Žiljak-Vujic et al., 2006.)

Custom designed and programmed screens as r95, r73 already found their place in screening techniques. Introduced realized ,proved screening elements attribute further arrangements as visual and technical way out for further wide gamut of realizations.

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Process and Structure of JDF Protocol in Production of Hardcover Books

Abstract

The primary purpose of the integration of digital printing process is the uninterrupted exchange of information about a given product within different production departments installed at various control platforms. Production parameters with the proposed workflows and information flow about the product are integrated into the JDF (Job Definition Format) protocol that provides remote control of production with emphasis on the optimization of the processes. Using the installed resources. XML (Extensibile Markup Language) independent markup language supports JDF records and introduces a new way of communication and control of graphical processes.

Key words: Integration, JDF, automation, MIS, XML

1. Introduction

Graphic processing industry on the market today integrates mostly heterogeneous working structure with an emphasis on an intermittent (or non-existent) transmission of digital information. Non-conformity and non-uniformity of such records and performing procedures forced the management to numerous discussions and seminars focusing on the issue of leadership and management of graphic production. Accordingly, a consortium of the world's most prestigious firms (MAN Roland, Heidelberg, Agfa, Adobe) was created with the purpose of setting a common standard of communication because each individual attempt was a failure and none of the proposed standards was measured as an ISO standard. The main common goal was solving the current situation and creating presumptions for the introduction of a new uniform code format that could integrate a complete video production, including management of production processes.

Although the JDF Protocol represents the prospective and safe future of production and managing, its complete implementation will be possible when all the elements of the system are networked. This means that the machines will with their memory and managing systems be able to correspond to the above stated programming languages, the operators who will be trained and master the programs and the standardisation which will certainly have to be defined according to the ISO Standard.

The ability to achieve results would be visible in the proposed integration of:

- automated production units,
- the production *(prepress – press – postpress)* and
- subsequent analysis with elements of corrections

2. JDF Protocol as Standard of Graphic Communication

The JDF graphic communication protocol describes the workflows that are based on the XML programming language and CIP3/PPF (International Cooperation for Integration of Prepress,

Press, and Postpress/Print Production Format) technology and represents the customization of the given industry standard. A transparent form of production integrates all the workflows, from the ideas of the authors presented in digital form, to the final appearance of the product, including the surrounding parameters with different inputs.

The main characteristic of the JDF communication is designing the system into a unique flowchart of the working phases, which are divided into groups: preparation (*prepress*), print (*press*) and finishing (*postpress*). The proposed JDF provides a progress in the description of automation of production processes with an emphasis on increased efficiency through the optimization of time and materials. The control and monitoring of workflows improves, and all the data are stored, and thus a database for further development is designed. The links are created to digital graphic system into a single entity using JDF records whose architecture allows the installation of control program through work tools.

The JDF job specification describes the syntax and structure of the JDF job orders JTF (Job Tickets Format). JMF (Job Messaging Format) with its syntax is also implemented in the protocol and provides valid information on management of information to the management of printing office. The mechanisms are provided for communicating through the construction of hierarchical platforms, which are divided into command categories with the accompanying networking. JDF installation is available for all the installed operating systems that are networked and connected to the server where the database is located. In addition to networking of production departments, it is necessary to link departments with resource stocks that are automated in the consumption by each work order. The mechanisms are created for control and monitoring of production and subsequent changes can be entered in the production process according to the commands sent by the MIS (Management Information Systems). The JDF record is not an application or system of graphic communication, but it integrates reference sources on the given graphic product.

The JDF and JMF file formats which are directed towards the vertical communication from management to production ensure the coherence of the records on the equipment of different manufacturers, which was not feasible before, and thus overcomes the obstacle in non-adjusted management systems.

With such a design JDF has the following benefits:

- the ability to record a unique code which describes the working phase and distributes them to all departments where necessary. These documents describe all the elements of the product as well as all CIP3 procedures up to delivery of the finished product;

- the ability of distributing information between the management of production (MIS) and all production departments by bi-directional communication. JDF provides an insight into the basic calculation lists and subsequent calculation after execution of the production;
- the ability to inspect the finished product by customer ideas, i.e. to harmonize product ideas according to the installed capacity of the printing office using optimum solutions;
- the ability to inspect work in graphic display on the screen and the definition of detailed manufacturing processes with selection of final production models. Each new production workflow complements the database of workflows that can be corrected in the production process.

The first beta JDF specification were presented in 2000, and the next version 1.0 a year later. The development of CIP4 standards is followed by the development of JDF, and the final version 1.3 was released at the end of the year 2005.

3. Exchange of Information within Structure of JDF Protocols

The structure of JDF protocols is presented as a delta flowchart with all the elements necessary for its execution. The work flow should be an automated manufacturing process which, as a whole or in segments, transmits information about the product and tasks to all the participants in the execution process. JDF provides three main features of the communication within the graphic industry and the integration of production systems:

- the first feature – JDF as an XML encoding mechanism for the exchange of information which are associated with different IT systems and integration of different productive resources,
- the next feature is the flow of information by sub-system that provides communication within the whole system of work for each computer station where an individual control is executed,
- the last feature is the ability to implement documentation that describes each resource required for the completion of all phases of printing work.

The set-up job assignments are set at key job nodes such as the technical characteristics of the hardcover book, MIS information on a particular product, information on a client, deadlines, delivery and more. The architecture in the exchange of information was constructed in the shape of a

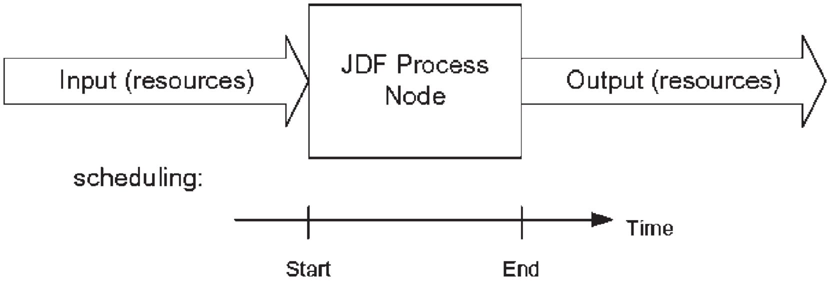

Figure 1. Flow of information through control node

pyramid, which is divided into three levels of management. The distribution is according to the management functions in the manufacturing process. The transfer of information about the product with all the elements and the network integration are managed according to individual workplaces. The flow within the pyramid itself is carried out using "nodes" to form a hierarchical pyramid of control.

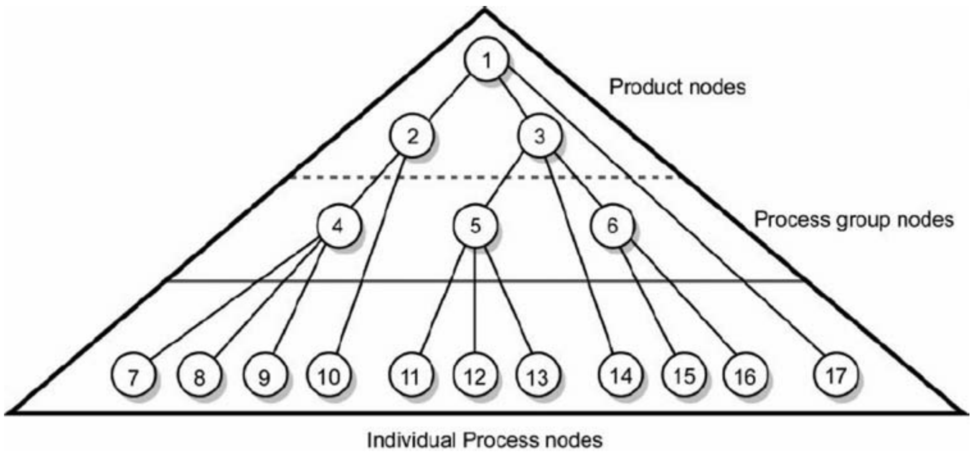

Figure 2. Control pyramid with JDF nodes and hierarchical information (JDF Specification)

The base of the pyramid consists of a specific information on the work product that describes every single working step made by the executor. The next step in the pyramid describes the graphic product with all production processes that should be executed i.e. it describes the workflows. The top of the pyramid belongs to the management department, which contacts the client, where all the basic information on all the ordered job tasks are entered. The JDF nodes contain attributes and elements, while elements contain their attributes and sub-elements, and they again their various elements. The distribution of tasks creates pre-conditions for optimization of the entire work process, with the description of each working node separately.

Adjusting the distribution of information to the description of the commands in the executive operating points (nodes) provides a complete review of the final tasks. The working documents applicable to printing and finishing machines that support it and can be connected to MIS departments, must be adjusted to their level of computerization. Recording of all work places should describe each phase of work (node) and through the digital record in the JDF determine its validity or the need for change in the organizational chart. In cases of economic non-rentability it is necessary to exclude such a position, and distribute the information about the product to the next node. The distribution points that describe the production flowchart, describe each phase or the process to be performed separately.

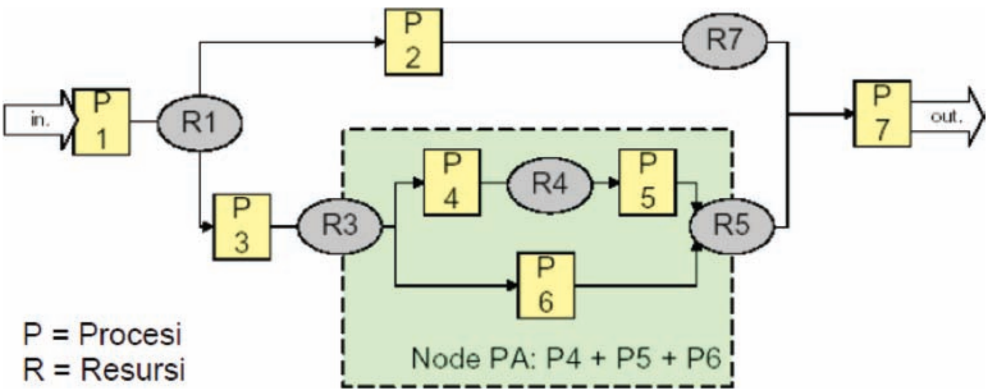

Figure 3. Exchange of information within process and installed resources (JDF Specification)

There are three types of nodes according to their descriptive function:

- Product nodes (transmit information about the intentions of the job),
- Process Group nodes (transmit information about the phases of the job, i.e. workflow of the production) and
- Process nodes (which describe an individual approach to individual work phases).

The nodes also support other information related to the product and they are located in the sub-groups of primary functions and describe actions to be subsequently executed. The relations between the nodes are positioned in two categories: in a hierarchical (vertical) or laterar (horizontal) direction. The combination of horizontal and vertical nodes forms a complex network environment and describes the entire production process. The output information of a node is usually input into the next node, where the exchange of process and resource files takes place. In simpler situations JDF document is shown as a node, which describes the function holder of a certain segment of the production (manufacturing, printing, finishing). The nodes from the perspective of separation of individual work phases represent distinct phases that include the data on imposition, time of printing, the information on finishing stages and the information on the final result.

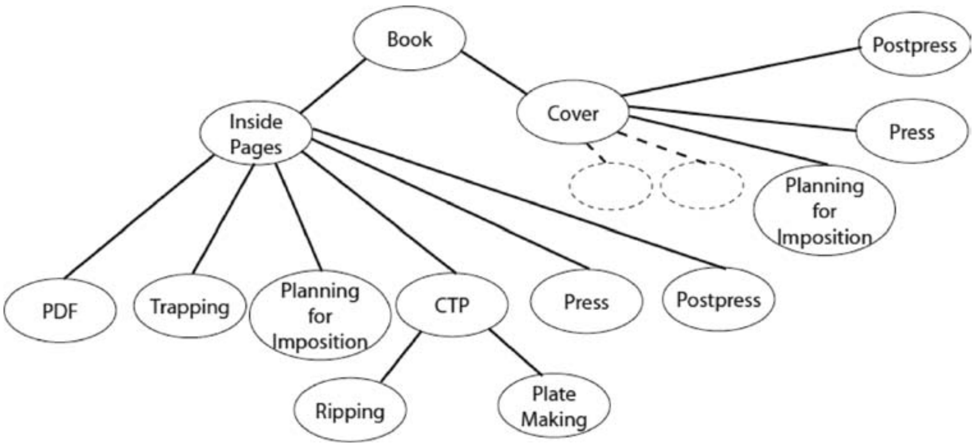

Figure 4. Tree diagram – processes in job ticket

4. Conclusion

Today there are more than hundred different versions which are presented on the market as ready-made solutions for printing which will be installed using the *plug and play* system and have their integration solved. Subsequently, however, the deficiencies and inefficiencies of such ready-made solutions are recognized. Many such projects have never been activated in a real graphic production, and the reasons for failure are in their unsystematic approach and in not recognizing the whole complexity of production. The concrete solutions are not presented and the individual production model that will suit the respective printer are not suggested. Only the solutions derived from the real production that were tested in concrete situations in the form of digital models and stochastic simulations can confirm the validity of the proposed model.

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Mechanical Methods of Soil Cleaning

Abstract

Soil cleaning technologies are becoming more and more important especially in industrialized countries. Application of soil washing i.e. physical separation results in cleaned soil which can be reused at the origin or the other location. Separated impurities (metals, hydrocarbons) are considered as special waste and further processed and/or disposed on special landfills. Technologies that were originally developed for mineral processing, due to similarity of operative goals – concentration/separation of certain matter adhering to a certain class of grain collective – have a high potential for use in soil cleaning. The purpose of this paper is to give a review of mineral processing methods which can be applied in soil washing technology, and to present some of the processes successfully applied in practice.

Key words: soil cleaning, soil washing, mechanical methods

1. Introduction

Soil cleaning (soil remediation) has been gaining more and more importance over the last decade, especially in industrial countries with considerable soil pollution due to intensive industrial activities. The sources of soil pollution are chemical, petrochemical, pharmaceutical and graphic industry, agriculture, metallurgy, mining, fossil power plants, transport, landfills, waste recycling plants, etc. Croatia, as a country with low industrial activity, has a relatively clean soil. However, due to lack of soil protection strategy, the soil as a resource was neglected until recent time and its quality is yet to be determined. According to the available data, 1,056 potentially polluted sites were recorded in Croatia, 69 of which were confirmed as polluted sites, but the number of potentially polluted sites is very likely higher (AZO, 2007)[1]. Also, 11 so called "black spots" were registered in 2005 (AZO, 2007)[2]. Two of them were remediated (power plant Plomin and PVC factory "Ina Vinil") and one is still in the process of remediation (coke plant in Bakar). Other sites with critical soil pollution due to industrial activities and improper disposal of hazardous technological waste are: asbestos-cement waste dumps of the asbestos products factory "Salonit" (Vranjic and Mravinačka kava), ex alumina factory in Obrovac, ex electrodes and ferro-alloy factory in Šibenik, Croatian Railroads station for washing and disinfection in Botovo, hazardous technical waste dump "Lemić brdo" near Karlovac, tar and waste oil dump in Jama Sovjak, phosphorous-gypsum waste dump of "Petrokemija" in Kutina (Figure 1).

Not so long ago, depending on the area of contaminated site and level of contamination, the main methods of dealing with contaminated soil problems were: the isolation of contaminated area with restricted admittance, covering the contaminated area with clean soil and vegetation, or excavation and controlled disposal of contaminated soil.

Today, there is a wide range of soil cleaning methods. Soil washing is a method of soil cleaning in which the contaminant is removed from the soil, and after that cleaned soil can be used again at the same or different location with no threat to humans or environment. Removed contaminants are further treated and/or disposed as a special waste.

2. Soil Contaminants

From the viewpoint of pedology, soil is an autonomous natural and historical creation as well as a capital good of agriculture and forestry (Martinović, 1997). Key factors of soil genesis and development are soil matrix, living organisms, climate, geomorphology, time and human activities. One of the essential properties of soil is its fertility which is closely linked to the development of vegetation and living organisms in soil. Soil is a system consisting of four phases – solid particles, solutions, air and living organisms, structured by different levels of hierarchy: atoms, molecules, particles, horizons, profiles, pedosystems, soil associations and pedosphere.

Contaminated soil is a soil that contains pollutant above a certain level causing a deterioration or loss of one or more soil functions (EC-JRC, 2010). The functions of soil are: production (food, biomass), biotopic function (biological habitat), environmental interaction (transformation, regulation, filtration, storage), source of raw materials, building platform (Martinović, 1997). Anthropogenic contamination typically arises from

Figure 1. Black spots (AZO, 2007)

the underground tanks leakages, extensive use of pesticides and fertilizers, infiltration of contaminated surface water to the subsurface, landfill and waste dumps leachate infiltration, industrial wastewater discharge, spilling and industrial waste disposal directly on the ground, etc. Soil contaminants can further contaminate a groundwater and air (EC-JRC, 2010; EPA, 2010).

Soil contaminants are usually divided into organics and inorganics. Further, organic contaminants are classified by volatility and presence of halogens in their chemical structure (Reis et al, 2008; FRTR, 2010):

1. Organics
   - Nonhalogenated Volatile Organic Compounds (VOCs)
     a. Light Hydrocarbons
     b. Benzene, Toluene, Ethyl benzene, Xylene (BTEX)
     c. Oxygenated Hydrocarbons
     d. Other compounds
   - Halogenated Volatile Organic Compounds (X-VOCs)
     a. Chlorinated Hydrocarbons
     b. Other X-VOCs
   - Nonhalogenated Semi-Volatile Organic Compounds (SVOCs)
     a. Heavy Hydrocarbons
     b. Nonhalogenated Pesticides
     c. Polycyclic Aromatic Hydrocarbons (PAHs)
     d. Nitrogenated PAHs and Amines
     e. Nonhalogenated Phenols
   - Halogenated Semi-Volatile Organic Compounds (X-SVOCs)
     a. Polychlorinated Byphenyls (PCBs)
     b. Halogenated Pesticides
     c. Other X-SVOCs
   - Dioxins i furans

2. Inorganics
   - Heavy metals
     a. Volatile heavy metals and compunds
     b. Nonvolatile heavy metals and compounds
   - Radionuclides
   - Other inorganic elements and compounds (azbestos, fluorine, cyanide, etc.)

3. Soil cleaning methods

Soil cleaning can be applied at contaminated sites using mobile plants or in stationary plants after transportation of excavated contaminated soil. Soil cleaning technologies are classified by main mechanism of cleaning into: physical, chemical, biological and thermal treatments (Martin et al, 2004). Since an operational goal of certain soil cleaning method can be separation of contaminant, detoxication of soil by contaminant destruction or contaminant immobilization, treatments of contaminated soil are classified into three groups: separation (physical and chemical methods), detoxification/ destruction (chemical, biological and thermal methods) and immobilization (chemical and thermal methods).

Physico-chemical methods based on physical and/or chemical properties of contaminant or contaminated medium are used for the separation or concentration of contaminant, or for its destruction i.e. the change of contaminant chemical properties. Chemical treatments can be divided into two groups: the group of separation methods used for improvement of physical separation (conditioning) and the group of destruction/detoxification methods. Chemical destruction/detoxification methods are based on destruction of contaminant by changing its molecular and structural properties when reacting with certain reagents, resulting in less toxic or non toxic compounds. Physico-chemical treatments are low in cost and energy consumption, treatment duration is relatively short, equipment is widely available and less demanding in terms of qualifications and number of personnel. Application of some treatments directly in the ground can meet the difficulties due to variations of soil parameters (e.g. clay and humus can cause the variations of soil horizontal and vertical hydraulic properties resulting in unevenly cleaned soil).

Biological methods, based on microbial activities, are used for degradation of organic contaminants products like CO_2, H_2O, fatty acids and biomass. Application is possible both on site and ex site in special reactor tanks. Usually, treatment duration is long but after contaminant destruction soil remains bio-active. Bio-treatments are applicable to soil, sediments, sludge and water. The costs of implementation are low. Contaminant destruction is almost complete and additional treatments are rarely required. Difficulty with these treatments is to determine when complete contaminant is destroyed, and additional problem can be the sensitiveness of microorganisms to toxins and high concentrations of contaminants.

Thermal methods are classified in the group of detoxification/destruction methods, but some of them are used for separation too. Using the high temperature in controlled environment, physical, chemical or biological properties and composition of contaminated material (soil, waste) are changed, i.e. contaminant is volatilized, incinerated, degraded, destroyed or melted. Thermal treatments are used for cleaning of soil contaminated with organics like oil and oil derivatives (soil near underground tanks, spilling). Destruction of contaminant is fast (depending on oven capacity and volume of contaminated soil), but energy consumption and equipment costs are high, as well as equipment maintaining and personnel requirements. In incineration devices, e.g. rotating ovens, at the temperature of 500-600 °C, organics are volatilized and oxidized, producing carbon-dioxide, water and toxic compounds like SO_2, NO_x, HCl, products of incomplete incineration and ashes. After thermal treatment, the soil is biologically dead. Heating the soil above 1600°C (vitrification) produces inert vitrified mass, i.e. slag. Because of high energy consumption, these treatments are used only if other treatments are not applicable or effective.

Immobilization (stabilization/solidification) is a group of treatments for immobilization of toxic compounds by their binding to materials like soil, sand or building materials. Toxic compounds are physically bonded or encapsulated in solid mass which has a high compressive strength and low permeability (cement or silicate based solidification, thermoplastic solidification, polymer based encapsulation, vitrification) or they are immobilized by chemical reactions with stabilizers (stabilization). Immobilization methods are applied mainly for inorganic contaminations, but they can be applied efficiently to volatile organics and pesticides.

Soil washing is a technological process of separation of highly contaminated soil particles from the remaining soil, based on difference in physical and physical-chemical parameters of soil and contaminant. The separation is conducted in water as a medium. After washing, clean soil is safe for environment and ready to transport to the original or other location. Soil washing is applicable to soil and sludge contaminated with heavy metals, oil derivatives, PAHs, cyanides, phenols etc. Soil washing refers to the group of methods based on physical separation and/or chemical extraction. Physical separation is used for the concentration of contaminants into a smaller volume of soil, based on difference in physical properties (particle size, density, magnetic, electrostatic and surface properties) between contaminated soil particles (contaminant carrier) and soil particles. The aim of chemical extraction process is to dissolve the contaminant using the water solution of reagents. If the soil contamination is in the form of particles, physical separation is applied, and if it is in adsorbed forms, then chemical extraction is applied. Definitions and use of expressions “soil washing”, “physical separation” and “chemical extraction” can vary from author to author, however, the prevailing technique in the process of cleaning has the main influence on choice of expression. In the USA and Europe, the expression “soil washing” usually refers to the soil contaminant removal by technologies commonly used in mineral processing (Dermont et al, 2008). The efficiency of separation methods in soil washing depends on soil characteristics: particle size distribution, particle shape of soil matrix and contaminant, clay content, humus content, soil moisture, heterogeneity of soil matrix, difference in density between soil matrix and contaminant, magnetic and electrostatic properties of soil and contaminant, surface properties of particles (wetting), etc. Soil washing for heavy metal removal can be difficult, especially in the following cases:

- Metal is firmly bonded to soil particle surface;
- Soil matrix and metal carrier particles have similar densities;
- Metal is present in wide variety of chemical forms;
- Metal carrier particles are present in wide size range;
- Contaminated soil contains more than 30-50% of clay, large amount of humus and/or very viscous organics.

Separation methods are applied primarily on urban and industrial soils contaminated by human activities. They are not so efficient for cleaning of agricultural soil because it contains relatively low concentrations of adsorbed metals, high amounts of clays, fines and organic matter, although some treatments like attrition scrubbing can be used for the improvement of chemical extraction of adsorbed metals. Some recent experiments have shown high efficiency of separation methods for the removal of hydrocarbons too. Only by water washing, 24% of n-alkanes is removed from the soil of particles size –0.8 mm, contaminated with diesel fuel at the concentration of 7% by weight, and the use of surfactants in washing process results in 97% removal of the contaminant (Khalladi et al, 2009). Attrition scrubbing experiments conducted on sand samples of particle size 0.1-0.5 mm, contaminated with diesel fuel 5-15% by weight, resulted in 96% contaminant removal (Bayley & Biggs, 2005). Flotation of sand (particle size 0.4-1.2 mm) also resulted in high percentage removal of diesel fuel (> 90%) (Couto, 2009). Mineral processing technologies can be efficiently applied not only for the removal of metal and organic contaminant, but also for radionuclide removal (Gavrilescu et al, 2009).

4. Technological process of soil washing

In mixture of water and contaminated soil, mechanical energy is introduced via certain machine or device and, if necessary, a reagent is added and/or mixture is heated. In that process, soil matrix is disintegrated, individual soil particles are liberated and contamination dissolved and redistributed. After classification, separation and dewatering, most of the processed material is "washed soil" that can be returned to the original location. Small amount of separated material contains most of the contaminants in the form of sludge, light products (wood, coal, coke, porous building material, etc.), flotation froth or water solution. Separated contaminated products are treated as special waste or further processed and disposed.

4.1. Laboratory characterization of soil samples

Material that enters the soil washing cycle is not just a soil in the pedological sense, it is a complex mixture of soil forming minerals, organic matter and impurities such as small pieces of brick, concrete, wood, slag, etc. Because of the large number of possible impurities in the mixture, their different physical and chemical properties, types of intergrowth between impurities and soil components, and differences in soil texture, it is not possible to define universal soil washing process. Each case must be thoroughly investigated and analyzed. Depending on determined specific values and technological indicators, decision about the most suitable process is made. Usual analyses of contaminated soil samples include (Salopek et al, 2004):

- determination of density, particle size distribution, mineral and chemical composition,
- determination of contamination content in each particle size class, mass content of light and heavy components (light – less than 1800 kg/m^3, heavy – above 2800 kg/m^3),
- determination of the type of intergrowth between contaminant and soil components,
- determination of chemical composition and concentration of contaminant, the possibilities of attrition, deagglomeration, dispersion, emulgation and solubility,
- determination of classification and/or separation cut (Tromp curve, HR-diagram), recovery and contaminant concentration in washed products.

4.2. Soil preparation

Contaminated soil can contain pebbles, rock, slag, concrete or brick pieces which, due to their size, are not appropriate for washing. Usually, grains larger than 30 (50) mm are separated on vibrating screens. If contaminant concentration in separated material is below a certain required value, then the material is treated as clean. If not, then separated material is crushed, e.g. in impact crusher, and returned to the washing process with the rest of the soil.

4.3. Liberation

The purpose of grain liberation is to physically separate the mineral grain from contaminant. It is a process of breaking the bonds between soil matrix constituents and contaminant in the soil matrix. Only successful liberation of contaminant particles guaranties successful separation. Choice of liberation process depends on the type of intergrowth between mineral particle and contaminant. The three main type of intergrowth are presented in Figure 2. Type 1 is easily achieved by mixing

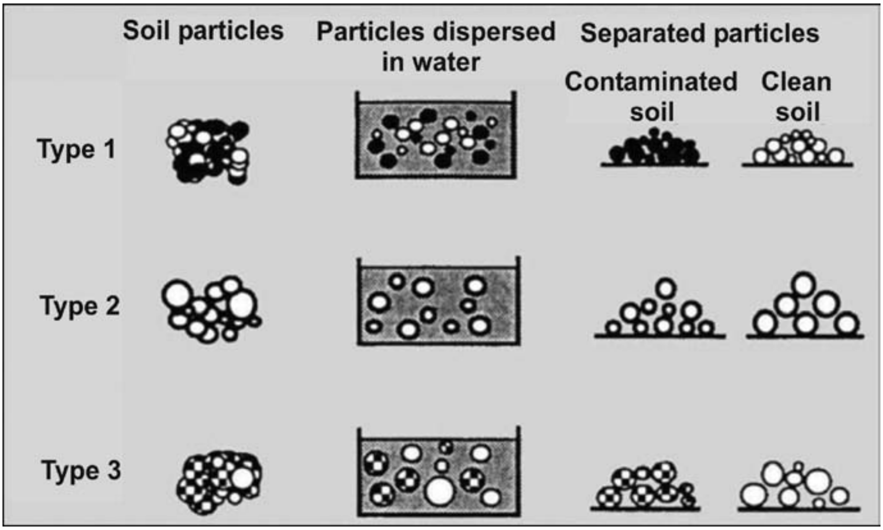

Figure 2. Main types of intergrowth between mineral particle and contaminant: type 1 – contamination in the form of free grains (coal, coke, brick or concrete particles mixed with soil particles), type 2 – contamination in the form of film on soil particle surface (particles enveloped with oil or oil derivatives film), type 3 – contamination dispersed inside the mineral particle (penetration of contaminant inside the grain).

with water in washing drum. Type 2 is more complex and requires larger input of mechanical energy. For film stripping attrition scrubber is used. If deagglomeration is required, high-pressure jet washing is applied. Attrition scrubbing products are cleaned particles, oil-water emulsion and sludge.

Type 3 of intergrowth is the most complex and liberation can rarely be achieved only by mechanical methods. Chemical treatment such as leaching, possibly after grinding, is usually required to convert the type 3 into type 2 or 1.

4.4. Classification

The purpose of classification is to separate the groups of particles of different size into classes. Separated particle classes can be the final product or input material for the next step of processing (separation). For example, after the first step of washing in washing drum, material is sieved on vibrating screen where the oversize (grains larger than 2 (4) mm) is a final product. Undersize (grains smaller than 2 (4) mm) is washed in the second step (attrition scrubbing) or further classified (in a hydrocyclone) and prepared for separation treatment (gravity concentration, flotation). Different types of vibrating screens are usually used for the classification of coarse material, and hydrocyclones or sometimes other types classifiers for the classification of fine material.

4.5. Separation (concentration, sorting)

After achieved liberation and separation of appropriate grain size class, the material is further processed by a certain separation method. The choice of separation method depends on physical and chemical properties of soil particles and soil contaminant. The properties are: density, magnetism, electrical conductivity and/or wetting.

In the case of type 1 intergrowth, with no firm physical bond between contaminated soil particles, separation is easily achieved. After grain size analysis of contaminated soil and determination of classes with the highest contaminant concentration, impurities could be removed by screening, providing they are present in the soil in the form of coarse particles. If the contaminant is concentrated in finer grain size classes, it can be removed by classifying in a hydrocyclone or hydraulic classifier. Therefore, in simple cases of contamination, classifying equipment could be used for contaminant separation. If there is a significant difference in density of soil particles and contaminant particles (wood, coal, coke, porous building material), soil particles are separated as a "heavy" component and contaminant particles as a "light" component using gravity concentration.

Separation of particles intergrown as type 2 or 3 is much more complex. In such cases, contaminant is separated together with bonded soil particles because complete liberation is impossible to achieve. For successful separation, most of the contaminant must be concentrated in a relatively narrow soil particle size range. In the case of type 2 intergrowth, the characteristic property of contaminated particles is particle size. Due to their large specific surface area and adsorption capacity, fine particles (e.g. clay particles in soil) adsorb a relatively larger quantity of contaminant than coarser particles. By separating fine particle size classes, most of the contaminant can be removed. Hydrocyclones are commonly used for that purpose. If contaminant is adsorbed on organic matter or has a distinct hydrophobic properties, separation of contaminated particles can be achieved by gravity concentration or flotation. In the case of type 3 intergrowth, where contaminant penetrates inside the soil particle, separation is only possible if there is a significant difference in one or more physical properties between contaminant and soil particles. In such case, gravity concentration, magnetic separation or flotation is applied. To obtain more efficient separation, additional treatments such as attrition scrubbing and/or comminution are usually required. If contaminant is concentrated in coarser particles (e.g. heavy metals in concrete particles), separation on sieves could be applied. In special cases, contaminant is directly separated by leaching.

4.6. Dewatering

Soil washing process ends with dewatering. Coarse grain size classes (sand, gravel) are dewatered on dewatering screens, and fine classes (sludges) in thickeners, filters or centrifuges, depending on particle size distribution and required final water content in product. Washed clean products can be returned to the original location or used for municipal landfill covering, road construction, concrete elements production, etc. Separated sludge (concentrated contaminant) is further thermal or biologically treated, or immobilized and disposed as special waste. Wastewater from washing process is cleaned as required, mixed with fresh water and returned to the process.

4.7. Examples of soil washing flowsheets

Figure 3. shows the general flowsheet of soil washing process (Mann, 1999). Contaminated soil is washed and sieved on vibrating screen. Screen oversize is the first clean soil product. Screen undersize enters the hydrocyclone for separation of fines. Hydrocyclone overflow is thickened in lamella thickener. Thickener overflow returns to the process, and the sludge is further thickened in a filter press.

Filter cake contains the most of the contaminant. After attrition, hydrocyclone underflow is processed by flotation. Flotation overflow is

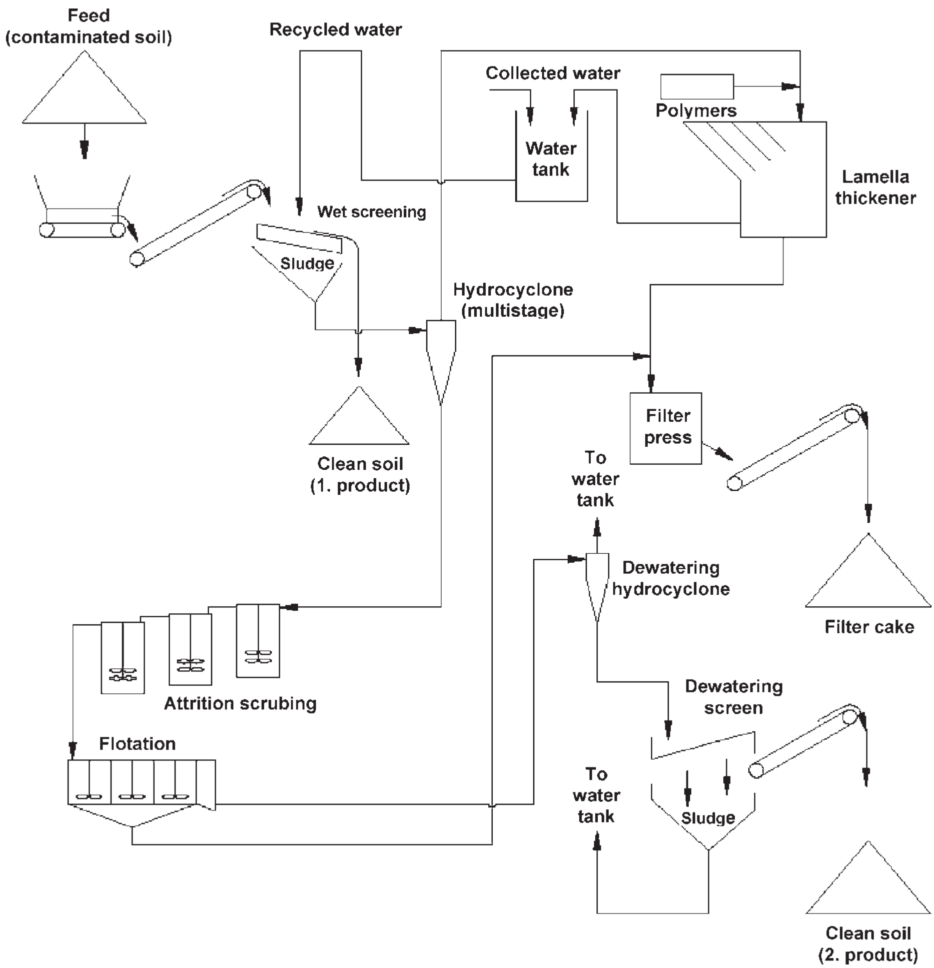

Figure 3. General soil washing flowsheet (Mann, 1999)

thickened in a filter press together with lamella thickener sludge. Flotation underflow, after dewatering in a hydrocyclone and on a screen, is the second clean soil product.

Figure 4. shows technological process of washing soil (14,200 t) contaminated with pesticides and organic mercury (Bunge et al, 1995). Feed material (grain size class –150 mm) is wet screened on vibrating screen with mesh size of 2 mm. Screen oversize is introduced to the washing drum and screen undersize to the hydrocyclone. After washing in drum and additional sieving on screen with mesh size of 2 mm, screen oversize is disposed as a clean product (mixture of coarse sand and gravel), and screen undersize together with the first screen undersize is classified in a

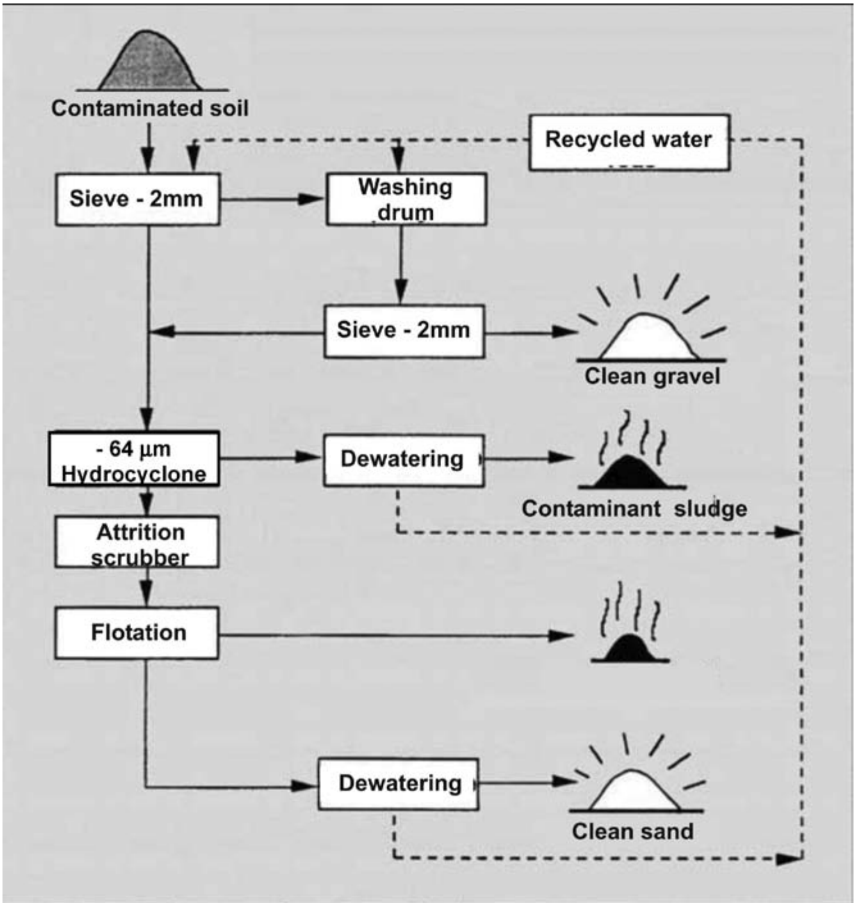

Figure 4. Soil washing flowsheet for the treatment of soil contaminated with pesticides and organic mercury (MBT Environmental Eng. Ltd.)

hydrocyclone. Hydrocyclone cut point is circa 0.064 mm. Hydrocyclone overflow is contaminated sludge which is further treated after dewatering. Hydrocyclone underflow is processed by attrition scrubbing and then by flotation. Contaminated flotation sludge is separated in overflow, and the underflow is disposed, after dewatering, as clean sand. Hydrocyclone and flotation overflows are treated with lime, sealed in barrels and disposed as special waste. Cleaned sand and gravel (screen oversize and flotation overflow) are returned to the original site. Water collected in dewatering process is, after fines removal, returned to the process. Total mass of clean products in presented soil washing process were: 7900 t (56% of input material) of material with grain size larger than 2 mm and 5400 t (38% of input material) of material with grain size from 0.064 mm to 2 mm. The mass of contaminated product (particle size smaller than 0.064 mm) was 900 t, i.e. 6% of input material. At the end of the washing process, 85% of contaminant is separated into 6% of total material mass. In addition, during process water treatment a part of contaminant is neutralized, therefore the amount of separated contaminant was 95% of total contamination. Soil washing plant capacity was 10 t/h.

Figure 5. shows the Deconterra process developed by Lurgi Company and used for washing soils contaminated with oil and oil derivatives (Hankel et al, 1992; Schneider, 1992).

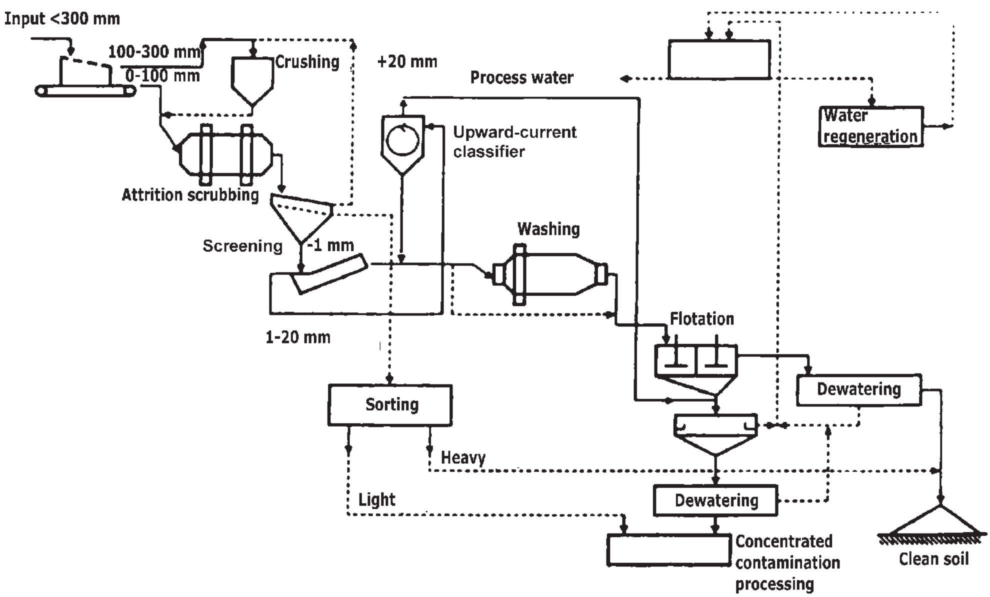

Figure 5. Soil washing flowsheet (Lurgi-Deconterra process)

Material is screened on a vibrating grizzly with 100 mm openings. Grizzly oversize is comminuted in impact crusher, and undersize is washed together with comminuted material in attrition drum. In attrition drum, material is deagglomerated and adhering contaminant is partially scrubbed from particle surface. After that, material is classified on double-deck vibrating screen with mesh sizes of 20 mm and 1 mm. Grain size class +20mm is additionally comminuted in a crusher, size class 20/1 mm concentrated in a jig, and size class –1 mm classified in spiral classifier. Classifier overflow is classified in upward-current classifier. Upward-current classifier underflow together with sand from spiral classifier is additionally washed in attrition drum. Drum output material is introduced to the flotation cell. After dewatering, flotation underflow is disposed as a clean product. Flotation and classifier overflows are dewatered and further treated. Heavy fraction separated in the jig is disposed as a clean product, and the light fraction is further processed. The water separated during dewatering is returned to the process. In the shown process, hydrocarbons concentration of 400-4000 mg/kg can be reduced to less than 50 mg/kg. More than 96% of the total contaminant is concentrated in the flotation and upward-current classifier overflow and in the jig light fraction. Heavy metal content are also partially removed during soil washing.

5. Research work

In recent years, a number of experiments, which results can be directly applied in studying and designing the soil washing processes, have been conducted in the Laboratory for Mineral Processing and Environmental Protection of the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, as part of projects financed by the Ministry of Science, Education and Sport of the Republic of Croatia.

In the field of gravity concentration, the separation of coal particles from sand samples extracted from the Sava River was tested. Coal content in input samples ranged from 1% to 6%. Samples of grain size class 4/1 mm were treated in a jig, and samples of grain size class 4/0.5 mm on a shaking table and Humphreys spiral. The results of performed tests showed reduction of coal content in sand down to between 0.03% and 1.37% with recovery of 70-80% after concentration in a jig, between 0.06 and 1.05% with recovery of 84-95% after concentration on a shaking table and between 0.16 and 1.25% with recovery of 95-98% after concentration in the spiral.

Hard coal floatability was tested in flotation column. Flotation of coal samples with 27-30% ash content, resulted in a concentrate with 8.9-9.5% ash content and 63.6-64.8% recovery. Underflow ash content was 53.9-61.4%.

Attrition scrubbing of silica sand (solids concentration in the suspension: 77%, impeller speed: 560 min^{-1}, attrition time: 20 min) resulted in the reduction of Fe_2O_3 content by 23% and Al_2O_3 content by 34%, while the content of SiO_2 was increased by 2,44%.

6. Conclusion

Overview of the achieved results in soil washing technology implies the need for further systematic fundamental research. Special attention should be paid to the investigation of liberation mechanism and contaminant redistribution depending on the type of intergrowth between contaminant and soil particles, as well as to the type and amount of energy needed for optimal liberation. Further research of physical separation processes should lead to finding more efficient flotation reagents and highly adsorptive minerals and organics for each type of contaminant.

The field of soil remediation is fast developing. The technologies are very expensive and increasingly demanding, therefore there is a risk that achieved results would not always justify the process costs. Each case should be thoroughly researched and analyzed in order to enable the choice of optimal technology, reliable evaluation criteria and control of the whole system based on scientific research.

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4D Data Compression Methods for Modelling Virtual Medical Reality

Abstract

Virtual reality is based on sequences of volumetric images whose motion is captured in time. Temporal 3D visualizations of various anatomical parts have been used for education of medical students. Various organ models have been developed using this data. These data sets are typically very large in size and demand a great amount of resources for storage and transmission. Therefore it is necessary to compress such data both fast and efficiently. Also, medical datasets usually contain a region representing the part of the body under investigation, and noisy background with no diagnostic interest. Therefore, it is important to identify contained sub-volumes as different regions of interest. In this paper we propose combination of lossless and lossy compression models to obtain toset demands. Coding of 4D data models should be both fast and efficient. In this paper is shown that with defining the regions of interest there can be achieved higher compression rates. Therefore we proposed lossless coding of areas of high interest and lossy coding areas of small interest.

Keywords: virtual reality, active model, region of interest, 4D data compression.

1. Introduction

Discovery, validation and storage of useful information in a vast amount of available data present an ever-growing problem in today's world. In certain applications memory and communication channel capacity constraints necessitate usage of various compression techniques, especially concerning applications relying on high-volume multidimensional data. Efficient compression of such data can be achieved with combination of different techniques and methods, as well as employing related comparison models. During the last several decades image compression field has attracted a lot of attention and reached the level of maturity, capable of delivering usable products today widely present in everyday life; both in a form of time-variable images (video compression) and static 3D models. But the combination of the two mentioned forms, compression of time-varying 3D models – 4D compression, still presents an open and exciting area of research. Motivation for such research stems from current significant problems in processing and storage of medical images as well as in different applications of virtual reality (Loncaric, 2005). The rest of paper is organized as follows. Active and appearance models are described in Chapter 2, shape description and transformation are denoted in Chapter 2.1, dealing with regions of interest in Chapter 2.2. Chapter 3 reports on applications of compression methods for data storage and presentation, while Chapter 4 is focused on describing of virtual medical reality. Fields of use are given in Chapter 5 and final remarks in Chapter 6.

2. Design of Active Models

Virtual reality is based on representation of subsequent changes of object positions in space and time. However, data sets used to represent such changes pose very large storage and processing power requirements on used systems. To alleviate those resource requirements, it is necessary to employ data compression techniques on such data sets, focusing on two key requirements for compression and decompression: efficiency and speed (Ibarria et al, 2003). In order to achieve maximal performance, different compression algorithms can be developed for specific regions of interest, utilizing area-specific features.

A typical compression method consists of three main components: transformation, area quantization and coding. Targeted input data set is transformed into a more appropriate space, revealing existing correlations among data in the set.

High-level information (high interest areas) and low-level information (background) is used to model the best-fit ellipsoids for each image part. The best-fit ellipsoid algorithm is based on the orthogonal ellipses (high-level information), their attributes (low-level information), and the best-fit ellipsoid after the iterative approximation. For three perpendicular surfaces, namely *surf1*, *surf2* and *surf3*, the diagonal components λ and the off-diagonal components γ are calculated for the 2x2 matrices representing the sectional ellipses according to Figure 1 (Zagar et al, 2007):

$$\begin{aligned}\lambda_{surf1} &= 1/2\,(\alpha_{surf2}(\cos(\phi_{surf2}))^2 + \beta_{surf2}(\sin(\phi_{surf2}))^2) + \\ &+ 1/2\,(\alpha_{surf3}(\cos(\phi_{surf3}))^2 + \beta_{surf3}(\sin(\phi_{surf3}))^2)\end{aligned} \tag{1}$$

$$\begin{aligned}\lambda_{surf2} &= 1/2\,(\alpha_{surf1}(\cos(\phi_{surf1}))^2 + \beta_{surf1}(\sin(\phi_{surf1}))^2) + \\ &+ 1/2\,(\alpha_{surf3}(\cos(\phi_{surf3}))^2 + \beta_{surf3}(\sin(\phi_{surf3}))^2)\end{aligned} \tag{2}$$

$$\begin{aligned}\lambda_{surf1} &= 1/2\,(\alpha_{surf1}(\cos(\phi_{surf1}))^2 + \beta_{surf1}(\sin(\phi_{surf1}))^2) + \\ &+ 1/2\,(\alpha_{surf2}(\cos(\phi_{surf2}))^2 + \beta_{surf2}(\sin(\phi_{surf2}))^2)\end{aligned} \tag{3}$$

$$\gamma_{surf1} = \alpha_{surf1}\sin(\phi_{surf1})\cos(\phi_{surf1}) - \beta_{surf1}\sin(\phi_{surf1})\cos(\phi_{surf1}) \tag{4}$$

$$\gamma_{surf2} = \alpha_{surf2}\sin(\phi_{surf2})\cos(\phi_{surf2}) - \beta_{surf2}\sin(\phi_{surf2})\cos(\phi_{surf2}) \tag{5}$$

$$\gamma_{surf3} = \alpha_{surf3}\sin(\phi_{surf3})\cos(\phi_{surf3}) - \beta_{surf3}\sin(\phi_{surf3})\cos(\phi_{surf3}) \tag{6}$$

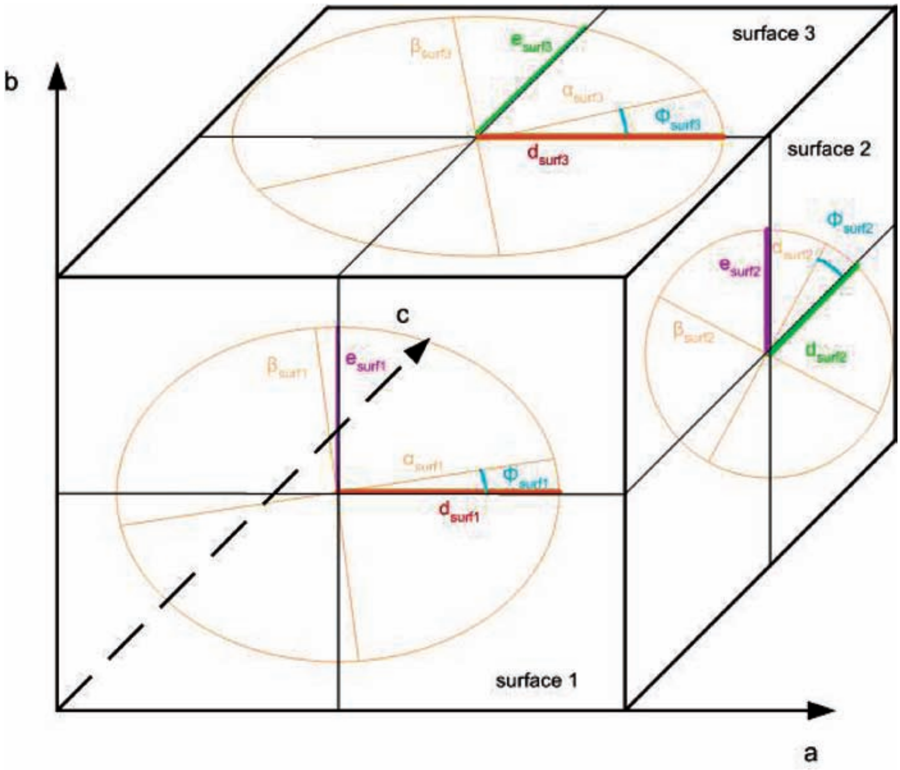

Figure 1. Orthogonal ellipses and their components

Prior to definition of compression algorithms and representation methods in such a process it is necessary to define what is implied under the term of a particular shape, how we can accurately represent particular object and which object features are significant in determining its representation.

The appearance models encompass both shape and texture which are coded in a single vector. The means of finding correlation between the two is eigen-analysis of the covariance matrix where principal component analysis gives encouraging results and can reduce the dimensionality of the data considerably well while still accounting for much of the variation (Fowlert et al, 1994). There is a significant disproportion between the space required and the loss that analysis imposes. In medical applications, low error rates are usually required and the presence of abnormality is difficult to spot. On the contrary, if real-time object tracing in a video sequence is required, subsequent framed can compensate for incorrect location and efficiency is at a premium.

2.1. Shape Description

One of the methods of shape description is the definition of reference coordinates on each modelled object, characterizing specific features of modelled object. Reference coordinates can be classified according to specifics being described by them. Anatomic reference coordinates are assigned by experts and represent a specific medically significant feature defined at the level of body organ, independently of its geometrical features (Anagnostou et al, 2001). In order to employ such a modelling approach, it is also necessary to define mathematical reference coordinates associated to certain mathematical or geometrical feature specific to shape of modelled object.

Mathematical representation of a certain shape using n reference coordinates in a k-dimensional shape has a form of a $n*n$ matrix:

$$object = \begin{bmatrix} x_1, y_1, \dots, k_1 \\ x_2, y_2, \dots, k_2 \\ \dots \\ x_n, y_n, \dots, k_n \end{bmatrix} \tag{7}$$

Virtual reality representation used in medical applications most often employs pseudo-reference coordinates as a combination of mathematical and anatomical reference coordinates, modeling internal characteristic features of a certain object, residing on object's very boundary.

In order to identify shapes according to their definition and compare them, it is necessary to transform scale, rotation and location. This is accomplished by introducing a reference coordinate system within which the rotation, scale and location of each object are defined and all shapes are aligned. Mentioned process is known as Procruster analysis (de Rooij and Vitanyi, 2006).

Shape space is a set of all possible shapes of an object. Formally, shape space $\sum_k^n$ is an orbit of all shapes represented by a set of n equal pseudo-reference coordinates on which all possible Euclidean transformations have been preformed. Dimensions of such a space are in a form of subspace with $k*n$ dimensions. The process of dimensionality reduction includes removal of translations (k dimensions), scaling (1 dimension) and rotation ($\frac{1}{2}k(k-1)$ dimensions), resulting with a new M dimensional space, where:

$$M = kn - k - 1 - \left(\frac{k(k-1)}{2}\right). \tag{8}$$

Alignment is performed in a four distinct steps: a centroid of each object is calculated, centroid location is placed into a reference coordinate system, rotation scaling and, finally, rotation filtering are performed. Following the alignment process, different prediction methods can be applied in order to achieve better compression rates. However, existing compression methods based on various prediction models are characterized with low complexity and unacceptable compression rates (Sanchez et al, 2006).

In order to achieve higher compression rates it is necessary to develop new prediction methods that will allow modeling of multimedia data on a higher level, with the aim of improved detection of typical redundant structures such as correlations of neighboring elements, edge detection, pattern detection and pattern feature detection. DCT and Wavelet based methods have proven as very efficient in compact representation of image and video data using lossy compression methods. The second important element, associated with determining the region of interest, is probability modeling with the aim of more effective data entropy coding (Fowlert and Yagel, 1994).

2.2. Defining the Region of Interest

Determining the region of interest is not an unambiguous process. For example, the region of interest in model of head images is brain with the rest of the image content treated as background. If head models are available to both coder and decoder, only parameters describing potential deviations from the standard model can be communicated. In coding of 3D objects the primary coding unit is voxel, an analogy of pixel in 2D images, a basic space unit described with a set of associated features (for example, colour). By increasing voxel size it is possible to increase algorithm compression rates. Associating regions of interest with voxels, defining the object, is depicted in Figure 2.

Medical images traditionally consist of inspected regions of interest that are given high priority in processing and coding, and low priority

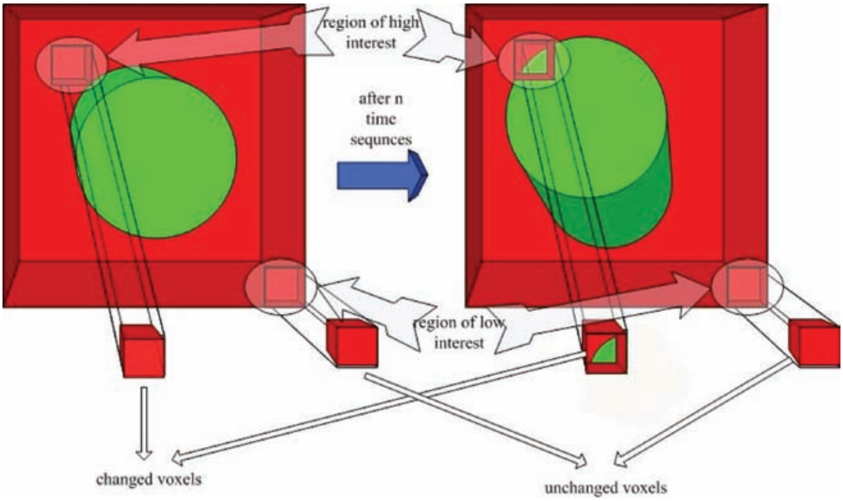

Figure 2. Defining the region of interest

background regions. As a consequence, those regions can be coded separately using different compression algorithms and allowing higher error rates (thus achieving higher compression rates) for background regions (Knezovic et al, 2006). Time required for coding process depends on a context. Basically, for compression of high interest regions more time is needed. In this way compression regions are divided into two disjoint regions coded separately and later joined into a single representation.

3. Application of Compression Methods for Data Storage and Presentation

4D data used to describe virtual reality define structural and process changes in time and can be regarded as a sequence if 3D objects. To reduce the amount of data it is necessary to employ some compression method. Generally there are various compression methods all of them falling into two main classes of lossy and lossless methods. Lossy algorithms achieve higher compression ratios than lossless ones, but due to potentially critical information loss can be applied only to regions of lower interest. With the introduction of user controlled coding error and representation degradation, significant improvements of algorithm properties can be achieved, together with lowering of memory requirements for data storage. In most volumetric data sets used in virtual reality representation in medicine and other areas, lossy compression methods are not acceptable. In those cases usage of lossless methods is mandatory.

Lossless compression is used in cases where original and decoded data must be identical. Those methods guarantee reliability in coding of high interest regions thus can be applied to important areas of time variable 3D data (Hamarneh et al, 2005). Lossless compression methods are usually consisted of two independent components – modelling and coding. 3D motion estimation is applied as a first step, efficiently eliminating redundancies present among subsequent compression steps thus decreasing inherent modelling error. Different coding techniques can be applied to resulting models, one of the most significant being entropic coding.

3.1. Acceleration and Efficiency Increase of Compression Methods

In acceleration and efficiency increase of compression methods it is possible to use the fact that the variation in sub-volume data in close time moments is relatively small compared to variation considered for the object as a whole. Consequently it is possible, for each volumetric data, to construct an optimal linear predictor with the smallest error as a result of solving a system of linear equations based on covariance values of related 3D objects. Optimal linear predictor is used to calculate differences among data frames, which are then coded. Since 4D data describe dynamic changes of 3D objects in time, higher time dimension redundancy is present than in static 3D objects (Zagar et al, 2007). 3D coding methods only try to discover redundancies within 3 dimensions, but if the maximal compression ratio is to be found, 4 dimensional search is a necessity. In processing of data describing dynamic 3D objects it is necessary to enclose both transformation and coding, respecting all the requirements related to transformation, prediction and coding.

In the proposed system, the object of interest and the background are encoded independently. Each generates a self-contained segment of the bit stream. This implies that the border information is encoded twice: as side information for both the object and the background. In this way, each of them can be accessed and reconstructed, avoiding artefacts along the contours for any quantization of the decoded coefficients. The encoding time depends on the context, and increases with the size of the neighbourhood. Efficiency can thus be improved by choosing spatial conditioning terms of small support.

Basically, the sub band coefficients within the area of interest mask are shifted up (or, equivalently, those outside this area are shifted down) so that the minimum value in the area of high interest is greater than the maximum value in the background (Hamarneh et al, 2005). This splits the bit planes respectively used for the area of interest and the background in two disjoint sets. The rate allocation procedure assigns to each layer of each code block (in the different sub bands) a coding priority which depends on both the semantics and the gain in terms of rate/distortion ratio. This establishes the relative order of encoding of the high interest area sub band coefficients with respect to the background.

4. Describing Virtual Medical Reality

Significant appliance of 4D compression is in medical applications and therefore it is very important to model scenes in appropriate way. Visualization of medical data is contented form different sets of data merged into one model which can be interactively inquired. Processed data sets represent models that are calculated by removing transformations and scaling in reference coordinate system. Modelling of 3D scenes is achieved with visualization tree (example shown on Figure 3.) which is consisted from transformation, volume and model nodes. Each node has its own features that specify data contained within that node. To describe 3D scenes which are composed from different types of medical data we use MRML (Medical Reality Modelling Language).

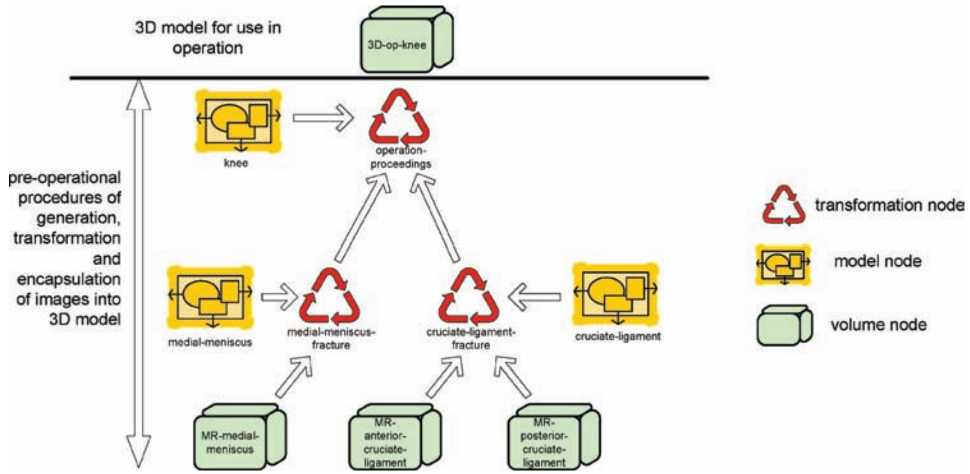

Figure 3. Hierarchical structure in MRML

Models of objects written in MRML are expound on hierarchical way and are described with hierarchical paradigms. Transformations related with specific node are compounded in one complex root node (Lemay et al, 1996). Example of hierarchical tree is shown on figure 2. Structure of this example describes methods of making 3D model of knee for which is assumed fracture of some cruciate ligament or medial meniscus. Therefore is used magnetic resonance for making volumetric model, for example MR-anteriror-cruciate-ligament, which is compounded with other volumetric data (in this example with MR-posterior-cruciate-ligament) in transformation called cruciate-ligament-fracture, which is then compounded with related model (model node cruciate-ligament) and transformed together with medial-meniscus-fracture transformation node to compare with model of knee. This breakdown is needed because it is diagnosed some fracture and we want to know as much details as it is possible. Same procedure is done to examine medial meniscus. This structure provides final result for 3D visualization used in operation. Segmentation of objects and models provided by MRML can be adopted also on compression methods to achieve higher compression rate. Defining regions of interest is much easier when certain models and affiliated segments can be provided.

5. Fields of Use

Creating of virtual medical reality is very important part of telemedicine. In implementation of telemedicine system, making the appropriate models, their coding and transmission to centre where expert knowledge is located are crucial for improving quality of service. It incorporates three operations for managing data sets, creating models and analyzing results: data management, model fitting and expert analysis. In each step compression algorithms enable faster communication between operations and enable more efficient usage of the storage devices. Examples come from clinical and preclinical trials where biomedical data display subject and residual unknown variations (Stegmann, 2010).

Heterogeneity of platforms, problems, interfaces causes difficulties in visualization of data and models but coding with compression algorithms is same on each platform and the most important thing, which is decoding to original (or pseudo-original image for backgrounds), is also platform independent. 4D modelling can be used in various health systems, analysis of mutations in cancer, prediction of protein structure, gene expression, measuring biodiversity and bioinformatics and computational biology.

6. Conclusion and Results

Realization of 4D models in virtual medical reality is based on combination of few technologies. First of all, high bandwidth communication channels, followed by mighty processors for processing expert knowledge needed for modelling of active models and describing it with appropriate computer languages. Very important steps are also decomposition on hierarchical structure and appliance of different coding algorithms on different regions o interest.

Coding of 4D bio-models should be both fast and efficient. Therefore we proposed lossless coding of regions of high interest and lossy coding regions of low interest (background). The interest-based processing enables a pseudo-lossless regime where the object of interest can be encoded/decoded without loss, and combined with the background that can be represented at a lower quality. Results of applied methods are shown on experimental neuro-dataset. Figure 4a represents original dataset (size of 209 kB), and Figure 4b same dataset coded with lossy JPEG compression (size of 24 kB) with compression ratio 1 : 8,7 and a measure of quality of reconstruction of lossy compression PSNR = 32,4 dB.

Since there are visible distortions on the right part (Figure 4b), we propose using of active models from virtual reality, different compression algorithms for coding interest of high regions and different compression algorithms for coding regions of small interest. Results are shown on Figure 5b compared with original dataset on Figure 5a. There are no visible

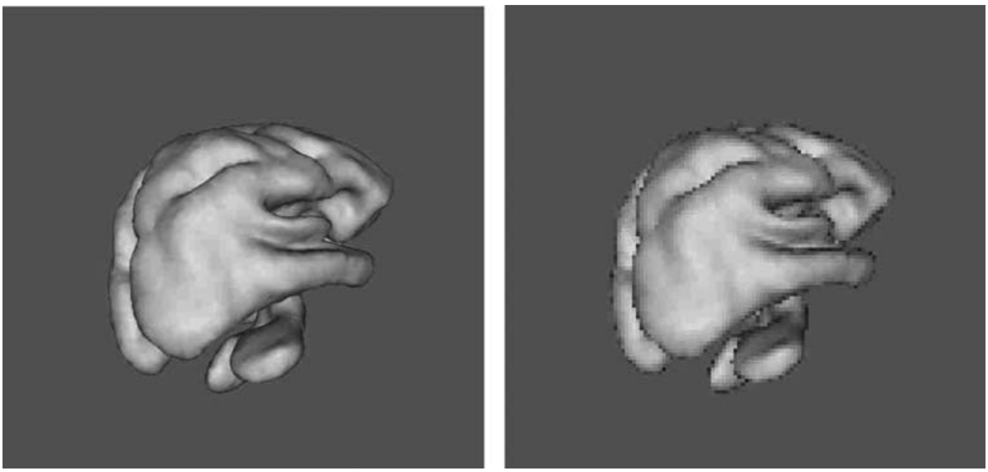

Figure 4. a) Original dataset and b) Original dataset coded with JPEG

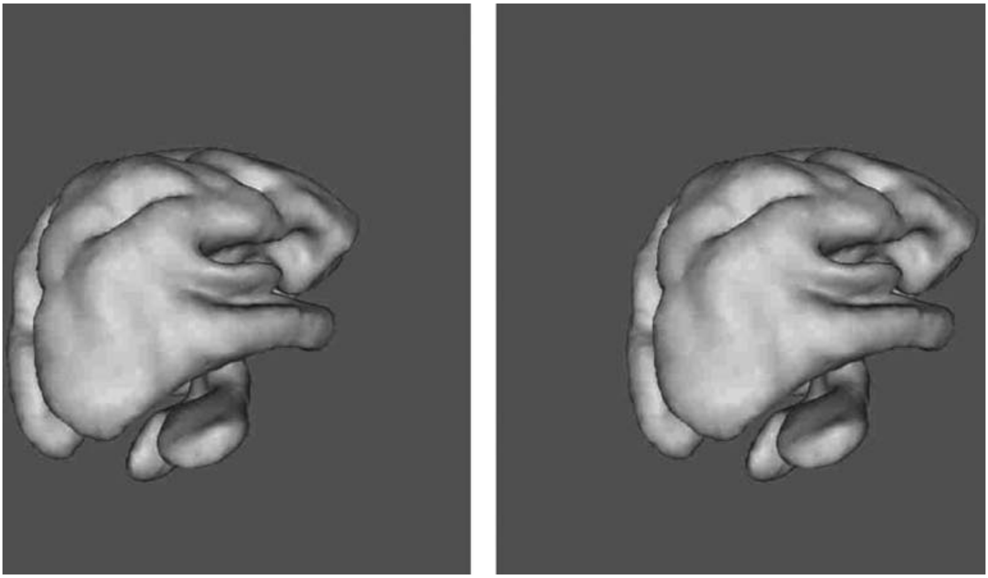

Figure 5. a) Original dataset and b) Original dataset coded with different algorithms and active models

distortions and size of compressed image is 38 kB and compression ratio 1 : 5,5 and PSNR = 41,7 dB.

With coding different sub-volumes separate, usage of different methods of compression and increasing of compression rate for regions of small interest, it is possible to achieve better compression efficiency and savings in storage and transmission systems. With this method, regions of high interest retain quality visualization, and background can be coded with higher compression rate. Field of 4D compression will be in the future, one of very interesting fields with wide usage in all sort of different applications, beginning with medical applications.

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Development of Electric Automobile in Croatia

Abstract

Based on the accumulated experience in the development and production of electric machines achieving successful export in targeting foreign markets, the producer has reached a decision that truly own-developed high-tech technology based on innovations is to be further utilized for a commercial program of passenger automobiles. A prototype of an urban electric vehicle has been made and high performance and vehicle functionality have been tested. This stage being completed, the company's intellectual capital has been synergised into a new product. The development of an electric city car is a step towards future architecture of modern urban transportation. It is a mono-space car with two doors, three seats, designed for urban transport featuring easy vehicle entrance and exit as well as parking. The true essence of this green urban vehicle is to simplify and enhance the mobility of drivers in urban conditions as well as to ensure active and passive vehicle safety.

In the upcoming decade, electric automobiles are going to contribute to the quality of living and urban transportation. The energy development strategy of the Republic of Croatia has in view to support projects of green transportation as well as the purchase of more energy-efficient vehicles. The purpose of this paper is to present a home-based project of an electric automobile in its full originality. The development focus is set on an own and original vehicle design and its attractiveness providing “environmental advantage” on the global market. The management of the most complex systems of vehicle control and the entire product provides development and production of a new generation of transport means in the Republic of Croatia.

Key words: electric automobile, urban three-seater, vehicle development, *XD-Concept*

1. Introduction

The purpose of this paper is to present domestic development of the electric vehicle in its originality. The development of the electric automobile was founded on own design and its attactiveness that provides “environmental advantage” on the market. It is a mono-space with two doors, designed for the transportation of three or four passengers featuring easy entry and exit from vehicles as well as parking.

Requirements for the development of Croatian electric automobiles:
- original functionality,
- demand and fashion trends,
- green solutions,
- mastering in development technology,
- the company’s competitive position,
- economic indicators,
- global market.

In the next decade, electric cars will contribute to the quality of living and city transportation, and will greatly affect the reduction of fossil fuel consumption. This is suggested by the recent studies of urban transport development . Based on experience in developing remote-controlled electric machines which are successful regarding exports to foreign markets, the manufacturer /DOK-ING Zagreb/ has reached a decision that the self-developed high-tech technology based on innovation is to be utilized for commercial application of passenger cars, motorcycles and quads. The primary project to be defined was the XD-city electric car concept. Thus the intellectual capital is transformed into a new domestic original product.

The thesis of using obsolete projects that convert classic vehicles into electric vehicles was rejected here. Only new creations can bring new high quality value rather than the modernization of classic cars with their powertrains thrown out and then mounting the electric drives instead. It is not in the company's interest to copy and assemble (the trap of the *know-how* transfer), but to create a product with added value. Any other method of developing electric cars is an inferior one. The ultimate goal of development is to control the entire product, starting from the development and ending in production and distribution providing a developmental perspective. Therefore, from its outset, the electric automobile has been designed for the global market.

The new product development process consists of six phases: creation of ideas, product selection, product design, prototyping, testing (analysis) and the final product design profile. For the production of electric cars in the Republic of Croatia, significant are the existing resources and experience. Resources of the producer DOK-ING include body design technology, making the chassis, intelligent drive management, vehicle system integration, polygon testing, finalization and logistical support. This integrates the individual resources of partners and major R&D institutions from the Republic of Croatian as well as one part of the assemblies imported due to economically unjustified self-development (batteries, ABS, servo steering wheel, wheels). The new product features the most complex and most expensive part of vehicle development, and thus also the production management. Based on the assessment of electric car

Figure 1. XD-Concept, Prototype

development and logistics infrastructure insurance, a clear need for domestic substitution of vehicles has been determined. Unless this is to be opportunely recognized in the following 10-20 years we will see a supply of electric cars from import, and one can estimate a multiple cost / price of such an acquisition, which, in that case, shall not include the domestic production share, the economic profit together with the technological progress. These are clear indicators of the necessity to define a strategy for the development of electric automobiles in Croatia.

2. Challenges

In the recent period, a number of studies have been investigating the matter and deducing that the time had not come yet for the hybrid vehicles nor the electric ones. These were all backed up with high costs of batteries together with logistic infrastructure, which will keep the electric vehicles marginalized for a longer period of time. However, new relevant studies affirmatively indicate the future of green hybrid and electric vehicles. These vehicles are going to penetrate the market quickly so they will make up 35% of all cars produced in the year 2025 – 25% of hybrid and 10% of pure electric vehicles. Major changes in the development of electric vehicles have been announced based on a set of relevant research criteria. Most of the corporations have ready-made solutions for electric vehicles, yet there is no mass production, mostly due to the lack of logistical infrastructure. Therefore hybrid vehicles penetrate the market more quickly, because of they have no limits in range, by mere transition to gasoline or diesel engines when the battery has been fully discharged. Parallel with hybrid vehicles, a progressive growth of pure electric vehicle (EV) is bound to follow.

Advances in hybrid and electric vehicles in the next decade is presented clearly by the following facts:

- ensuring the autonomy of a 250-350 km reach in pure electric mode;
- pure EV sports design *Tesla Roadster* has better performance than its conventional rivals;
- batteries can provide a lifetime of at least 150,000 km;
- life cycle costs of electric vehicles are significantly lower;
- EVs emit no CO_2, making it fully environmentally friendly;
- incentives to producers and buyers of EV.

Within the coming decade, the manufacturers will offer hybrid cars even without any pricing or logistical obstacles in the way in which Japanese companies at one time took over the Western markets 20 years ago, by offering high quality vehicles fully equiped and free of additional charge. At that point there will be no firm reason for conventional alternative to these vehicles.

The essence of an urban vehicle is to facilitate and enhance people's mobility in urban conditions. The streets are becoming less and less serviceable, jammed with parked cars and a variety of surprises at every corner, and hence deemed unsafe for pedestrians. Therefore, transport technology is looking for a new philosophy of urban driving, a one which will sustain life on the streets in a more efficient and humane way altogether. Apart from better urban vehicle mobility, their expert systems will enable people to watch and communicate both in an easier and safer way.

A study of *Electric Vehicles 2010-2020* together with the reports of the consulting company *McKinsey & Co.*, based on the new philosophy of urban living and traffic, come out with advice useful to investors, producers, component suppliers, marketing strategists, legislators as well as those who plan financial support. The study has found that large cities are the primary territory for electric vehicles. Light electric vehicles like Smart ED, Mitsubishi's MiEV are able to 'achieve great mileage' in big cities. The very first buyers will use electric vehicles in cities as a second car, mostly for commuting purposes. The researchers have discovered that these first buyers will be willing to support the city's inadequate charging infrastructure in order to be the first in the neighborhood driving an electric car.

European car manufacturers are going to compete with competitive electric cars from Japan, China and the United States. The EU will encourage the production of electricity for electric vehicles, yet not on the existing technology, which, on the average, emits around 400 grams of carbon dioxide for every kilowatt-hour of electricity in the EU, but rather on the parallel development of an electric grid based on renewable resources and "green" energy. The incentives for purchasing a new hybrid car are already in place and being used. Most European countries have reduced or abolish the tax on hybrid and electric vehicles.

Parallel with the development of electric vehicles, there is also the development of battery recharging stations, describing them as cells that will not overburden the network, but will rely on the energy of the sun (and possibly the wind). Stations for electric vehicles will store solar energy in batteries, which in turn will be ready to be used to recharge electric vehicles. The infrastructure includes utilization of renewable energy, smart grid and supply of cells for different mobility scenarios. The development of new technology will provide EV owners to restore their green-vehicle batteries in a time frame of a few minutes, equivalent to that of refueling gasoline engine**s**. What should be developed first is a 40 kW rapid battery restoration within 20 minutes (400 V, 63 A). After this has been successfully performed, a power system equaling 300 kW, which recharges the batteries within 6 minutes, is the final target. In accordance with this, the manufacturer plans to participate in the growing infrastructure development and standardization of EV recharging points.

3. Initial requirements

At the beginning of the XD-project, a general requirement was set for the development of small prototypes of electric city car in a three-seater model, recognized for its small dimensions, user-friendliness, driving and parking agility in a narrow spaces.

XD-Concept

For the development of a prototype electric three-seater, the initial requests have been set:

Kerb weight: 1000 kg
Dimensions: length, width, height / 2.8 m, 1.75 m, 1.6 m
Wheelbase: 1.8 m
Maximum speed: 130 km/h
Drive: rear-wheels
Batteries: lithium-iron-phosphate ($LiFePo_4$)
Engine: electric AC, 80 kW power (2x40 kW, permanent magnets)
Mileage reach: 250 km in electric and regenerative mode
Turning and parking maneuvres in narrow spaces

After several years of preparation and development, the project documentation was prepared and a prototype urban three-seater powered by batteries was made, designated as the *XD-Concept* model. XD was conceived initially as a vehicle with rear-wheel drive, followed by the front-wheel drive and finally an all-wheel drive. The batteries, electric motors and controllers are located in the battery cage chassis, thereby providing vehicle's low center of gravity. The torque of each electromotor reaches 160 Nm. The acceleration of the vehicle amounts to around 7 seconds to reach 100 km/h, while the maximum speed is limited to 130 km/h. Braking is achieved in two ways, using electro-regenarative braking and hydraulic ABS braking system. The engines work as generators to charge batteries that provides additional driving autonomy (mileage reach) by loosening the accelerator pedal.

Inasmuch as in urban conditions the above-average high performance is not required for a vehicle, the driver can control the dynamics electronically by transferring to the driving mode "Economic" (suitable for city drive), or "Sports" when the vehicle is available for maximum performance and overtaking other vehicles. For safety and reliability reasons, the XD has built-in batteries of high capacity and recent technology: lithium-iron-phosphate. They are non-inflammable and are less prone to heating. In urban drive mode with one battery charge the vehicle is able to reach up to 250 km. Plugged into a 220 V network and controlled by a safety fuse of 10 to 16 A, charging an empty battery to full capacity takes approximately 8 hours, while boosting it from 20 or 30% up to 80% of capacity requires 3 to 4 hours. Charging the battery and the XD with a source of 32A current takes half as much. The batteries are durable and guarantee their effectiveness for at least 150,000 kilometers, along with electric charging cost equal to around HRK 7 for 100 km – according to low tariff cost of electricity in Croatia. The batteries are the most expensive part of the car, whereas their estimated lifetime, with daily charging, reaches five years.

The XD design is dominated by three elements – sculpture of the rounded body with incorporated bumpers and gullwing doors, its peculiar front appearance "with a discerning eye," and featuring X-shaped warning lights which are designed to define the rear end. The prototype has a fiberglass body, whereas the car series production line plans to feature only graphite. An ergonomic concept of functionality, roominess and comfort is the basis of the interior XD design. Its wide doors open up almost the length of the entire cabin; therefore, the actions of entering and sitting down on the front seat and the "rear" seats are quite simple. The doors open, first sideways, and then upwards. The three seats are set in the form of a "Y"; this arrangement providing plenty of space to the driver as well as to the passengers in the back. The driver is seated forward in the

Figure 2. XD-Cockpit

middle of the cabin while the passengers sit behind the driver and sideways, thus providing the driver with as much legroom as possible.

The driver's seat is located in the middle of the cabin, so when the driver enters or exits it is tilted by about 25 degrees in order to facilitate the driver's action of sitting down. The cabin lighting is diffuse, and both the color and the intensity can be regulated, i.e. programmed as desired. The instrument panel has three clear and easily accessible touch screens. The middle screen indicates information about the vehicle's velocity and the batteries' capacity. The right screen provides the vehicle's commands, including a prominent "Start" button. The menu of driving direction is located at its edge: forward – neutral – reverse, together with the selection of the driving regime – "Economic" or "Sports". On the side there is a light switch, then the ones for opening the windows, windshield wipers speed control, windshield washer switch and the air-conditioning regulator, while on the left there is an "infotainment display" that not only serves to manage radio and other devices, but also for viewing their content – a road map or video.

The XD prototype was fully computer-developed with own software-supported electric drive control. Having produced the prototype, an original design of the home-made car in a three-seater model was created. Trimming the prototype and its adaption to serial production requires still a couple of stages. A prototype is not a serial product, but rather demonstrated knowledge aimed at resulting in production. Once being produced and sold to the known customers or in serial production, the city electric automobile needs to be entirely a product for domestic and global market.

4. XD-engineering

The project management is conducted on the basis of simultaneous engineering whose simultaneous phase overlapping intensifies the development instead of traditional engineering (so-called relays). The project team determines the activities of the project management. The Chief Engineer decides on harmonizing the construction solution, its suitability, reliability and technical issues of production, recycling, law enforcement, EU directives and costs. The Chief Engineer is responsible for changes in trade-off decisions on the prototype as a result of compromise and feedback from testing. An important item in engineering is the creativity of individuals. The purpose of systematic engineering design and experience is to support the creative design due to *systematic engineering inability to replace the creativity of individuals*! The project must remain challenging and manageable.

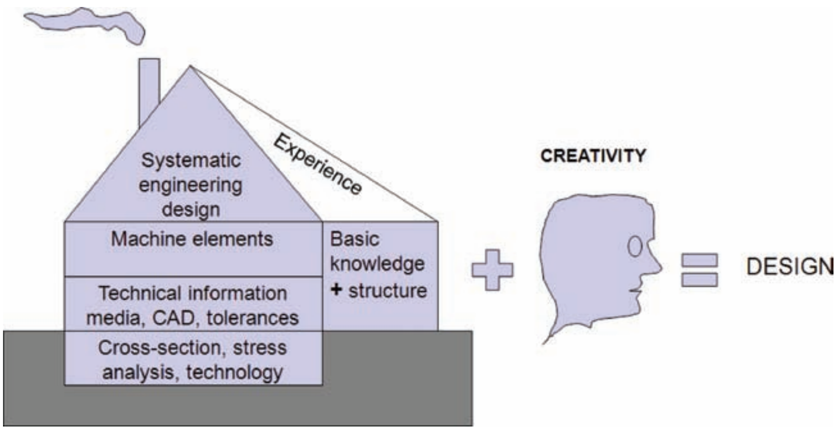

Figure 3. Systematic engineering design and experience supplements a creative design

XD-engineering provides:

– XD *state of the art* product making it of 50% innovation and 20% newly developed parts (mono-space body, gullwing doors, cockpit, controllers, lights / electromotors and gears, ..),
– "rapid prototyping" technique even at an early stage of development brings forward the findings and necessary corrections which would only emerge at a later date in serial production,
– service-life cost transparency (battery recharging, power stations, spare parts, maintenance, special tools and equipment, ..),
– integration of certified requirements and guidelines of the EU.

By producing a prototype the selection of best solutions for individual devices is defined as probably the best. For final selection regarding the best solutions, simulation and multicriteria optimization is performed. A car cannot be designed “part by part” because, for instance, replacing an electromotor requires reconstruction of the power transmission, brake system, suspension, and more. The same applies if one other vital part is changed. A “puzzle” of all subsystems, that is, a complete harmonization of the related properties affecting the vehicle performance and its other features is to be reached. When analyzing multiple subsystems a need arises for more coordination and implementation of optimization by using computer simulation techniques. For example, to illustrate the application of a simulation model in aligning the performances of individual subsystems and systems, hereby a study on the influence of gravity-centre shift on the vehicle brake system performance and vehicle stability is presented (ECE Regulation 13). The integral systematic engineering approach, experience, innovative breakthroughs and optimization are seen by far as the best course of development.

XD-prototype vehicle performance:
- in horizontal drive (0%) vehicle speed is greater than 130 km/h,
- climbing up a 10% steep slope, the vehicle speed reaches 115 km/h,
- a vehicle can manage a 30% climb,
- vehicle acceleration is 7 s/100 km/h.

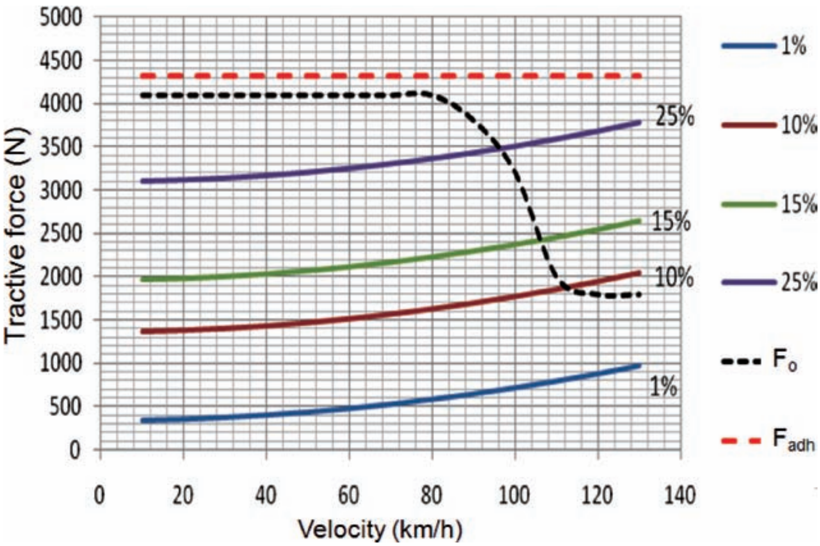

Figure 4. Traction characteristics

5. Energy Development Strategy

The Croatian Energy Development Strategy (NN 130/2009) encourages installation of energy systems via tax incentives and/or subsidies. The transportation sector of the economy participates with its share in the total direct energy consumed with around 30%. Its growth rate is also extremely high (over 5% annually over the past five years). Due to an emerging number of cars, the travelled distance per car and reduced count of passengers per car, the energy consumption is expected to rise constantly. Therefore, the focus of the energy efficiency policies regarding our transportation sector is exactly on road traffic. The Croatian Government will, in accordance with the Energy development strategy, pass a package of energy efficiency measures which include:

- Prescribing more rigorous standards for new vehicles;

The Republic of Croatia will follow and adopt the EU adopted technical standards for vehicles and by this ensure that only effective products enter the market.

- Promotion of greener transport projects and procurement of energy-efficient vehicles.

A range of measures will encourage the use of vehicles that emit under 120 g CO_2/km, electric vehicles, hybrid vehicles – for companies and individuals, backed up through investment subsidies, granting free parking spaces, the right to use the yellow lanes (reserved for public transport), etc.

The automotive industry can be reanimated, should the *Auto klaster Croatia* get involved, which represents the interests of the automotive sector within the HUP system (Croatian Association of Employers). What is also important are the first orders of large domestic companies as well as the first sale subsidy, which is generally considered a recommendation for export to the global market.

6. Conclusion

The domestic development of a city electric car is a step towards the future architecture of urban transportation. The essence of this green urban vehicle is to facilitate and improve people's mobility in densely populated urban conditions as well as to provide active and passive vehicle safety.

The production of automobiles based on innovation and domestic labor costs gives off a perspective of the production wider recognizability. Croatia needs reindustrialization through products of the new technology. In this aspect, the production of an electric vehicle aspires to develop a new technologic generation of vehicles while maintaining and further strengthening the world's knowledge standards.

There is no doubt that, despite the recession, the electric car popularity in the upcoming decade is bound to grow. Following the environmental trends and developing the latest technological achievements, the DOK-ING Company is engaged in programs of sustainable development, which encompass the transition to alternative drives. Although there is no strategy of development specifically for electric cars, the energy development strategy of Croatia in its "transportation" chapter states its plans to promote greener traffic projects and procurement of more energy-efficient vehicles. It has been stated also that various measures will be used to encourage the use of vehicles such as hybrid and electric ones.

The XD-project requires support to insure a stage for developing a local urban vehicle, as a supplement to conventional vehicle programs. A domestic intelligent technical system provides a future to the company and the society as a whole. The prototype development has its own logic that fits into the overall development of the DOK-ING brand. The decisions are made based on opportunities and making use of the developing circumstances for production after all documentation has been prepared, having the prototype testing phase successfully concluded and, finally, having carried out the certification according to EU regulations and directives. The company's management evaluation is that they cannot lose on the project of an electric car, neither in the technologic nor in the economic terms. This means that the project is not overly ambitious, but rather realistic and plannable. Since its founding in 1992, the time when, as a small workshop, it began conquering new markets, DOK-ING has evolved into a renowned brand when it comes to exports based on innovation. For its innovations the company has received the most highly-praised national and international awards. Many years of experience in developing special machines allows forecasting a promising future for the selected product, *XD-Concept*, which was exhibited at the *80th International Motor Show Geneva 2010.*

When a company is competitive and oriented towards the future, then it is the right time to diversify one's products, in this case the time has come for an electric car. It is known that a company is considered competitive should a product younger than 3 or 5 years earn an income equal to 50% of the total turnover. It is important for producers not to allow selling an outdated product. Marketing starts with a hypothesis: if the public desires a product such as an electric car it will surely succeed. A product must meet its consumers' needs, to return the investment yield and create new value. The entrepreneurs have an idea which they hold as good business opportunity, invest intellectual capital together with borrowed money (investment), procure fixed assets and working capital, employ people, organize and manage the business and undertake a lot of other activities, all of this being aimed at establishing their own entrepreneurial vision. On the other hand, however, one ought to work on the awareness of customers and the society as a whole, i.e. that the time has come for electric vehicles which benefit urban life. Hence it can be concluded that the Company, the legislation, the green activist associations and manufacturers of green electric vehicles, all of them have more work ahead of them to be done. In line with this are the EU guidelines on the subsidies to utilize automobile procurements.

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Detection of environmental contaminants by *in vitro* biological systems

Abstract

Chemical characterization of polluted waters and soils does not satisfy requirements for adequate risk assessment because there are no data about environmental mobility and bioavailability of contaminants. It is impossible to predict in which manner will behave stabile salts and complexes formed after contaminants binding to soil particles. For these reasons, toxicological investigations on biological test systems must be conducted as well.

In this work results obtained after chemical and toxicological investigations of wastewaters from landfill and metal industry will be presented. Also, advantages in the usage of *in vitro* biological test systems will be explained including importance of toxicological investigations.

Key words: environmental pollution, *in vitro* test systems, ames assay, cell culture

1. Introduction

Environmental pollution caused by municipal and industrial waters is increasing problem in majority of the European countries. Rapid economic development, increased demands on life quality and raw materials extrapolation have lead to the significant pollution by both, organic and inorganic complex compounds. Additional problem represent release of heavy metals, soluble organic compounds, dyes, nitrates and phosphates, released into environment from households, agricultural fields and dumping sites (2, 4, 5).

Direct pollution effect can be determined on biosystems of affected area, soil, rivers and lakes. Chemical characterization of polluted waters and soils is not adequate indicator for pollution, because for majority of contaminants mobility and bioavailability is unknown. On the other hand, numerous contaminants form stabile complex with organic ligands which cannot be determined. So for the adequate risk assessment it is necessary to determine the influence of waste waters on biological system (7, 9,10).

In this work, biological test systems used for risk assessment of polluted waters and soils are presented. Also, some advantages and disadvantages of each test system will be described as well as parameters that can be determined by certain test system to obtain results that can be used for adequate risk assessment (8, 9, 13).

2. Parameters of toxicity

The major determinant of certain compound toxicity is its bioavailability, (bio)degradation and its ability to penetrate through cell membrane. Once in the cell, it can be accumulated in bones or soft tissues or it can be degraded into more or less active intermediates. In the case of bioaccumulation and chronic exposure, its concentration permanently raises during life-time. In the presence of other compounds, synergism, potentiating and antagonism among different compounds must be taken into account.

In the case of metabolism, different intermediates can be formed, with different affinity to bind to the cellular macromolecules, including proteins, lipids, RNA and DNA, causing permanent changes in the structure and composition of the cell (10, 18, 21).

Compounds or their metabolites can interfere with major metabolic pathways, causing more or less significant obstacles in normal cellular functions and signaling, causing direct changes in tissue and organism functioning (11).

3. Methods for determination of the degree of the critical area pollution

Chemical composition of soils, waters and sediments gives information about chemical contamination of critical area, but for adequate risk assessment of jeopardized area, information about bioavailability, pollutant mobility, formation of stabile complexes with organic ligands and affinity to form stabile salts are needed. In order to detect real influence of environmental pollutants on certain ecosystem, except chemical analysis of affected area, toxicological profile on biological test systems must be determined (3, 4, 13).

Ecological importance of such investigations relies on information about direct consequences on ecosystem at affected area. Also, investigations can be conducted on surrogates of autochthone communities under laboratory conditions. Experimental systems *in vitro* enable detection of any effect of pollutant on cellular level including effect on DNA molecule (DNA breaks, point mutations and influence on cell division (10, 14, 16, 17).

4. *In vitro* test systems

There are many advantages in usage of *in vitro* test systems in investigation of environmental pollutants. *Salmonella* microsome test is often used experimental system because of its simplicity, simple procedure and reliable results which in more than 80% point out on deleterious events on DNA molecule of animals and men. It is possible to mimic animal (or men) detoxifying system by adding liver microsomal fraction isolated from animals (in the most cases from rat) which was previously treated with chemicals that induce detoxifying enzymes of phase I (1, 10, 16).

Other thankful test system is animal and human cell cultures isolated from certain tissue and grown in *in vitro* conditions. It is possible to detect a range of effects caused by certain compounds from cell survival to free radical production, lipid damage, cell and organelle membrane changes and DNA damage. On this type of test system it can be determined what the critical pathway for cytotoxic effect is, and what type of cell death predominates when the cells are exposed to lethal doses of investigated pollutant. Because of genetic similarities and identical source from which these cells are isolated, it is easy to repeat experiments, statistical analysis is simple and results obtained after repeated experiments are reproducible and reliable (10, 14).

Maybe the most important obstacle in this system is the uniformity of cells and lack of different tissues and organs typical for multicellular organism which give different response to same concentration of pollutant. This disadvantage is often by-passed by appliance of different cell lines isolated from different tissues (17).

5. Samples of waters and test systems used for detection of potential geno(toxic) properties

In this work, waters from two different locations were investigated; two samples of landfill leachate from Rovinj landfill site (prior and after purification with active carbon) and five samples from and around metal industry; (41- water sampled from river, 600 m upstream from factory's sink, 42-wastewater sampled from collector 1; water used for high furnaces cooling; 43- wastewater sampled from collector 2; used wastewater from hot and cold steel mill; 44-water sampled from river, 50 m downstream from factory's sink; 45-Danube water sampled from pump station, used for cooling of industry facility).

Phosphates, nitrates and nitrites were determined by UV/Vis spectrophotometer. The atomic absorption spectrometer was used for the analysis of the elements Na, K and Ca. Heavy metals were analyzed by energy dispersive X-ray fluorescence method (EDXRF).

In order to determine a genotoxic profile of wastewaters bacterial test system *Salmonella typhimurium* strains TA98 and TA100 were used (1, 14, 16, 17).

For determination of the potential of examined wastewaters to induce single and double DNA strand breaks, two human cell lines were used; human laryngeal carcinoma cell line (HEp2) and human cervical carcinoma cell line (HeLa) (15, 19, 20).

6. Results of the chemical analysis of the wastewaters

All parameters in the purified water collected from the landfill site were significantly lower compared to initial concentrations and maximum allowed values for wastewater suitable for discharge directly into the environment.

Table 1 – Concentrations of the elements in the landfill leachate samples collected at two different locations at the landfill site prior purification

Element (mg/L)	Original wastewater		MAV
	Wastewater, location 1 (PI)	Wastewater, location 2 (PII)	
Total P	134.2 ± 1.48	227.4 ± 2.50	2
NO3-N	168 ± 2.02	134 ± 1.61	10
NO2-N	224 ± 2.91	571 ± 7.42	0.5
COD	2800 ± 67.20	4230 ± 101.52	300
BOD5	284 ± 11.64	350 ± 14.35	30
Na	1050 ± 33.60	13000 ± 416.00	–
K	1260 ± 64.26	4200 ± 214.20	–
Ca	16.59 ± 0.73	14 ± 0.62	–
Pb	0.025 ± 0.0024	0.032 ± 0.0031	0.200
Hg	0.029 ± 0.0012	0.041 ± 0.0018	–
Se	0.01 ± 0.0004	0.01 ± 0.0004	0.020
As	0.047 ± 0.0043	0.043 ± 0.0040	0.200
Zn	0.334 ± 0.0107	0.574 ± 0.0184	1.000
Cu	0.058 ± 0.0031	0.064 ± 0.0035	0.100
Ni	0.125 ± 0.0071	0.187 ± 0.0107	1.000
Co	0.031 ± 0.0007	0.031 ± 0.0007	0.500
Fe	5.197 ± 0.0572	8.096 ± 0.0891	2.000
Mn	0.632 ± 0.0398	0.604 ± 0.0381	1.000
Cr (VI)	0.04 ± 0.0024	0.07 ± 0.0043	0.050
Cr (tot)	0.189 ± 0.0117	0.197 ± 0.0122	1.000
V	<0.001	<0.001	0.050

MAV – maximum allowed values for wastewater suitable for discharge directly into the environment

Table 2 – Concentrations of the elements before and after purification in leachate samples collected at two different landfill locations

Element (mg/L)	**Wastewater location 1 (PI))**		**Purified wastewater (location 1 (PpI)**	**Wastewater location 2 (PII)**		**Purified wastewater location 2 (PpII)**	**MAV**
Total P	134.2 ± 1.48	→	4.5 ± 0.05	227.4 ± 2.5	→	7.7 ± 0.08	2
NO_3-N	168 ± 2.02	→	16.7 ± 0.20	134 ± 1.61	→	16.7 ± 0.20	10
NO_2-N	224 ± 2.91	→	56.6 ± 0.74	571 ± 7.42	→	37.1 ± 0.48	0.5
COD	2800 ± 22.56	→	940 ± 67.20	4230 ± 101.52	→	1050 ± 25.20	300
BOD_5	284 ± 11.64	→	4 ± 0.16	350 ± 14.35	→	5 ± 0.21	30
Fe	5.197 ± 0.0572	→	0.014 ± 0.0002	8.096 ± 0.0891	→	0.017 ± 0.0002	2.000

MAV – maximum allowed values for wastewater suitable for discharge directly into the environment

Chemical analysis of the samples collected around metal industry revealed that all parameters in the wastewater that was released into environment were significantly lower compared to initial parameters measured in the water in the facility.

Majority of the wastewaters that are released into environment satisfy law regulative on limit values of hazardous substances in wastewater but the effect of the mixture of compounds can be detected only on biological system. Results obtained by chemical analysis and bioassays enable prediction of a real danger for ecosystem if certain wastewater is released into environment.

Table 3 – Concentrations of the metals in the samples of wastewaters collected from 5 locations in metal industry

Parameters (mg/L)	Samples of the wastewaters from 5 locations					MAV
	42	44	43	45	41	
pH	7.95±0.06	8.5±0.07	8.8±0.07	8.05±0.06	8.15±0.07	
N (NO_3^-)	1.793±0.02	1.677±0.02	1.781±0.02	1.617±0.02	1.296±0.02	12
N (NO_2^-)	0.12±0.002	0.06±0.001	0.06±0.001	0.03±0.0001	0.02±0.0001	0.5
N (NH_4^+)	11.65±0.151	0.97±0.013	0.233±0.003	0.097±0.001	0.097±0.001	0.1
Fe	0.33±0.0036	0.5±0.0055	0.33±0.0036	0.25±0.0028	0.5±0.0055	0.5
Phenols	0.009±0.0001	0.005±0.0001	0.003±0.00001	0.003±0.00001	<0.001	0.001
Pb	0.097±0.0094	0.026±0.0025	0.017±0.0016	<0.01	<0.01	0.005
Cr (total)	0.006±0.0004	0.006±0.0004	<0.006	<0.006	<0.006	0.005
Cu	0.03±0.0016	<0.03±	<0.003	<0.03	<0.03	0.1
Zn	6.76±0.2163	0.486±0.0156	0.023±0.0007	0.048±0.0015	0.02±0.0006	1
Cd	0.045±0.0023	0.002±0.0001	<0.02	<0.002	<0.002	0.01
O2	9.2±0.10	11.16±0.12	10.82±0.12	12.07±0.13	12.34±0.14	
Suspended particles	<60.0	26±0.42	62±0.99	20±0.32	34±0.54	

7. Biological effects of the examined wastewaters

The highest concentrations of landfill wastewaters from both locations caused weak mutagenic effect. The lower sensitivity of *Salmonella* test can be explained in the light of the lower extractability of metals from soil into leachates.

On human cervical carcinoma cell line (HeLa), deleterious effect of landfill leachates and purified samples on DNA was examined. Oxidative damage of DNA is higher during the first 24 hours of incubation. Prolonged incubation leads to activation of cellular repair mechanisms, so damage is not high as in short-time experiments. Cells that more resistant to genotoxic effects of wastewaters survived and continued with divisons.

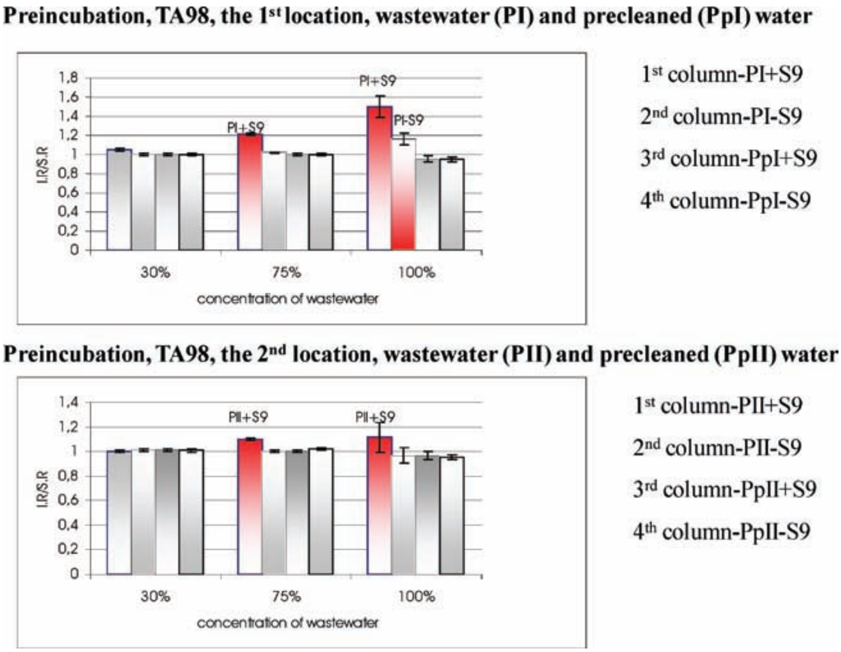

Figure 1. Induction of revertants caused by landfill leachates (PI and PII) and purified samples (PpI and PpII)

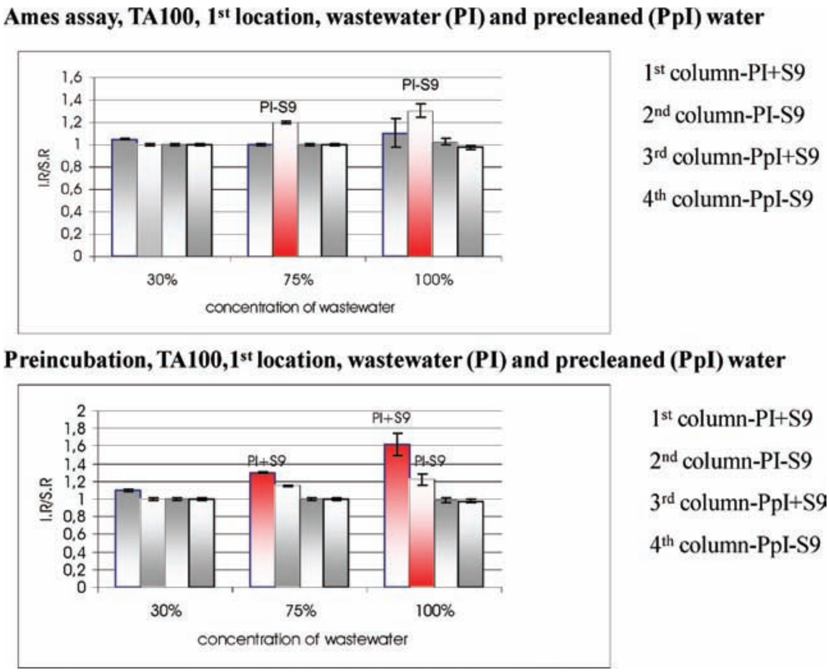

Figure 2. Induction of revertants caused by landfill leachates (PI and PII) and purified samples (PpI and PpII)

Table 4 – Comet assay-early exponential phase of growth, short exposure, water samples from first location

	Tail length (μm)			Tail intensity (DNA %)			Tail moment		
	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max
30 % PI	16.56 0.19	10.9	29.5	2.50 0.68	0.00	21.3	0.37 0.24	0.00	5.7
75% PI	18.72 0.21	14.1	34.7	4.50 0.8	0.00	40.15	0.70 0.23	0.00	7.72
100 % PI	23.29 0.33	10.8	44.8	9.54 0.94	0.00	36.6	1.65 0.4	0.00	8.15
30% PpI	16.21 0.12	11.6	19.92	3.26 0.64	0.00	14.3	0.43 0.19	0.00	1.75
75 % PpI	17.17 0.16	10.3	25.5	3.83 0.76	0.00	18	0.55 0.24	0.00	3.14
100 % PpI	18.18 0.16	11.5	25	3.66 0.72	0.00	22.2	0.55 0.24	0.00	3.07
Positive control	23 ± 0.26	10.9	41.6	4.55 0.82	0.00	26.5	0.8 0.34	0.00	7.51
Negative control	14.78 ± 0.10	12.17	19.2	1.16 0.43	0.00	11.64	0.14 0.1	0.00	2.16

Red: statistically significant differences compared to control (95 % confidence)

Table 5 – Comet assay-early exponential phase of growth, short exposure, water sample from second location

	Tail length (μm)			Tail intensity (DNA %)			Tail moment		
	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max
30 % PII	18.29 0.21	8.7	27.00	5.99 0.86	0.00	31.06	0.86 0.33	0.00	5.10
75% PII	18.073 0.2	10.3	31.4	5.70 0.8	0.00	32.22	0.82 0.29	0.00	4.25
100 % PII	16.52 0.16	11.53	28.84	1.98 0.6	0.00	21.91	0.28 0.17	0.00	2.25
30% PpII	14.62 0.22	8.33	27.00	2.06 0.64	0.00	17.17	0.27 0.18	0.00	2.70
75 % PpII	15.03 0.17	7.05	21.15	4.22 0.85	0.00	36.31	0.56 0.29	0.00	4.50
100 % PpII	17.13 0.16	10.90	27.56	3.21 0.65	0.00	17.31	0.47 0.21	0.00	2.8
Positive control	23 0.27	10.9	41.6	4.55 0.82	0.00	26.5	0.8 0.34	0.00	7.51
Negative control	14.78 0.1	12.17	19.2	1.16 0.43	0.00	11.64	0.14 0.1	0.00	2.16

Red: statistically significant differences compared to control (95 % confidence)

Table 6 – Comet assay-late exponential phase of growth, long-term exposure, water samples from first location

	Tail length (μm)			Tail intensity (DNA %)			Tail moment		
	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max
30 % PI	15,65± 12	10,90	21,80	2,55± 0,65	0.00	36,55	0,42± 0,25	0.00	4,92
75% PI	17,54± 0,17	11,5	30,8	3,70± 0,70	0.00	44,2	0,59± 0,27	0.00	6,79
100 % PI	17,02± 0,15	12,8	27,00	3,16± 0,70	0.00	45,36	0,56± 0,27	0.00	6,10
30% PpI	15,16± 0.14	8,90	20,50	2,55± 0,65	0.00	25,20	0,33± 0,19	0.00	3,44
75 % PpI	16.71± 0.12	10.25	25.64	3.70± 0.71	0.00	27.17	0.51± 0.23	0.00	3.83
100 % PpI	15,68± 0.14	10,25	20,50	3,16± 0,7	0.00	27,50	0,42± 0,20	0.00	3,17
Positive control	21,23± 0,25	12,12	35,26	10,54 1.15	0.00	60,76	1,55± 0,51	0.00	9,74
Negative control	14,99± 0.18	7,05	21,79	4,17± 0,86	0.00	44,58	0,51± 0,28	0.00	5,14

Red: statistically significant differences compared to control (95 % confidence)

Table 7 – Comet assay-early exponential phase of growth, short exposure, water sample from second location

	Tail length (μm)			Tail intensity (DNA %)			Tail moment		
	Mean ± SE	Min	Max	Mean ± SE	Min	Max	Mean ± SE	Min	Max
30 % PII	18,14+ 0,22	8,33	24,36	2,54+ 0,67	0.00	17,37	0,41+ 0,22	0.00	0,89
75% PII	18,27+ 0,18	12,18	28,85	4,74+ 0,72	0.00	21,11	0,71+ 0,26	0.00	8,84
100 % PII	18,64± 0,18	10,89	34,61	6,63± 0,89	0.00	40,45	0,95± 0,34	0.00	16,32
30% PpII	16,14± 0.14	10,26	21,80	3,40± 0,70	0.00	26,11	0,45± 0,21	0.00	3,30
75 % PpII	15,92± 0,17	10,26	21,70	1,88 ±0,57	0.00	12,34	0,28± 0,16	0.00	4.13
100 % PpII	16,26± 0.19	6,41	21,8	4,17± 0,82	0.00	39,15	0,57± 0,29	0.00	4.13
Positive control	21,23± 0,25	12,12	35,26	10,54 1.15	0.00	60,76	1,55± 0,51	0.00	9,74
Negative control	14,99± 0.18	7,05	21,79	4,17± 0,86	0.00	44,58	0,51± 0,28	0.00	5,14

Red: statistically significant differences compared to control (95 % confidence)

It can be seen that basal level of DNA damage (negative control) measured as a tail length, reaches significantly high values. The one should carry in mind that genetic material in immortal cell line is highly unstable, and often spontaneous DNA breaks and aneuploidy occur, resulting in increased number of chromosomes and chromosomal fragments.

Still, the use of cell lines is highly reasonable, because compounds which cause DNA damage increase single and double DNA breaks in comparison to negative control, so deleterious effect of investigated pollutants can be measured.

The other parameters of DNA damage (tail intensity and tail moment) do not reach high values in negative control in early exponential phase of growth, but as the cells reach confluence and exhorter growth medium, with consequent elevation of the concentrations of organic acids and other metabolic products in growth medium, increase of tail moment and tail intensity also occurs.

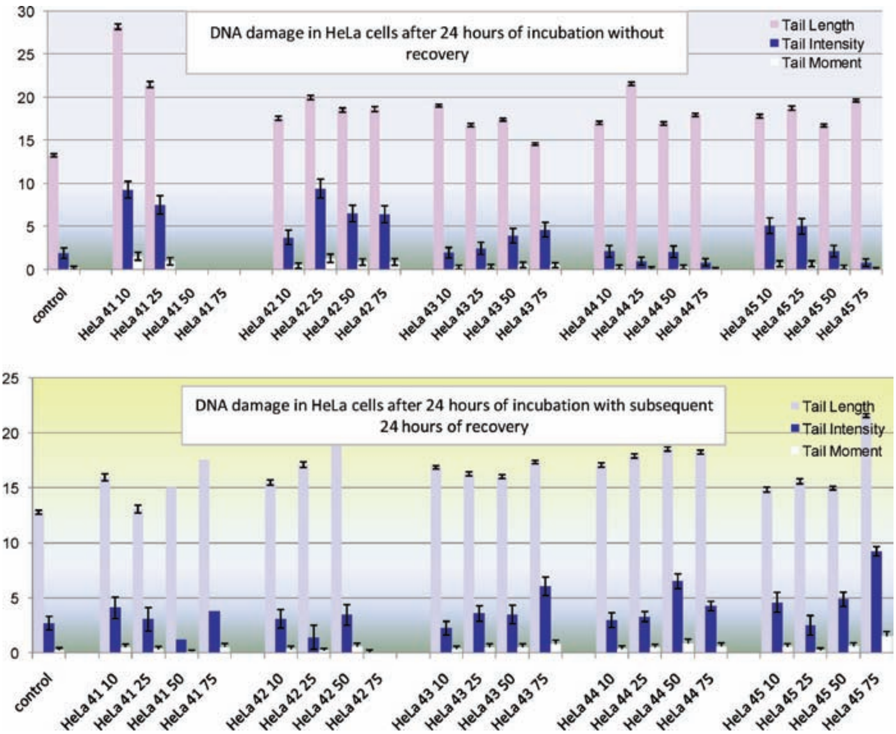

Figure 3. Results of the comet assay during 24 hours of incubation with and without subsequent recovery

It is worth to mention that the values of DNA damage in the cells treated with the highest concentrations of examined pollutants are decreased in comparison to the values measured in cells treated with lower concentrations of pollutants, or even negative control. The reason for this phenomenon lies in the fact that during prolonged exposure of the cells to the high concentrations of toxic compounds, only resistant clones survive. Such cells have more efficient mechanisms of DNA repair, increased levels of endogenous molecules which prevent DNA damage etc. That is the reason why range of concentrations must be investigated. Otherwise, the one could bring completely wrong conclusions about genotoxic potential of investigated chemical, like in this case where the highest concentrations of wastewaters cause false-negative results. Additionally, other parameters must be determined and compared to get a complete picture about genotoxicity of investigated compound.

In the case of wastewaters collected in and around metal industry, Chemical analyses showed that investigated wastewaters did not contain drastically increased levels of heavy metals or phenols, but mixture of these elements did cause severe DNA damage and cytotoxic effects.

The sample of river collected upstream from factory and Danube water contain contaminations of other origin. According to that data it is necessary to estimate what is the impact of household and agricultural contamination of waters on total genotoxic potential of waters.

8. Conclusions

Total concentrations of metals and other contaminants in wastewaters and soils are poor indicators of toxicity. Evaluation of effectiveness of pretreatment of the wastewater can be done by applying an integrated chemical/biological approach.

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Part II

International Cooperation

Agreement signed between HATZ and Austrian Academy of Sciences

AGREEMENT
ON
CO-OPERATION

between the

Croatian Academy of Engineering

and the

Austrian Academy of Sciences

Article 1

The *Croatian Academy of Engineering* and the *Austrian Academy of Sciences*, called "Parties" in the following, agree to foster the collaboration of scientists/scholars in all disciplines represented in the mentioned Academies.

Article 2

It is intended to make it possible for scientists/scholars of both Parties to become acquainted with current research projects in the other country particularly through the regular exchange of published reports, proceedings, newsletters and other publications as well as of information about existing joint projects or colloquia.

Article 3

Where financially possible, the two Parties will initiate or encourage common research projects and continue projects already in progress.

Article 4

Users of archives, libraries and similar institutions can avail themselves of the good offices of both Parties.

Article 5

Both Parties shall endeavour to ensure regular meetings of competent members and responsible co-workers to discuss the progress of their collaboration, if possible, not less than every two years.

Article 6

Visits shall be arranged exclusively on the basis of invitations by the hosting Academy. The participation in conferences, congresses, seminars, symposia, workshops, and other scientific bi-and multilateral events will be subject to funding under this Agreement only in case these initiatives are organized by one of the Parties.

Article 7

The hosting Academy shall be provided with documentation about guests no later than two months before the planned visit. The content of this documentation is set out in Annex I, attached.

Article 8

All collaborative activities will be carried out following the provisions specified in Annex I to this Agreement.

Article 9

On the basis of the present Agreement,
a) The sending Party provides:
- return travel costs to the seat of the receiving Academy;

b) The receiving Party provides:
- accommodation;
- a daily subsistence allowance to cover food, local transport and other incidental expenses;
- travel costs within the host country, in accordance with the agreed scientific working programme;
- personal insurance in case of sudden illness or an accident.

Article 10

Persons invited within this Agreement receive as a basic principle no honorary for lectures, reports or other scientific activities.

Article 11

Reports on the research visits carried out within this Agreement shall be put forward to both Parties.

Article 12

Any intellectual property and other rights arising from joint research work carried out within this Agreement shall be considered as joint property of both Parties.

Article 13

The terms of this Agreement may be amended in writing by mutual consent of both Parties. Each amendment shall form an integral part of the Agreement and shall be annexed to it.

Article 14

This Agreement will come into force on the day of its signing by both Parties and shall be valid for a period of 4 years, automatically renewable for a same period, unless terminated by either Party giving at least six months prior notice in writing to the other Party. Such termination shall, however, not affect collaborative activities already agreed.

Article 15

This Agreement was signed in Vienna on June 18th 2009 in two English copies, both being equally valid.

ON BEHALF OF THE CROATIAN ACADEMY OF ENGINEERING	ON BEHALF OF THE AUSTRIAN ACADEMY OF SCIENCES
Prof. DR. Zlatko Kniewald (President of HATZ)	Prof. Dr. Peter Schuster (President of AAS)
Prof. Dr. Stanko Tonković (Vice-president of HATZ)	Prof. Dr. Herwig Friesinger (Secretary General of AAS)

Zagreb, June 23. 2009.

Meeting between HATZ and Austrian Academy of Sciences

CAETS

CAETS 2009

International Council of Academies of Engineering and Technological Sciences

Canadian Academy of Engineering/ L'Académie canadienne du génie

"Our Heritage of Natural Resources – Management and Sustainability"

July 13 – 17, 2009, Calgary, Canada

The meeting was held at the Hotel Westin in Calgary, Canada. The biggest and most important annual meeting of CAETS – 18th Convocation of the International Council of Academies of Engineering and Technological Sciences was attended by 137 participants, out of which 52 delegates from 22 member countries of CAETS. President of the Croatian Academy of Engineering – Prof. Stanko Tonković, Ph. D. also took part at the meeting. 38 lectures were given (presentations are available on the premises of the Academy) in 5 thematic sections which also represented "scientific" part of the meeting (from July 14th – 16th, 2009), i.e.:

1. **General Natural Resources**
2. **Energy**
3. **Forest**
4. **Water Management**
5. **Mining and Materials**

The entire meeting could be divided in three parts:
July 13, 2009 – CAETS Board of Directors Meeting
July 14 – 16, 2009 – Scientific Segment of the Meeting
July 17, 2009 – CAETS Council Meeting

These are most important proposals and conclusions of the CAETS meeting:

- South African Academy of Engineering has been accepted as full member of CAETS.
- Membership of the Slovenian Academy of Engineering has been renewed.

- Thus the number of member countries of CAETS has amounted to 26.
- New Presidency of CAETS has been elected for the period up to December 31, 2010.

  Assuming the above persons are elected, the Board membership for the period January 1, 2010 through December 31, 2010 will be:

President	Klaus Bock	ATV, Denmark
President-Elect	Jose Antonio Ceballos	AI, Mexico
Secretary, Treasurer	William C. Salmon	United States
Past President	John Leggat	CAE, Canada
Member[1]	Jong Kee YEO	NAEK, Korea
Member[1]	**Stanko Tonkovic**	**HATZ, Croatia**
Member[1]	Charles M. Vest	NAE, USA
Member[1]	Reiner Kopp	acatech, Germany
Member[2]	William Arnot Wakeham	RAEng, United Kingdom
Member[2]	Baldev Raj	INAE, India
Member[2]	Stig Gustavson	TAF, Finland
Member[2]	Kjell Arne Ingebrigtsen	NTVA, Norway

[1] Term is 2009 and 2010

[2] Term is 20010 and 2011

- Financial report for 2008 has been accepted, as well as plans for 2010 and 2011.
- Membership fees for the member academies remain at the last year level.
- To all member academies and the Governments of Canada and USA (their respective Ministries) CAETS is going to send final version of the document “CAETS 2009 STATEMENT” (included in the Annual 2009)
- Next CAETS meetings:

  Annual Meeting in Copenhagen, Denmark, June 29-31, 2010.

  Convocation in Mexico City, Mexico in 2011.

A more detailed account and important material are presented in this Annual, while some other details are available on the web pages of CAETS (caets@nae.edu).

Issues of Concern – 2009

(as received from Academies)

➢ Argentina, ANI

a. Comprehensive development and education of engineers for the XXIst Century

b. Obtaining financial resources for ANI's studies and research projects, preserving the independence and objectivity of conclusions and recommendations.

c. Construction safety of precarious settlements, known as "shanty towns", located at major cities, especially in Buenos Aires.

d. Argentina's deficient situation related to lack of investment in Infrastructure, regarding every area of transportation:
   1. Road
   2. Railways
   3. Air

e. Argentina's deficient situation related to lack of investment in Energy Production, regarding all possible sources:
   1. Hydraulic
   2. Thermal
   3. Nuclear
   4. Non conventional

➢ Australia, ATSE

The Academy is working on a range of technological science and engineering challenges facing Australia principally around the issue of accelerated climate change, including:

- Energy generation in a low carbon future; and
- Sustainable water usage in light of Southern Australia's extended drought.

The Academy is also addressing other national challenges such as education and innovation.

As part of our response to these key challenges to Australia (and the world), ATSE has formed the following strategic approaches:

1. Policy Formulation

- Strengthen the development of evidenced-based policy formulation for input to government;
- ATSE seeks to have a greater input to informed public debate and policy formulation in strategic areas for the Academy;
- Undertaking the synthesis of ATSE position statements in a neutral, technological sciences and engineering based framework on controversial areas where there are strongly held minority positions within the Academy (for example, climate change and nuclear power generation).

2. Industry Engagement

- ATSE's recognises the need to work in partnership with industry, noting a sustained and productive relationship with Australian industry would enhance the Academy's ability to deliver technologically based solutions to the challenges identified. Further, the better our practical engagement with industry, the more efficiently we can achieve evidenced-based problem solving and the greater our ability to influence sound policy making.
- ATSE is considering both activity-based and structural initiatives to this issue and has noted the approaches that some other Academies have adopted as a guide.

3. Education

Australia's challenge to achieve the sustained level of high technology skills that are envisaged to be needed if we are to meet the national technological challenges, such as responding to climate change, highlight current trends which are of concern in our education sector . These include:

- Limited enrolment by secondary students in advanced science and mathematics subjects
- Limited entry by secondary students into science and engineering courses at university
- Lack of interest in scientific and engineering careers within the most able cohorts of school leavers.

4. Innovation

- Innovation is key to making the nation more productive and more competitive.
- ATSE is developing its thinking on what are the key technological scientific and engineering challenges that face Australia today, to assist it in setting its strategic goals and to enable the Academy to contribute to national policy formulation.
- ATSE will actively promote productive innovation in Australia.
- As an example of its engagement in innovation, ATSE is undertaking a project in *Smart Technology for Healthy Longevity.*

5. Foresighting Emerging Technological and Policy Issues

- ATSE has established a Working Group to indentify how the Academy should set new strategic directions, and review existing strategic directions. These strategic directions act as focal points for the Academy's projects, policy development and engagement mechanism with Government and industry on emerging policy issues/priorities.
- ATSE is responding to a number of key national challenges and is committed to providing evidenced-based policy advice to governments, industry and the community in order that technology and engineering are seen as relevant to our everyday lives and as providing best practice solutions to our problems.

➢ Belgium, BACAS

1. Innovation

Belgium wants to achieve the so-called "Lisbon targets" of the European Union regarding R&D and innovation: the E.U. wants all its member states to spend at least 3% of their GDP to innovation. The Flemish committee CAWET (part of BACAS) has investigated the progress made in this field in Flanders (Dutch-speaking part of Belgium).

The working group made the following recommendations:

- Considering the importance of innovation and against the background of a dire and still worsening economic situation, parliament should dedicate more time and interest to the innovation issue. The impact of governmental bills and measures with respect to innovation should be monitored and, when needed, corrective actions, should be proposed.

- Launching of an "Innovation Council" to audit current innovation programs and to advise the government about new innovation initiatives. A suitable existing organization could be charged with those tasks.
- Establishment, with the participation of the major actors, of a Strategic Master Plan for the Flemish economy. Selection of the spearhead economic domains, which consequently should be fostered and deserve a priority treatment.
- Critical evaluation of results, goals, efficient use of funding, overlaps… of all programs, initiatives, organizations,… set up to boost innovation.
- Quicker suspension of underperforming programs and initiatives. Improvement of collaboration and cooperation between services and organizations covering overlapping domains.
- A systematic and thorough evaluation of innovation programs has to assure a proper "return on investment" of the engaged financial means. Suitable consideration should be given to the commercial value of the obtained results. This is, after all, the ultimate goal of the innovation effort.
- Progressive lowering of the administrative burden involved in obtaining government funding with a view to replace it by a comprehensive midterm and post evaluation.
- Setting up of a freely accessible and user-friendly database containing all relevant information about innovation initiatives, programs and projects.
- Keep a proper balance between basic and applied research. Basic research efforts should be maintained at a sufficiently high level to fulfill the needs and expectations of the Flemish economic tissue.

2. Nanotechnology

Nanotechnology is expected to have a major impact in many fields, ranging from medicine to electronics. An expert group has investigated if this is just a new "hype" or if it is really going to fundamentally change our society in the coming years. Communication is also an issue: scientists should sufficiently communicate about their research in order to avoid negative reactions such as the ones that have been experienced in other domains (nuclear energy, biotechnology …) because of a lack of objective information.

3. Interaction between high school education and private enterprise

There is a gap between what students are taught in secondary schools and what the business world demands.

The first part of this paper looks at the problem itself. There are several reasons why this gap exists, despite the high quality of our educational system.

In the second part we look at the somewhat difficult relationship between the business world and the educational system. The business world is extremely heterogeneous and changes rather rapidly, while the educational system tends to be rather sluggish and is not able to respond immediately to all needs of the business world.

The third part deals with the information given to our youth about technology, the possibilities of a career in the business world, and what obstacles remain in deciding to choose a job in the business world.

In the fourth and last part suggestions are put forward for changing the organisation and structure of our educational system. Changes however must also be carried by society, including: parents, the business world, administration, youth movements and sports clubs. An all round education is certainly not the responsibility of the school only.

➢ Canada, CAE

The Canadian Academy of Engineering's main issues of concern are as follows:

- Globalization of engineering with impact on engineering education, training and soft skills
- Our Heritage of Natural Resources – Management and Sustainability
- Energy and Climate Change Challenges
- Sustainable Infrastructure
- Northern Communities

More specifically:

- The innovation system in Canada and improving Canadian productivity
- Impacts of climate change on Canada's North and implications for adaptation
- The need for a national comprehensive water management strategy
- Diversification of energy production so as to reduce dependency on fossil fuels
- Bio-security
- Security of food supply
- Improving the safety of our infrastructures and replacing our aging infrastructure
- Engineering for cold climates
- Battling cybercrime
- The impact of the economic downturn on the Canadian manufacturing sector
- The future of Canada's automotive sector
- Engineering and the needs of an aging population
- The role of engineering in improving the quality of life for Canadians

➢ **China, CAE**

1. Strengthening efforts to ensure the qualification of CAE Member Team by improving election process and implementing the measures for quality control.

2. Speeding up the process of building up CAE into a State Think-tank of Engineering & Technological Sciences so as to serve the goal of economic and social development and innovative nation construction in China.

3. Making contribution to the battle against financial crisis by providing Strategic Consultations to the Central Government.

4. Bettering the strategic studies on medium and long term national development programs of engineering and technological sciences.

5. Strengthening the ongoing study on National Strategy of Energy and Environment.

6. Continuing the efforts in enhancing Academy-Industry interaction and cooperation.

7. Upgrading and deepening the exchange and collaboration between CAE and sister Academies around the world.

➢ **Croatia, HATZ**

- Croatian Academy of Engineering held its 24th Annual and also Elective Assembly on March 14th, 2009. The mandate of Prof. Zlatko Kniewald, Ph.D. as the head of this eminent and honorable Croatian institution ended. For the new mandate, from 2009 up to 2013 (beginning with **July 1st, 2009**), the participants elected the President Prof. Stanko Tonković, Ph.D., Vice-Presidents Prof. Miljenko Lapaine, Ph.D. and Prof. Vilko Žiljak, Ph.D. and Secretary-General Goran Granić, Ph.D. We expect "transition period" of the six months (till January 1st, 2010).
- Due to the modification of Articles of Association, the Croatian Academy of Engineering became, on May 12, 2009, Full Member of Euro-CASE.
- First task of new Governing Board is to establish novel Presidency of the Croatian Academy of Engineering, relating additionally to elected (same Assembly) Department Secretaries, Standing Committees & Chairpersons and Heads of the Academy Centers.
- We will try especially to activate Centre for Lifelong Education in relation with the Ministry of Science, Education and Sports, University of Zagreb and Croatian Academy of Sciences and Arts, and with the general effort in Croatia to establish new National Curriculum for High Schools, considering mainly the influence of new technologies in educational process.
- The Academy must become a partner of state institutions and associations and create the cooperation with all relevant industry, engineering and manufacturing sectors in the field of technical and biotechnical sciences. This is both, a commitment and responsibility of the new Board, Presidency, all organizational Units of the Academy, as well as of all its members.
- New Governing Board will continue preparations for the celebration of the 300th Anniversary of the birth of Ruđer Bošković, 2011.

- The Academy should become the meeting point of the members for presentations of their achievements & discussions, as well as for social gathering.

➢ Czech Republic, EA CR

Engineering Education

- During the whole 2008 and the beginning of the 2009 Engineering Academy of the Czech Republic was taking part in the discussion of the Academia on the Reform of the University Education, which also concerned Engineering Education. The reform was being prepared by the Ministry of Education, Youth and Sport of the Czech Republic. Number of topics for this discussion emerged also from the International Workshop "The Role of Engineering Education in Knowledge Society" organized by EA CR in Prague in October 2008. Due to the serious reservations the draft of the reform was withdrawn for the thorough revision. The Academy will follow the work on a new draught of the reform and will be expressing its views.

Technological Foundation of the Czech Republic

- As an outcome of a new bill on the Research and Development which was passed by the Parliament of the Czech Republic in March 2009, a Technological Foundation of the Czech Republic (TC FR) is being introduced. The Foundation will provide public financial support to the applied research and development. EA CR was the first that came up with the project of a Technological Foundation already in the year 2004. EA CR considers this a very significant achievement and delegated its Fellows into the TF CR Preparatory committee. This committee has been preparing all the basic documents, which will regulate the functioning of the Foundation.

➢ Denmark, ATV

- Research, Education and Innovation
- Sustainable Infrastructure
- Sustainable Food Systems
- Energy and Climate Change
- Health
- Sustainable Transport

➢ Finland, TAFF

- How to make technologies main vehicles for the growth strategies of the next upturn?
- How to provide accurate and simultaneously easy-to-understand information on complex technological issues for general public, for example on sustainable energy solutions in the society?
- How to make the innovation climate more suitable for spin-off companies to excel in Finland?
- Technology Foresight.

➢ France, NATF

Research and innovation

The Academy is adressing a number of technology and innovation related national challenges through Policy formulation and active participation in governance boards:

1. Restructuration of the high level education, including research, towards autonomy of the universities .
2. Bringing together the small and medium size companies and the public research labs on well defined medium and long term projects.
3. Maintaining a true technology teaching in secondary schools.

Climate change and new energy production technologies

NATF is very active in adressing the issues of energy savings and the development of new energy production technologies. This is of particular interest in France where both the national (with the size of the nuclear energy) and european context make any change complex.

The role of technology in outing the crisis

Although nobody can predict when the crisis will end and the growth will start again the Academy decided to initiate a study on how the technology could help the recovery in the medium-long term future.

➢ Germany, acatech

acatech perceives itself as a flexible working academy and as a science and business network. In order to promote sustained growth through innovation, acatech focuses on four core areas:

- Scientific recommendations: acatech advises policy makers and the public on future technology issues based on the best of research.
- Transfer of expertise: acatech provides a platform for exchange between science and business.
- Promotion of young scientists and engineers: acatech is committed to supporting young scientists and engineers.
- Voice for science and engineering: acatech represents the interests of scientists and engineers at a national and international level.

The members of acatech engage in the central issues of science and technology. These issues are structured into topical networks that give rise to project groups. The topical networks are:

- Biotechnology
- Education and Knowledge Management
- Energy, Construction, Infrastructure and Environment
- Foundation of Engineering and Technology
- Information and Communication Technology
- Materials
- Mobility
- Nanotechnology
- Product Development
- Safety and Security

➢ Hungary, MMA

- MSc-BSc experiences
- Energy strategies
- Food security

➢ India, INAE

Enhancing Industry-Academe Interaction

The lack of adequate interaction between the Academe and Industry is a barrier in converting R&D into actual products, processes and goods in the market. The Scientific Advisory Committee to the Cabinet (SAC-C), Government of India is also concerned about this problem. The SAC-C has suggested that the Indian National Academy of Engineering (INAE) should conduct Seminars/Debates on All-India basis for enhancing the interaction between the Academe and Industry. Four separate discussion meetings entirely devoted to the subject were convened by INAE and a summary of discussions of all these meetings has been forwarded to the Office of the Principal Scientific Advisor to the Cabinet (SAC-C), Government of India.

Academy's Role in formulating and influencing Science & Technology Policy

Most of the S&T Departments and the Agencies in India such as Atomic Energy, Space, Defence etc. are headed by Scientists, and they and their senior colleagues make policies. However, there are many areas of national activity, notably, Environment, Communication and Information Technology, various aspects of Infrastructure, Education, Health Care etc., in which the Policy-making individuals and bodies involve Generalists and not Specialists. In these areas, certainly there is a need for creating both awareness among the public as well as the decision- makers on the S&T issues.

In order to face the challenge of sustaining its rapid economic growth while dealing with the global threat of climate change, the Government of India has initiated a "National Action Plan on Climate Change" which addresses the urgent and critical concerns of the country through a directional shift in the development pathway. This Action Plan identifies measures that promote the development objectives while also yielding co-benefits for addressing climate change effectively. It outlines a number of steps to simultaneously advance India's development and climate- change related objectives of adaptation and mitigation.

Improving the Quality of Engineering Education

Engineering Education in India has had unprecedented expansion in the last few years. The number of Engineering Colleges/Institutions in India has increased from 50 during the year 1950 to 2300 during the year 2009. However, the number of qualified engineering teachers has not grown proportionately. This expansion has therefore resulted in a decline of the quality of engineering education.

It is further observed that whereas the number of Polytechnics has increased from 46 during the year 1950 to 1500 during 2009, the intake of students has not increased correspondingly. The popularity of polytechnics is also on the decline.

It is considered necessary to employ a host of strategies in order to improve and sustain the Quality of Engineering Education in the country.

The private sector continues to be a major player with its current share in engineering education today being close to 86%. Most engineering colleges are privately owned & administered and are affiliated with state Universities. The Indian Institutes of Technology (IITs), are a group of autonomous engineering and technology-oriented institutes of higher education created to train scientists and engineers, with the aim of developing a skilled workforce to support the economic and social development of India after independence in 1947. The government plans to establish eight more Indian Institutes of Technology (IITs) across the country within next five-six years. Each new IIT will have 2,000 undergraduate, 500 postgraduate, 400 doctoral and 100 post-doctorate students.

The Government of India has also established five Indian Institutes of Science Education and Research (IISER). The IISERs represent a unique initiative in India where teaching and education are totally integrated with state-of-the-art research nurturing both curiosity and creativity in an intellectually vibrant atmosphere of research. Each IISER is an autonomous institution awarding its own Masters and Doctoral degrees.

Bridging the Digital Divide

The ever widening gap between the developed and developing nations needs to be rapidly bridged to ensure a minimum acceptable quality of life for the vulnerable people in the poorer nations. This can only happen when we are able to build a strong digital bridge and empower weaker nations and vulnerable societies to reap the benefits of economic globalisation using the tools now available from information and communication technology revolution. What is needed is a strong political will and enlightened leadership committed to bridge the digital divide to achieve the dream of a truly global village.

Design for Recycling

Mankind's spectacular technological progress often results in unforeseen and unintended adverse effects on society and environment. India is on the throes of spectacular economic expansion, which will result in greater consumption of engineering and engineered goods, which have a limited life. The problem of disposal of these items would need to be addressed well before it assumes the proportions of a major ecological disaster. The population of cell phones is increasing by millions. Similar growth is being reported in other consumer durables and other industries like steel, cement, plastics and petrochemicals. All these engineered goods have a finite life and will become scrap at the end of their useful economic life. We need to develop technologies for scrap recovery and setup mechanisms to collect and process the scrap generated to produce useful raw material and goods. It is imperative that the design of the engineering goods and consumer durables etc. should be such that they are amenable for recycling.

INAE had organized a Seminar on "Recycling for Electronic and Automotive Industry". The aim of the seminar was to devise strategies for disposal and recycling of engineering goods so as to protect the environment and conserve depleting natural resources like iron ore and bauxite, with a focus on two major sectors, viz., Electronics and Automotive Manufacturing. The Seminar included the invited talks by renowned scientists and technologists. Presentations were made on "Problem Definition and Possible Solutions in the Indian Context"; "Economics and Business Models"; "Regulations"; "Research and Development Issues"; "e-Waste Management"; "Economics & Business Models"; and "Effects of e-Waste on Environment".

The policy recommendations of the Seminar have been sent to the Planning Commission, Ministry of Heavy Industry, Ministry of Environment, Ministry of Information Technology and Department of Science & Technology for follow-up action.

Some Contemporary Issues and Questions

a) How to exploit more effectively and efficiently the expertise of our Fellowship on issues and activities of national concern.

b) How to raise interest in Science. The number of science students in the school has fallen significantly during the last few years due to various socio-economic reasons. Fewer students are now opting for careers in science, especially research work.

In this context, Department of Science & Technology, Government of India has recently proposed three new schemes, for implementation during the next Five Year Plan, for attraction of talented students to study and pursue careers in science, viz, (i) S*cheme for early Attraction of Talents for Science* for a total of one million young learners of the age group 10-17 years once in their school career. (ii) Ten thousand *Scholarships for Higher Education for* the age group 17-22 years, per year. . (iii) *Offering Assured Opportunity in Research for* the age group 17-22 years, for 5 years' doctoral research, backed by an assured research career opportunity for another period of five years after their PhD in sciences. All these schemes include attractive scholarships for motivating the students.

c) How to adapt Engineering Education to serve Industry needs better.

d) How to ensure adequate and sustained funding for the core activities of the Academy.

➢ Japan, EAJ

1) **Policy Recommendations**

A variety of task forces are working on preparing recommendations related to national policy on science, technology and innovation. Efforts are being made for putting the ideas into practice. In particular, EAJ aims at letting its assertions be incorporated into the 4th Science and Technology Basic Plan (2011-2016) keeping closer relationship with the Council for Science and Technology Policy and the Science Council of Japan.

2) **International Activities**

- The 9th Japan-America Frontiers of Engineering Symposium (Irvine) (Co-organized with NAE and JST)
- The 13th East Asia Round Table Meeting of Academies of Engineering (Nagoya)
  Symposium Theme: "Transportation toward Low Carbon Society" (Co-organized with CAE and NAEK)
- Bilateral Cooperation with RAEng, NATF, acatech, IVA, ATSE and other academies are underway.

3) **Domestic Activities**

Symposia:

- "How to Nurture Potential Leaders"
- "Frontiers of Water Research"
- 3 ~5 more symposia will be held in FY2009

Lecture Meetings and Others

- Special Lecture: "National Policy on Science, Technology and Innovation in the Global Era"
- 3~5 lecture meetings will be held in FY2009.
- 7 working groups are studying on various political and/or technical issues, including engineering education, engineering ethics, safety and security, Social infrastructures and commission, etc.
- Regional lecture meetings in Hokkaido-Tohoku, Chubu, Kansai and Kyushu areas. Efforts are being made to more activate regional acivities and discover eligible members in those regional areas.
- Efforts are also being made to strengthen relationship with supporting corporate members and other academic/industrial/governmental organizations.

➢ Korea, NAEK

Our major concerns are

Korea's competitiveness in sciences and technology which will shape the future of Korea.

- Committees on Strategies for Future Engineering Technology and Convergence Technology, Sustainable Development of Manufacturing separately address pertinent issues.
- Particularly the Committee on Strategies for Future Engineering Technology recently set up to propose short and long term strategies to the government how industries should respond to the vulnerable market transformations caused by a recent global financial crisis. It will tackle 10 classified industries – automobile, shipbuilding, steel, semi-conductor, mobile communication, display, health, environment, energy, and materials.

To increase public understanding of science and engineering and to attract talented students to enroll engineering disciplines.

- Support YEHS students (Young Engineers Honor Society, engineering students in BS) to develop their leadership, and communication skills.
- A Series of Newspaper Column that introduces '12 Significant Future Technology' in *Chosun Daily Newspaper.*

➢ The Netherlands, AcTI-nl

The Netherlands Academy of Technology and Innovation's main issues of concern are as follows:

- Enhancing the Academy's function as a meetingplace for high level decision makers and experts in technology development, research, higher education and innovation .
- Strengthening the Academy's role as an informal sounding board for key decision makers in politics and government agencies.
- To develop a coherent vision on the vital importance of technology and innovation for societal well-being, and to have an impact on societal debate and actions on these issues.
- Raising the awareness of the Academy amongst higher education institutions, R&D organizations, government agencies, industry, politics, and NGO's.
- Securing its independent position in relation to government, industry, NGO's and scientific and educational institutions.

➢ Norway, NTVA

Norwegian Academy of Technological Sciences (NTVA) has identified the following issues of importance:

- Increasing the political influence of NTVA
- Funding for NTVA project work
- Innovation, private and public R&D
- Engineering Education
- Young people and Science Education
- Actions to help the public understand science and technology

- Energy and climate
- Nanotechnologies
- Marine industry
- Medical technology
- Technology foresight
- Innovation
- Transport
- Global Production

➢ Slovenia, IAS

- Societal visibility, understanding and appreciation of the role and significance of engineers for national development;
- Comprehensive education and professional training of engineers for XXIst century;
- Competitiveness of small and medium enterprises in Slovene industry;
- National strategic energy and climate changes policy;
- Linking the universities and research institutions with industry.

➢ Spain, RAI

- To evaluate and to promote the contribution of Engineering to a sustainable development, with a particular emphasis on energy, transportation and climate change issues. To study and promote the use of new technologies for sustainable solutions.
- To predict the technological, socio-economical and environmental evolution in the next 5, 10, 25 and 50 years. To define the profile of the future engineers. Engineering Education should be based on the social and technological needs, and adapted to their changes.
- To foster new tools for the Information & Knowledge (I & K) Society. To consider Information and Communication Technologies as our new way to manage and share Information, and as an essential tool for exploiting Knowledge. To promote new ICT solutions as an important tool for Education, Research, Creativity and Innovation.
- To make Engineering Education attractive to young people. To increase the technological interests and abilities at schools.

- To strengthen the social impact of our Academy. To raise the awareness of the Academy amongst engineers, government, industry and the general public and to increase the mutual interaction. Dissemination of the importance of the present technologies.

In addition, high level issues of concern relate to:

- Nanotechnologies
- Sustainable Infrastructures
- Actions to help the public understand science and technology
- Promote more active interactions with mass media
- Health engineering
- Security engineering
- Engineering solutions to increase the quality of life in poor countries
- Actions to foster engineering innovation

➢ Switzerland, SATW

The guidelines of all activities of SATW are

- providing foresight to society-relevant subjects in the fields of education, research and technology
- fostering ethical-based responsibility in dealing with scientific knowledge, especially in the field of technology
- advancing the dialogue between science, especially engineering sciences, and politics and society.

An issue of permanently high priority of SATW is motivating people, especially the young generation, to better understand technology in order to be able to recognize its imperative to overcome global existential problems like global warming, energy and resource crisis etc.

In more details the issues of concern of SATW in 2009 are the following:

1. Supporting efforts for highly efficient production, transition, use, and recycling of materials and energy.
2. Fostering new approaches towards sustainable mobility.
3. Fostering the comprehension of engineering and technology within society, aiming in particular to motivate youngsters and their teachers to deal with technology and to recognize its relevance for the society.

4. Encouragement of knowledge transfer between research and industry in the pre-competitive phase in order to more effectively exploit the market potential of research findings.
5. Promotion of ethics and integrity in science and technology.
6. Fostering broad application of information and communication technologies (ICT) especially in the health care system and the education system. Advancing the computer literacy of society in general.
7. Investigating and communicating the chances and risks of new technologies, in particular bio-technology (synthetic biology, green biology and bio-fuels) and nanotechnology, and their development – together with ICT – towards converging technologies.
8. Augmenting the effectiveness of our activities as well as their perception in the public, especially with politics.
9. Fostering the relations to and collaborations with sister academies in Switzerland and abroad.

➢ United Kingdom, RAEng

The Academy's main issues of concern are set out in the Strategic Plan 2005–2010. This defines the Academy's Strategic Objectives as being:

- To engage more effectively with the public and the public policy process
- To attract more people to a wider range of engineering careers
- To enhance the contribution of engineering to raising the UK's innovation performance
- To strengthen the Academy and its ability to make an impact.

The Academy works towards these objectives by structuring its activities around three priorities: to enhance the UK's engineering capabilities, to recognise excellence and inspire the next generation and to lead debate by guiding informed thinking and influencing public policy.

In addition, the President of The Royal Academy of Engineering, Lord Browne, has set out the following priority areas for his five year term of office, which runs from 2006 to 2011:

- Energy and climate change
- Poverty reduction
- Health and well-being
- Education
- Infrastructure

➢ United States, NAE

Systems Engineering and Financial Regulation

In recent years, the Federal Reserve has been working to transition from a supervisory regime that is focused on the health of individual financial institutions to one that focuses on the health of markets. This transition is incomplete, and in fact no one really knows how to regulate the systemic risks that characterize financial markets. The need for fresh thinking was captured in a 2007 NRC report, *New Directions for Understanding Systemic Risk*.

The ongoing stresses that began last summer – which are referred to as the sub-prime credit crisis – have emphasized the need for a better understanding of systemic risks and market behaviors. The ramifications of the sub-prime credit crisis have been more severe than might have been predicted originally. The severity of the response has been traced to factors such as a surge of new financial products over the past decade and a major shift toward investing outside of the traditional banking system (and therefore beyond the control of the Federal Reserve System). The behaviors of some markets during the crisis (e.g., the spreads between offering and selling prices) have also been contrary to what had been seen during previous systemic events, such as those in 1997-98.

The Federal Reserve, Department of the Treasury, and Congress are all grappling with how to respond to the lessons learned from this crisis. On June 9, 2008, Timothy Geithner, President of the Federal Reserve Bank of New York, gave a speech at The Economic Club of New York in which he outlined his vision of how the financial regulatory system must evolve. He asserted that "the severity and complexity of this crisis makes a compelling case for a comprehensive reassessment of how to use regulation to strike an appropriate balance between efficiency and stability . It is going to require significant changes to the way we regulate and supervise financial institutions, changes that go well beyond adjustments to some of the specific capital charges in the existing capital requirement regime for banks." He later said "This crisis gives us the opportunity to bring about fundamental change in the direction of a more streamlined and consolidated system with more clarity around responsibility for the prudential safeguards in the system."

Geithner made the case for the Federal Reserve System to have supervisory authority not only over its traditional institutions, but also over existing markets and over new types of institutions, markets, and instruments. The Federal Reserve, Treasury, and Congress are proceeding with efforts to construct that authority. It seems likely that some structural and policy changes will be put in effect over the next 6-12 months. Those changes, while major, are essentially policy decisions, and they will proceed without Academies input.

But it is not clear how the regulatory system will go about building up the capabilities for analyzing and controlling the systemic risks. Not enough research has been conducted on this topic, and the Academies might play a role in (a) identifying appropriate research directions (albeit, only after the most important questions have been identified), (b) identifying relevant concepts and methods from other fields that might be adapted to regulation of the financial system, (c) making an unbiased assessment of the scale of research that is required (which cannot be argued well by the Federal Reserve, which conducts much of the relevant research), and (d) building the broader research community that is necessary.

Some systems engineers have experience in the design, analysis, and control of systems as complex as that which the Federal Reserve must regulate. Yet there is very little overlap between the systems engineering and financial regulatory communities. There would be value in cross-fertilization, and we are exploring how the experience of some systems engineers can directly assist the financial regulatory community in addressing new systems challenges. The following questions are appropriate to address:

- What are some of the challenges to developing the analytical and control capabilities envisioned by the Federal Reserve?
- Would there be value in improving the level of interaction between the systems engineering and financial regulatory communities?
- If so, what are the intellectual areas where an improved interface would provide value?
- What are some existing, or developing, methods that could enable better understanding and control of systemic risk in financial markets? These might include agent-based modeling, evolutionary economics, and hierarchies of models, for example.
- How might the NAE work to improve this interface?

CAETS

International Council of Academies of Engineering and Technological Sciences

Global Natural Resources – Management and Sustainability

A CAETS Statement

Calgary, Alberta, Canada, July 13 - 17, 2009

The 2009 CAETS Convocation, hosted by the Canadian Academy of Engineering, addressed the grand challenges and opportunities associated with the sustainable management of natural resources. Resource activity worldwide is increasingly impacting society in both positive and detrimental ways. Demand for resources threatens to outstrip supply in many areas; extraction, refinement and utilization are contributors to greenhouse gas (GHG) emissions and climate change, and affect water supplies and the land base. Society faces an urgent need to reduce the demands on all kinds of raw materials and energy. New approaches are required to managing global resources and the supply chains they feed, to ensure that humanity's needs are fulfilled for current and future generations. A balance must be struck between economic gain derived from resource exploitation and utilization, and the impacts on society and the environment. Issues related to energy, water management, forestry, and mining/minerals must be considered in an integrated approach and in harmony with nature, which examine their interdependencies and tap the cross-sector opportunities for novel strategies, processes, technologies and solutions.

Overarching Recommendations

1. Industry and government must consider sustainable development, stewardship, conservation, recycling, re-use, substitution and responsibility to local inhabitants when assessing the present and future management of our natural resources base.
2. Engineering design as well as industry and government evaluation of a product's sustainability must account for its entire life cycle, including processes for manufacture, services for use and disposal.
3. Adaptations to climate change must be robust against uncertainty, informed by data and research, integrated across sectors and consistent with climate change mitigation policies.

CAETS is the International Council of Academies of Engineering and Technological Sciences, Inc. It consists of those national academies of engineering and technological sciences that have satisfied an agreed set of criteria for membership. It was established in 1978 and was incorporated as a charitable non-profit corporation in the District of Columbia (US) in 2000. Its Articles of Incorporation, Bylaws and Operating Procedures set down its objectives and governance arrangements. These documents and its membership and achievements are posted on the CAETS website, www.caets.org.

ENERGY

A major global challenge of the 21st century is mitigating and adapting to climate change while assuring an affordable, clean and secure energy supply and end-use technologies to meet the needs of an expanding population for higher living standards, especially in the developing world. Cleaner, more efficient fossil fuel extraction, production and utilization are needed, as are renewable technologies for power generation to reduce GHGs. Carbon capture and storage must be developed at the commercial scale required to deal with continuing coal-fired generation. Investment in clean energy must be complemented by an equal commitment to energy efficiency, demand-reduction technologies and policies, incorporated in a systems approach. Biomass and gas from hydrates offer potential for cleaner fuels. Nuclear fission will be an increasing source of power in India, much of Europe and the U.S., but less likely in Germany, where renewables now account for nearly 15 percent of the electricity supply, or Australia. Fusion offers potential for the long term. However, more trained personnel are necessary to ensure the continued development of nuclear energy.

The intermittencies of renewable technologies such as solar Photo-Voltaic (PV) and wind power will require large installed base capacity as well as cheap storage, to replace coal-fired energy. Modern transmission and distribution (T&D) systems, including DC transmission, are urgently needed to integrate renewables, reduce storage requirements and accommodate distributed and self-generation sources, demand-response technologies and electric vehicles.

Implementation costs will be challenging. For example, the investment to reduce Australia's total GHG emissions by just 10 percent by 2020 ranges from US$37 billion for wind power to US$140 billion for solar PV. Modernizing the electric power T&D systems in the U.S. will cost US$225 billion and US$640 billion, respectively (20% more than 'business as usual'), over the next 20 years. On a global scale, with electricity growth at ~1.9% a year, the International Energy Agency projects an investment of US$16.5 trillion in new technologies is necessary to achieve global reduction of GHGs by 50% from current levels by 2050.

Energy Recommendations

4. Governments must adopt policies to encourage the investments required – supported by engineering assessment – to transition over the next 20 years to clean energy systems; to increase the supply of renewable energy; to establish connectivity among smart grids; and to implement effective energy efficiency and conservation technologies and programs.
5. Governments must adopt environmental protection rules and climate change initiatives, including carbon pricing, which support a long-term market view and ensure a level playing field for all countries and resource sectors.
6. The global community needs to support increased technology transfer of clean energy systems and services between developed and developing countries.
7. Governments must adopt international safety standards and enhance public understanding of nuclear power generation.

FORESTS

As petroleum became the world's major source of fuels and chemicals, the global forest industry continued to prosper by producing building products and a wide variety of paper products. The industry is currently undergoing a dramatic repositioning. Increasing demand for forest products is being met by high-growth plantation forestry in South America (e.g., Uruguay's US$2 billion for new paper mills is the largest investment in the country's history), Indonesia and southern Europe. The industry is establishing a new balance between its traditional products and an array of new eco-friendly, high-value products. Production of renewable and carbon-neutral biofuels and chemicals presents an economic opportunity for the industry, while decreasing use of nonrenewable resources.

Forests act as a major sink for carbon dioxide and generator of oxygen, so sustainable forestry plays a crucial role in controlling GHGs. Forests also help maintain watersheds, prevent erosion and desertification, support biodiversity and provide wildlife habitat and recreation. Within the forest ecosystem, many social, economic and ecological elements, including fire and pest control, are linked through multiple relationships acting across different scales. Integrated forest management recognizes this complexity and utilizes new institutions and processes for effective decision making.

Forests Recommendations

8. Government, industry, engineering and environmental groups should jointly develop a framework for assessment of the benefits that society derives from forests to foster a balance between the economic, ecological and recreational values of this resource.
9. Industry must develop improved forest management practices that will enhance the benefits of this resource to our global environment.
10. Industry should develop recyclable, reusable, high-value products that use the full potential of raw materials from trees to reduce depletion of non-renewable resources.

WATER MANAGEMENT

The world population tripled in the last century, while the use of fresh water grew six-fold. Agriculture consumes about 70 percent of the world's water; with a population forecast to grow 40 to 50 percent in the next 50 years, much more water will be needed to produce food and supply drinking water, particularly in heavily populated regions. The volumes of fresh water needed to support the growth in energy production (including biofuels, nuclear energy, hydropower and non-conventional oil and gas) are not available with today's water management policies and practices. Aging water-delivery systems compound these issues.

On the supply side, climate change presents important challenges for local and global water resource management. Rainfall levels in many regions are already impacted, evidenced by increasing frequency and severity of floods and droughts that also have a serious impact on the aquatic ecosystems that support the sustainable supply of food and fresh water. The capability of global climate models to predict precipitation is poor, and the understanding of regional catchment scale impacts remains highly uncertain. Water management policies and practices at the catchment scale must be adaptable and must ensure the protection of watersheds and groundwater aquifers for future water supply and conservation of ecosystem function.

Water conservation and management solutions must reflect local conditions of supply, demand and environment and include water recycling, re-use storage, redistribution and regeneration. Tools used should include: regional watershed management and drought response plans; on- and off-stream storage; trading systems to promote reallocation among uses; incentives to employ new technology for conservation or use of non-fresh water; groundwater aquifer development; and inter-basin water transfers. The application and success of these strategies depend on the engineering community working with national and regional governments to integrate social, environmental and economic factors into locally appropriate policies and practices.

Water Management Recommendations

11. Climate change modeling must inform regional watershed planning; government funding should focus on making models usable for local decision making.
12. Government policy must support local management of strategic water resources, under a broad mandate of water conservation, environmental protection and sustainable economic development, integrating new technology, security provisions, policy development and appropriate changes to legislation/regulation.
13. Water is a key input for food and energy production, and significant energy is used to process and deliver water; this interlinked water-energy-food system needs to be better understood to make appropriate trade-offs for future social and economic development.
14. Government policy must support investments in building and refurbishing infrastructure for delivery of clean drinking water and handling of waste water all over the world.

MINING AND MINERALS

In the mining industry, extraction processes are changing rapidly to reduce GHG emissions, reduce water requirements and cut the volume of tailings and slags. However, these advances are challenged as the quality of the deposits exploited continues to decline. The pressing need for new technology is made difficult by the capital-intensive nature of the industry, the long-term investments required in an often volatile global commodities market, and the poor record of technology breakthroughs succeeding in the marketplace. Natural resource industries rely heavily on civil infrastructure.

Compounding these mining and mineral challenges is the general infrastructure crisis, especially in developed countries, which lowers private sector productivity, a country's real income and international competitiveness. An estimated US$1.6 trillion will be needed in the next five years to alleviate potential problems with the civil infrastructure in the U.S. In Canada, the current infrastructure deficit is US$110 billion and growing annually by US$1.7 billion – six to 10 times the level of all annual government infrastructure spending.

Mining and Minerals Recommendations

15. International collaboration in R&D and policy development, especially on large-scale projects that demonstrate best available environmental technologies and practices, must be encouraged and supported.
16. Development of novel technologies and processes that reduce GHGs, water utilization and energy used in extraction, production, utilization and recycling needs to be promoted by industry and incentivized by government.
17. Sufficient investment in new materials and technologies, supported by government leadership and sound policy, is required to build and renew public infrastructure.

CONCLUSION

The engineering challenges associated with sustainable resource management are indeed vast – but the opportunities are likewise enormous. With rapidly depleting natural resources, many non-renewable, we must harness the power of engineering to develop new solutions, supported by clear policies and regulatory frameworks and with appropriate consideration of the necessary social implications. To succeed in meeting these challenges, the engineering profession will work with society, industry, public organizations and politicians.

The 2009 CAETS Convocation examined the transition to sustainable resource management on a global scale. The CAETS academies are committed to bring engineering knowledge and skills to lead and accelerate this transition, and to design and deploy the innovative technologies, systems and organizations needed for sustainability in a changing world.

CAETS Member Academies

National Academy of Engineering (ANI), Argentina
www.acadning.org.ar

Australian Academy of Technological Sciences and Engineering (ATSE)
www.atse.org.au

Royal Belgium Academy of Applied Sciences (BACAS)
www.kvab.be

Canadian Academy of Engineering (CAE)
www.acad-eng-gen.ca

Chinese Academy of Engineering (CAE)
www.cae.cn

Croatian Academy of Engineering (HATZ)
www.hatz.hr

Engineering Academy of the Czech Republic (EA CR)
www.eacr.cz

Danish Academy of Technical Sciences (ATV)
www.atv.dk

Technology Academy Foundation of Finland (TAFF)
www.technologyacademy.fi

National Academy of Technologies of France (NATF)
www.academie-technologies.fr

German Academy of Science and Engineering (acatech)
www.acatech.de

Hungarian Academy of Engineering (HAE)
www.mernoakademia.hu

Indian National Academy of Engineering (INAE)
www.inae.org

The Engineering Academy of Japan (EAJ)
www.eaj.or.jp

The National Academy of Engineering of Korea (NAEK)
www.naek.or.kr

Academy of Engineering (AI), Mexico
www.ai.org.mx

Netherlands Academy of Technology and Innovation (AcTI.nl)
www.acti-nl.org

Norwegian Academy of Technological Sciences (NTVA)
www.ntva.no

Slovenian Academy of Engineering (IAS)
www.ias.si

South African Academy of Engineering (SAAE)
www.saae.co.za

Real Academia de Ingenieria (RAI)
www.real-academia-de-ingenieria.org

Royal Swedish Academy of Engineering Sciences (IVA)
www.iva.se

Swiss Academy of Engineering Sciences (SATW)
www.satw.ch

Royal Academy of Engineering (RAEng), United Kingdom
www.raeng.org.uk

National Academy of Engineering (NAE), United States
www.nae.edu

National Academy of Engineering of Uruguay (ANI)
www.aniu.org.uy

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Euro-CASE

Euro-CASE 2009

Euro–CASE (The European Council of Applied Sciences and Engineering), founded in 1993, is an independent non-profit organization of national academies of engineering, applied sciences and technology from 21 European countries. Upon the invitation to Croatia to join the European Union in 2005, the Croatian Academy of Engineering, founded in 1993, became 21st associate member of Euro-CASE, as a non-member country of the EU.

Last year activities of Euro-CASE were marked by two major events:

- **Euro-CASE Board Meeting n° 34, Paris, France, May 12, 2009**
- **Euro-CASE Board Meeting n° 35, Stockholm, Sweden, November 6, 2009**

(preceded a day before by a one day meeting – 2nd Euro-CASE Annual Conference 2009 entitled “Increasing Interest for Higher Education in Mathematics, Science & Technology”)

For the Croatian Academy of Engineering the meeting in Paris has been of utmost importance. Due to the activities of the Academy and at the incentive of the then president of the Academy, the Statute of Euro-CASE was changed at the Euro-CASE Board Meeting in Paris on May 12th, 2009 having enabled the Academy to become full member of Euro-CASE, even before Croatia itself acquired full membership in the European Union. The Croatian Academy of Engineering received unanimous support of the Board members and became 21st full member of Euro-CASE as the only non-member country of the EU. President of the Academy Prof. Zlatko Kniewald, Ph.D. and vice president Prof. Stanko Tonković, Ph.D. attended the ceremony.

Both CAETS and Euro-CASE have supported the celebration of the 300th anniversary of the birth of Rugjer Boskovic, the organization of which has been entrusted to the Croatian Academy of Engineering by the Ministry of Science, Education and Sports of the Republic of Croatia, and agreed to be its patrons. Unfortunately, the suggestion of the Academy to hold Euro-CASE 2011 Meeting in Zagreb during the celebration has not been accepted.

More details about these events can be found below.

Dear Board members,

At the request of Zlatko Kniewald in London on 4 November 2008 to Lena Treschow Torell, the Executive Committee members who met on 3 February 2009 agreed to propose to the Board members the full membership for the Croatian Academy. The articles 3 and 10 of the Articles of Association (version January 2004) which refer to membership and amendments need to be modified and adopted by the Board.

Please find attached a proposal for updated Articles of association.

ARTICLE 3 – MEMBERSHIP

3.1. Full Membership. Applications for Full Membership from organisations in EU or EFTA countries will be considered by the Board of Euro-CASE which may approve the application if it conforms to the following criteria:

3.1.1. The applicant is recognised as the single national academy or equivalent qualified organisation representing engineering or applied sciences in that country, and is actively engaged in the promotion of applied sciences, technology and engineering.

3.1.2. The applicant can demonstrate that it is independent of governmental or other external control.

3.1.3. The applicant is active, has access to the experts in that country, agrees to contribute to the work of Euro-CASE, and is capable of dealing promptly with the Euro-CASE headquarters in Paris over routine business.

3.1.4. The applicant agrees to abide by the Articles of Association and the Rules of Procedure current at the time of admission.

3.1.5. The applicant agrees to pay a joining fee in the year of joining and an annual membership fee thereafter in accordance with the Rules of Procedure.

3.2. Associate Membership. Academies from states on the European Union's List of Candidate Countries may apply for Associate Membership of Euro-CASE providing that they meet the criteria in articles 3.1.1 to 3.1.5. Associate Members pay a reduced annual subscription to be decided by the Euro-CASE Board, and do not have a vote on the Board, but attend its meetings. An Associate Member academy will normally become a Full Member of Euro-CASE when its parent state becomes a full member of the European Union.

3.3. Applications for full or associate membership of Euro-CASE should be made in writing to the Paris headquarters, together with a copy of the applicant's statutes, process for electing new members, list of current members, copy of the latest annual report and accounts for the past two years, and its record of relevant activities over a similar period.

3.4. The decision to admit a new Member or Associate Member academy will rest solely with the Board of Euro-CASE, based on a recommendation of the Executive Committee following consultation with the Membership Committee.

3.5. Any member-body desiring to withdraw from Euro-CASE must give prior notice of resignation by registered letter addressed to the Secretariat at least six months before the end of a financial year and will contribute its share in any deficit resulting from the year's activities.

ARTICLE 10 – AMENDMENTS

10.1. Any proposed amendments to these Articles of Association shall be considered by the Board only if there is a quorum present representing at least two thirds of the member-bodies. Members of the Board or alternates not present may vote by proxy. It shall require a vote in favour representing at least two thirds of the member-bodies for any amendment to be carried.

10.2. All member-bodies shall be informed at least two months before any amendment is considered by the Executive Board.

**European Council of Applied Sciences,
Technologies and Engineering**

Euro-CASE Vision 2020: 2nd draft

Euro-CASE is the European Consortium of 21 National Academies of Engineering, Applied Sciences and Technology.

By 2020, Euro-CASE will be the voice of European excellence in Engineering, Applied Sciences and Technology.

It will facilitate networking and exchange of ideas among the national engineering academies and their members- 6000 of the most eminent engineers in Europe- and deliver evidence-based policy advice on key European issues to a range of EU stakeholders, including the European Commission and Parliament.

Euro-CASE will derive its credibility and its unique position in Europe from the range of expertise and quality of inputs provided by its member academies.

What shape will Euro-CASE take in 2020?

- Euro-CASE will continue to be a commercially and politically independent non-profit consortium representing its member academies in the European arena.
- Euro-CASE will draw upon the resources of its member academies to produce policy advice for a range of EU stakeholders.
- Euro-CASE will be a think tank of European stature in the field of Engineering, Applied Sciences and Technology.

Who will Euro-CASE work with in 2020?

- Euro-CASE will be a partner of European institutions (especially the European Commission and Parliament, EIT) and will seek to inform EU-positions on relevant issues in international fora.

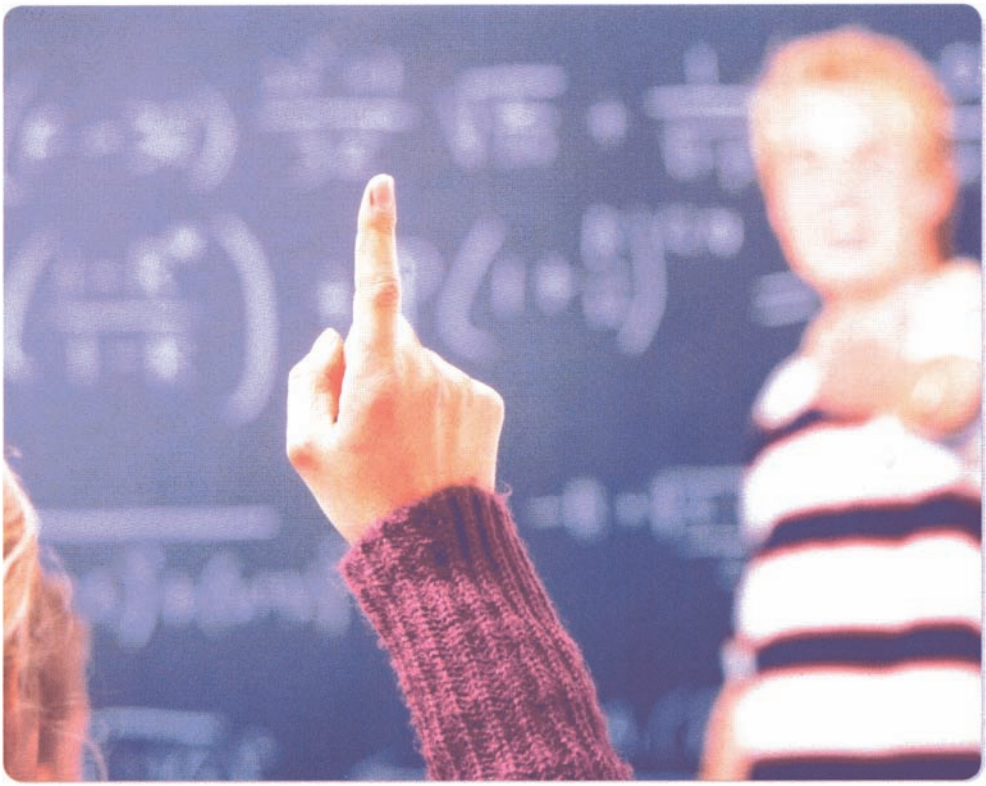
- Euro-CASE will be the natural partner of international organisations and academies who wish to engage with engineering excellence in Europe.
- Euro-CASE will co-operate with other European stakeholders, if there is a need, or if this cooperation strengthens the activities of Euro-CASE.
- Euro-CASE will seek project oriented funding for specific activities from the European Union, other European Institutions and possibly from industry.

What areas will Euro-CASE focus on in 2020?

- Euro-CASE will concentrate on the major challenges facing Europe.
- Euro-CASE will engage in shaping policy at an early stage on the European level on aspects of Engineering, Applied Sciences, Technology and Engineering Education.
- Euro-CASE will promote attention to excellence in Engineering, Applied Sciences and Technology.
- Euro-CASE will help improve public understanding of engineering and technology by providing clear, independent and balanced advice on technological issues and their impact on society and the environment.
- Euro-CASE will support all efforts to develop advanced technologies in order to strengthen Europe's position as the leading innovation location in the world.
- Euro-CASE will promote engineering as a career to young Europeans.

2nd Euro-CASE Annual Conference 2009

Increasing Interest for Higher Education in Mathematics, Science & Technology



Background

The emerging knowledge-based societies require knowledgeable citizens and consumers as well as skilled personnel at all levels. Knowledge in science, technology and mathematics are vital in order to cope with the many challenges – economic growth and competitiveness, the environment and climate change, a sustainable supply of energy etc. – which our societies are already facing and which will become even more pressing in the very near future. Scientific capabilities and technological competences are critical for innovation and providing solutions to all of the problems of modern society.

The conference will focus on encouraging young people to study and pursue careers in science, technology and mathematics. It will include presentations and opportunities to exchange experiences from some very interesting initiatives and actions taken within Euro-CASE member countries. The success and effectiveness of the various approaches and solutions will also be discussed.

Moderator: *Eva Krutmeijer*, Science Communicator

Programme

09:00 **Registration, Coffee**

09:30 **Welcome**
Professor *Lena Treschow Torell*, Chair of Euro-CASE

Opening
Professor *Björn O. Nilsson*, President, Royal Swedish Academy of Engineering Sciences

Keynote addresses
Science and technology – pillars of the knowledge society
Dr *Tobias Krantz*, Minister for Higher Education and Research, Sweden

A European perspective on higher education for competitiveness and growth
Dr *Odile Quintin*, Director General for Education, Training, Culture and Youth, European Commission

10:35 **Coffee**

11:05 **Improving interest for science and technology studies in an international perspective**
Dr *Dirk van Damme*, Head of CERI Centre for Educational Research and Innovation, OECD

11:25 Competence for growth
European Round Table of Industrialists (ERT) and Swedish Technology Delegation
Professor *Jan-Eric Sundgren*, Senior Vice President, AB Volvo

Mentometer opinion polls (part I)

12:30 **Lunch**

13:30 **Establishing "Best Practice": Presentations of selected initiatives**
Initiative 1: STEM: Science, Mathematics, Engineering, Technology, UK
Matthew Harrison, Director, Education Programmes, Royal Academy of Engineering

Initiative 2: Platform Bèta Techniek, Holland, *Hans Corstjens*, Director

Initiative 3: Wissensfabrik, Germany, *Eva Müller*, Managing Director

Initiative 4: Swiss Academy of Engineering Sciences, Switzerland
Rolf Hügli, Managing Director

Initiative 5: Academie des Technologies, France
Jacques Levy, Directeur Honoraire, Ecole des Mines de Paris

Initiative 6: Science and Technology for All (NTA), Sweden,
Gerd Bergman, Development Manager

15:30 Coffee

16:00 **Panel discussion and mentometer opinion polls (part II)**

17:15 Closing address
Professor *Lena Treschow Torell*, Chair of Euro-CASE

17:30 **Reception**

18:00 **Dinner**

Date:	5 November 2009, 09.00–18.00
Venue:	IVA's Conference Center, Grev Turegatan 16, Stockholm, Sweden
Registration:	Register at *www.iva.se/euro-case* no later than 31 October 2009. The cost of seminar, reception and dinner is 200 €, please send it to IBAN SE11 6000 0000 0000 1492 030.
More information:	Contact Kirsti Häcki by e-mail at *kh@iva.se* or by telephone at +46(0)87912956.

This meeting is the 2nd annual meeting of The European Council of Applied Sciences and Engineering, Euro-CASE and is hosted by the Royal Swedish Academy of Engineering Sciences, IVA.

The European Council of Applied Sciences and Engineering is an independent non-profit organisation of national academies of Engineering, Applied Sciences and Technology from 21 European countries. Euro-CASE acts as a permanent forum for exchange and consultation between European Institutions, Industry and Research.

Through its member academies, Euro-CASE has access to top expertise (around 6,000 experts) and provides impartial, independent and balanced advice on technological issues with a clear European dimension to European Institutions, national Governments, companies and organisations.

Euro-CASE is governed by a Board consisting of senior representatives from each member Academy. An Executive Committee is elected from the Board. The secretariat is based in Paris.

IVA is an independent arena for the exchange of knowledge. By initiating and stimulating contacts between experts from different disciplines and countries the Academy promotes cross fertilisation between industry, academia, public administration and various interest groups. Bringing people together to take part in lectures, conferences, research exchanges and other projects serves to generate new ideas and knowledge. Please visit www.iva.se

Euro-CASE

IVA

ROYAL SWEDISH ACADEMY OF ENGINEERING SCIENCES

Part III

Who is Who in the Croatian Academy of Engineering

Presidency of the Croatian Academy of Engineering

The members of the Presidency of the Croatian Academy of Engineering are members of the Governing Board, Secretaries of the Departments, Chairs of the Standing Committees and Heads of the Centers.

Members of the Governing Board

– Prof. Stanko Tonković, PhD., President of the Croatian Academy of Engineering
– Prof. Miljenko Lapaine, PhD., Vice-President
– Prof. Vilko Žiljak, PhD., Vice-President
– Assist. Prof. Goran Granić, PhD., Secretary-General
– Prof. emer. Zlatko Kniewald, PhD., Past-President

Secretaries of the Departments

– Prof. Franjo Jović, PhD., Secretary of the Department of Systems and Cybernetics
– Prof. Tihomir Jukić, PhD., Secretary of the Department of Architecture and Urban Planning
– Prof. Krešimir Fertalj, PhD., Secretary of the Department of Information Systems
– Prof. Sonja Grgić, PhD., Secretary of the Department of Communication Systems
– Prof. Nikola Čavlina, PhD., Secretary of the Department of Power Systems
– Prof. Vesna Cerovac, PhD., Secretary of the Department of Transport
– Prof. Damir Medak, PhD., Secretary of the Department of Civil Engineering and Geodesy
– Prof. Vladimir Medica, PhD., Secretary of the Department of Mechanical Engineering and Naval Architecture
– Prof. Ratimir Žanetić, PhD., Secretary of the Department of Chemical Engineering
– Prof. Zdravko Hebel, PhD., Secretary of the Department of Electrical Engineering and Electronics
– Prof. Jasna Franekić, PhD., Secretary of the Department of Bioprocess Engineering

– Prof. Miroslav Gojo, PhD., Secretary of the Department of Graphical Engineering
– Prof. Josip Črnko, PhD., Secretary of the Department of Mining and Metallurgy
– Prof. Dubravko Rogale, PhD., Secretary of the Department of Textile Technology

Chairs of the Standing Committees

– Prof. Franjo Jović, PhD., Chairman of the Committee for Ethics
– Prof. emer. Zlatko Kniewald, PhD., Chairman of the Foundation Committee
– Prof. Vladimir Medved, PhD., Chairman of the Committee for International Cooperation
– Prof. Đurđa Vasić-Rački, PhD., Chairman of the Committee for Awards
– Prof. Jure Radić, PhD., Chairman of the Committee for Economic and Regional Cooperation

Heads of the Centers

– Prof. Juraj Božičević, PhD., Head of the Center for Development Studies and Projects
– Prof. emer. Zlatko Kniewald, PhD., Head of the Biotechnical Center
– Prof. Miljenko Lapaine, PhD., Head of the Center for Geoinformation and Cartography
– Prof. Đurđa Vasić-Rački, PhD., Head of the Center for Environmental Protection and Development of the Sustainable Technology
– Prof. Tomislav Filetin, PhD., Head of the Center for Lifelong Education
– Prof. Vilko Žiljak, PhD., Head of the Center for Graphical Engineering
– Prof. Nenad Dujmović, PhD., Head of the Center for Traffic Engineering

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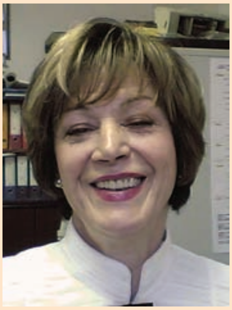	**Franekić, Jasna**, Prof. PhD. Born: 1945 Department of Bioprocess Engineering, Full member (2009) University of Zagreb, Faculty of Food Technology and Biotechnology, Pierottijeva 6, 10000 Zagreb +385 1 4836013, fax: +385 1 4836016, e-mail: jfran@pbf.hr Genetic Toxicology, Ecotoxicology, Genotoxicity Action of Environmental Agents Antimutagenicity of Glucosinolates
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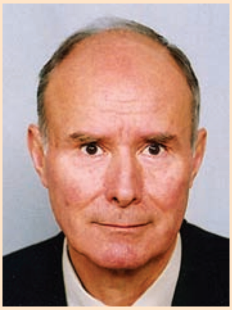

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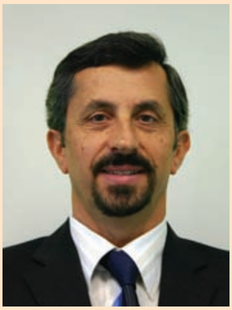

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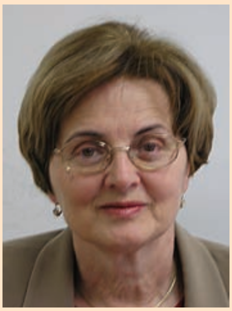	**Mandić, Milena L.**, Prof. PhD. Born: 1949 Department of Bioprocess Engineering, Associate Member (2000) University of Osijek, Faculty of Food Technology, Franje Kuhača 18, 31000 Osijek +385 31 224300, fax: +385 31 207105, e-mail: milena.mandic@ptfos.hr, http://zhp.ptfos.hr/en/index.html Biotechnology, Food Technology, Human Nutrition

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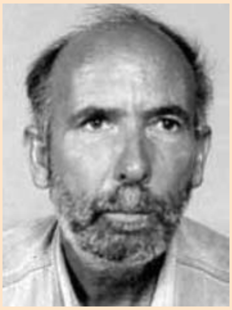

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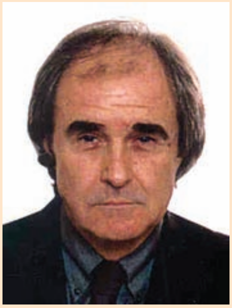

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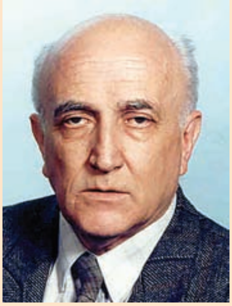

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