

## Earthquake Engineering in Croatia

The development of contemporary earthquake engineering in Europe began after the catastrophic earthquakes in Agadir, Morocco, in 1960 and in Skopje, Macedonia, in 1963. The European Association for Earthquake Engineering was founded in Skopje in 1964 and today numbers 28 members – national societies of European and non-European Mediterranean countries. The Croatian Society for Earthquake Engineering has a tradition of 35 years and is systematically monitoring world achievements. The Society promotes the engagement of Croatian scientists in European programmes through their participation in projects, workshops and conferences. In addition, it is active in introducing the most recent ideas and knowledge in the practice of design and building in Croatia.

The most recent disastrous earthquakes in Turkey (August 1999), with tens of thousands of victims, and then those in Greece, are a warning that there are many things in this area that we must overcome to achieve a socially acceptable level of protection of human lives and to minimise the material damage of buildings. This relates to both design and construction, as well as to the selection of adequate and high-quality materials and the supervision and maintenance of buildings. It seems that everyone will learn from the consequences of the earthquakes in Turkey about inadequate constructions and concepts, but also about the necessity to concentrate on a higher quality of construction.

The experimental work of Croatian scientists is particularly focused on built constructions. The mechanical properties of masonry, brickwork, porous concrete and stonework during earthquakes have been studied. Theoretical research includes the behaviour of different types of buildings made of reinforced concrete or their elements during earthquakes, as well as the behaviour of bridges. In the case of steel constructions, the behaviour of containers for liquids has been analysed.

In the practical implementation of theoretical findings, Croatian scientists have encouraged the design of reinforcements for buildings damaged in earthquakes, particularly those belonging to the cultural heritage that are built of stone and which are used for different purposes: housing, business, museums, churches, monasteries and bell-towers. There are plans in Croatia to build around 2,000 km of highways and the construction of large bridges in earthquake areas is, therefore, of particular importance. The use of modern computer programmes in the calculations of constructions is extensively applied and well-established.

The experience of several generations of engineers is based on their own observations and on the damage of buildings and other objects in their immediate surroundings. Croatia is located in an area of potentially strong earthquakes, which recur several times during the existence of buildings.

In the area of legislation, the adoption of the entire system of contemporary European norms for the calculations of constructions (EN 1991 to EN 1998) is underway to substitute the existing Croatian norms. The Croatian Chamber of Architects and Engineers in Construction was revived only recently, and we hope that this will encourage the free movement of products used in construction and the participation of Croatian engineers in the European distribution of work in design, construction and supervision.

The Croatian Academy of Engineering supports the earthquake engineering by encouraging professional discussions of technical (civil engineering) and natural (seismology and geology) sciences, convinced that such discussions will contribute to a better understanding of different professions and to technical progress.

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# The Encyclopedia of Technology

## Part I – A Significant Publishing Achievement

*The Encyclopedia of Technology* (*Tehnička enciklopedija*) is published by the Miroslav Krleža Lexicographical Institute in Zagreb. It can be seen as a major publishing undertaking in the field of engineering and technology in the second part of the last century, not only because of its immense scope, the large number of volumes, and the extensive period of time required to prepare it for publication, but in other ways as well.

The original conceivers of *The Encyclopedia of Technology* began the preliminary work on the project in the 1950s. However, the first volume was not issued until 1963, and the thirteenth volume, the last, was issued in 1997. The encyclopedia was conceived as a comprehensive project, which would offer readers up-to-date knowledge of technological development as well as development in those fields of natural science and engineering that are the basis for all modern technology. The completion of this vast project, on which two generations of Croatian specialists in various disciplines have worked, provides an occasion to review the encyclopedia's beginnings and discuss the way in which it was compiled.

**History.** *The Encyclopedia of Technology* is an original work realized mostly by Croatian specialists following a long tradition of Croatian encyclopedic and lexicographic literature going back many centuries. It was Pavao Skalić who, in 1559, first used the term *encyclopedia* for a comprehensive collection of knowledge. Although never complete, the first two editions in Croatia, the *Croatian Encyclopedia* published in 1887 and the volumes compiled from 1941 to 1945, presented comprehensively the extent of technology and the natural sciences for their respective periods.

Only a few years after the Croatian language achieved official status in 1847, and had been introduced into middle schools, technical and scientific literature appeared in Croatia. It proved to be popular. Among many works published between 1860 and 1930 by Matica hrvatska (Matrix Croatia), there was a series of twenty books, which were intended to popularize natural science and technology. This series was the well-known *Novovjekni izumi* (*The Century's Inventions*). The methodology used in these publications was so advanced that even today they serve as models for writers who wish to make technology and science accessible through such works and encyclopedias to a wide circle of readers.

Croatian technical and scientific vocabulary evolved markedly in the fields of the natural sciences and technology during the period, but its roots go back further than is generally realized. Of particular interest is Bogoslav Šulek's work, *Rječnik znanstvenog nazivlja* (*A Dictionary of Scientific Terms*), which he published in the 1870s,

thereby laying the foundation for a Croatian scientific and technical terminology which Croatian philology still follows today.

The traditions of technical dictionaries in the Croatian language go back to 1881. The generations of Croatian scientists and technical experts who prepared *The Encyclopedia of Technology* derived their culture and developed their competence as a result of such works, and this is reflected in their methodological approach and technical vocabulary.

**Conception.** The Lexicographical Institute in Zagreb was founded in 1950, initially with the objective of preparing the *Encyclopedia of Yugoslavia* (*Enciklopedija Jugoslavije*). However, the program was soon broadened to include a *General Encyclopedia* (*Opća enciklopedija*), a *Comprehensive Encyclopedia* (*Velika enciklopedija*), and a series of ten specialized encyclopedias, among them *The Encyclopedia of Technology* (*Tehnička enciklopedija*). The first of the latter to appear was the *Maritime Encyclopedia* (*Pomorska enciklopedija*) under the general direction of Dr. Mate Ujević, who oversaw the compilation of the first volume, which appeared in 1956. Encouragement to embark on *The Encyclopedia of Technology* came in June, 1951 from the Society of Engineers and Technicians of the Croatian People's Republic. The initial meeting of the representatives of the Lexicographical Institute with those from the Society of Engineers and Technicians and the University of Zagreb's Technical Faculty was held in September, 1951. The first working meeting of a narrower circle of future contributors and editors took place on 20th May, 1952.

*The Encyclopedia of Technology* was conceived as a reference work primarily intended for technicians with secondary school or university education, but it was also intended for technicians with advanced training as a means of acquainting them with technical fields outside their own specialties. Finally, it was intended for those among the general public who were neither scientists nor technicians, but who were interested in technology and science. The encyclopedia therefore was meant to provide basic knowledge in those fields on which technical developments depend – above all mathematics, physics and chemistry – as well as specific technical information.

Unfortunately, encyclopedias with similar titles, which were produced in different languages, in different environments, with rich technical literature, could not serve as models for *The Encyclopedia of Technology*. At the time they were written and published, many articles in *The Encyclopedia of Technology* were the first basic texts in Croatian on the particular themes. This presented the writers and editors with enormous difficulties, particularly regarding the use of technical terms.

To be continued...

# Education for the Information Society

The Third Colloquium, **Cognition, Knowledge and Reasoning**, held in October, was indeed a multidisciplinary event. Engineers, educators, sociologists, philosophers, economists and other professionals participated in a vivid and useful debate. The discussion focused on the cognition and understanding of the changes influenced by the Information Society, as well as by the development of the knowledge-based economy.

In Croatia, human resources became increasingly important. Brain drain and brain wastes are our serious points in dispute, and the Croatian economy is in a period of transition. During the last decade, numerous factories and many businesses within the industrial sector have gone bankrupt, while those which have survived, are now confronted with the overwhelming impact of communication and information technologies on the modes of production and commerce. Besides that, in the emerging knowledge-based economy, fewer and fewer workers are able to sustain their working lives without the ability and willingness to learn. The contribution of training programmes on the results of the companies is obvious.

Higher education in Croatia suffers from many problems influenced by the current political and economic transitions, but especially by the peculiar and inexplicable isolation, through which the EU has restricted the Croatian scholars, professors, and institutions, access to participate actively in any of the numerous European programmes.

Fortunately, over the past decades, rapid advances in personal computers, computer networks and software, have facilitated us to overcome many of those difficulties. Students have access to personal computers, and universities provide their students with access to the computer networks. Therefore, the particular mission of our project, Education for the Information Society is to motivate discussion on useful application of that potential and to see that it is properly integrated into the curricula in our schools, to enable the understanding of the areas where the innovative applications of computer technologies have a significant impact.

Facing the existing changes and other changes likely to happen, the university faculty must decide what to teach the students now, in order to prepare them for practice in several decades to come. The participants of the Colloquium particularly emphasised the importance of education for better communication between various disciplines, especially technical and non-technical.

A student must be prepared for life-long learning, and hence the important advice of the participants of the Third Colloquium to the educators is: Try to help the students to learn three basic things: fundamentals, how to learn, and how to solve problems.

The Fourth Colloquium, **Engineer of the Future**, will be held in February, 1999.

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## The Dialogue with Doctors

Biotechnology and Biomedicine were the subjects of the first in series of the Forums, **Communication and Co-operation of Physicians and Engineers**, held on February 23, which we organised in co-operation with the Croatian Academy of Medical Sciences. Our member, Prof. Zlatko Kniewald, Chair of this multidisciplinary meeting, contributed with his experience to the vivid and intense discussion on a broad area of topics, which were initiated through the following questions posed to participants:

- How to develop an efficient co-operation between engineers and physicians, through joint projects and, through individual co-operation, by support of the University, or through the scientific and professional societies?
- How to transfer the good practices and experiences from abroad, and apply them in Croatia?
- How to motivate industry to introduce new technologies and to produce new products?
- How to join in, and contribute to, strategic projects in the field of the biotechnology and biomedicine?
- How to stimulate and support co-operation between biochemical engineers, biotechnologists and physicians in the research and development of new and sophisticated drugs, etc.



# Round Table Discussions

## CROATIAN PRODUCTS AND MANUFACTURING

In December 1998, the First Cycle of six Round Table Discussions, **Croatian Products and Manufacturing**, was completed with the debate on the position of Croatian industry in the era of globalisation and in the circumstances of the Information Society. The central question was the accomplishment of the efficient international exchange of Croatian products, both cultural and material. Most of the participants pointed out the necessity to raise awareness. The Croatian economy is at the point of radical change and the study of new forms of the organisation of the Croatian social, economic and governmental subsystems is the urgent task. In this context, it was suggested that the Second, the 1999-, Cycle of the Academy's Debates, should particularly address those questions. The other participants spoke about Croatian technological potential, which must be strengthened, as well as better and fully exploited. They called for new synergies, particularly in the area of biotechnology.

### **The Seventh Round Table Discussion: *Polymers***

The Second Cycle of Round Table Discussions started this year, in February. The production of polymers, manufacturing of polymer products and their recycling have been the subjects of the Seventh Round Table Discussion. The developing potential and the role of the petrochemical industry in the Croatian economy and co-operation with multinational companies were the topics of a vivid debate, which motivated the examination of the influences of the global market on the existence of this sector of industry. Additionally, the debate on the organisation and efficiency of the collecting and recycling of the plastic and rubber waste has shown the need for separate examination of the subject.

The discussion on polymers has brought together academics, managers and industrial engineers to debate a broad spectrum of important questions.



*On the discussion on polymers academics, managers and industrial engineers have gathered to debate broad spectrum of actual questions.*

### **The Eighth Round Table Discussion: *Manufacturing for Automobile Industry***

The Eighth Round Table Discussion, held in March, had a particularly interesting topic, **Manufacturing for Automobile Industry**. As well as the well-argued introductory analyses for the continuous development of this sector of industry, and excellent co-operation with international companies, particular attention was paid to human and financial resources necessary to support future development. The debate on the ability of manufacturers to adapt and flexibly approach the new market situation has initiated a critical examination of the investments in research and development, as well as on the efficient use of new materials and technologies, on the training of personnel and improvement of the management performance.

The discussion on the manufacturing for automobile industry attracted the interest of the managers of small and medium companies.

### **The Ninth Round Table Discussion: *Textile and Clothing***

The Ninth Discussion will be held this year, in April, and will deal with the sector of traditional Croatian industry – the textile and clothing, and its ability to survive in the very competitive conditions of the international market.

Eight additional discussions are planned to be held during this year. They will deal with the manufacturing of building materials, the wood processing and manufacturing of furniture, tools manufacturing, etc. The participants will also discuss the application of digital technologies in the printing industry.



*The discussion on the manufacturing for car industries particularly attracted interest of managers of small and medium companies.*

## Books



Zorislav Sorić, *Masonry Structures, Part I*  
University lecture book (in Croatian)  
Croatian Association of Civil Engineers,  
Zagreb, 1999, 317 pages, ISBN 953-6686-02-3

*The only construction work observed on Earth by astronauts, after landing on the Moon, was the Great Chinese Wall, the 6,000 kilometres long masonry structure.*

Masonry structures were for many years on the periphery of interest to the civil engineering profession. More modern building materials produced in the 20th century (steel, reinforced concrete, plastic materials), attracted more attention than the traditionally produced brick masonry. Masonry was left to a large group of individual builders who, in our country, have erected about three quarters of the total number (about one million), without any scientific knowledge and technical support. Thus they became the largest users of brick products.

The practical problems in masonry structures became obvious when many of the old masonry buildings came to the stage of requiring renewal, when one tried to strengthen buildings damaged in strong earthquakes, or after many construction errors came to light in recently built homes. In the post-war reconstruction of damaged and destroyed family houses in Croatia, (1995-2000), masonry buildings have been considered almost exclusively. Slowly, people came to the realization that masonry buildings also need the expertise of civil engineers and architects.

Throughtout the world masonry buildings have thousands of years long tradition. Bricks and stones are such good buildings materials and of such good quality, that they will never be replaced by contemporary materials. They can be used to erect construction works to satisfy at the general and essential principles of construction: the buildings have strength (they are safe), they are comfortable to their occupants, and they are durable and beautiful.

This book is the result of many-years of work by the author in the field of masonry structures. It presents new design methods of masonry structures based on the European Standard ENV 1996, but also on the results of the author's own and other theoretical and experimental research done during the last decades throughtout the world and including Croatia. The book covers the area of structural

design, calculation and detailing of buildings, but it does not cover architectural design and building physics.

There is no similar book written in Croatian language. Therefore this book is important not only as a lecture book for students of civil engineering, but also as a permanent source of knowledge and data for designers of masonry structure.

This book will enable the design of masonry buildings to follow methods adopted in Europe and will therefore open the door for Croatian designers to the European market. One can hope that this book is our contribution to the common goal – the integration of the Croatian and European economies.

Dražen Aničić



Božidar Križan, *Fundamentals of the Calculation and Design of Machine Elements* (in Croatian),  
Second revised edition, University of Rijeka,  
Faculty of Engineering, Rijeka 1999.  
287 pages; 168 figures; 107 tables;  
ISBN 953-6326-16-7

Contents: Introduction. Preferred Numbers. Tolerances, Fits, Surface Roughness. Fundamentals of the Machine Elements Strength Calculation. Allowable Stresses. Designing the Machine Elements in Relation to Strength and Rigidity. Materials Selection. Tribology.

This is a book on basic knowledge which an engineer needs in designing and processing machine elements. The originally conceived presentation of very classical contents makes it equally suitable for these classroom use and for engineers in practice. However, the primary intent of the author was to provide a textbook for the new generation of students of mechanical engineering and shipbuilding. The book is well written, readable and accurate.

Each chapter of the book includes those areas that rely on the process of design on computers. Beside of design principles, tolerances, construction, materials, the study of allowable stresses and fatigue strengths, various useful data are provided as well as a basic knowledge of friction, wear and lubrication.

Mirko Krpan

# A Century of the Application of X-Rays in Croatia

At the time of Roentgen's discovery of x-rays in 1895, Croatia was part of the Austro-Hungarian Empire. The news of the discovery spread around Europe and the world very quickly and the first records in daily newspapers appeared in early 1896: on 5 January in the Viennese *Die Neue Presse*, on 7 January in *Frankfurter Zeitung*, on 8 January in *Berliner Tageblatt*, etc. In the Croatian newspaper, *Obzor*, the news of Roentgen's discovery was published on 8 January, 1896. The first review article, entitled *Roentgen's Rays*, was published in *Liečnički viestnik (Medical News)* of 15 February, 1896. In the article, the properties of x-rays were explained and compared with traditional photography. Possible applications of this discovery in medical diagnostics were also given.

All over the world, physicists repeated Roentgen's experiments to test his results. The first experiment with x-rays in Croatia was carried out by Professor Petar Salcher, after a lecture on the discovery in Rijeka, on 20 February, 1896. With the help of Crooks and Hittorf's tube and Ruhmkorff's transformer, he succeeded in obtaining x-rays and in making a roentgenograph of the hands of Baroness Vranyczány and of some keys placed in a wooden box. A report of that experiment was published on 24 February, 1896 in the local Rijeka newspaper, *La Bilancia*.

On 2 July, 1897, Vinko Dvořák, professor at the Faculty of Science in Zagreb, made and described his experiments to demonstrate the properties of roentgen rays at the emergency conference of the Croatian Medical Association in Zagreb. The presentation was published under the title, *On Roentgen Rays*, in *Liečnički viestnik*. Professor Dvořák demonstrated the way a roentgenograph was made for Grand Duke Leopold Salvator who then lived in Zagreb. He was said to have also x-rayed the Grand Duke's broken arm.

It became clear in Croatia that the basic application of roentgen radiotherapy would be in medical diagnostics. The purchase of the first roentgen devices for medical diagnostics was initiated in the first years following the discovery. There are records from the 31<sup>st</sup> Meeting of the Region of Dalmatia of 1896 about the collection of money to purchase a roentgen device for a hospital in Arbanasi, near Zadar. It is not known whether such a device was ever purchased. Rijeka got its first roentgen device by 1897, as did later the hospitals of numerous other cities. All these roentgen devices were of a fairly simple construction, but were not easy to handle. We must remember that in order to provide roentgen radiotherapy, high voltage had to be achieved. At that time, most towns did not even have an electrical system and the devices were fed from primary cells or batteries.



Prof. Petar Salcher and the hands of Baroness Vranyczány.

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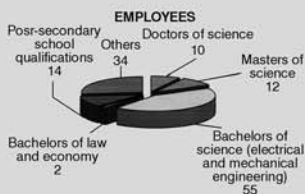
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The first professional article on the use of roentgen rays in medical diagnostics was published by Dr. Kurt Hühn in 1902.

Dr. Miroslav Čačković was the most prolific author of expert medical literature in the first years of the implementation of roentgen radiotherapy in diagnostics. He published a series of articles in *Liečnički viestnik*, beginning in 1907 with the article, *Nekoliko riedkih Roentgen nalaza (A Few Rare Roentgen Findings)*. Roentgen's experiments were described in detail by Dr. Oton Kučera in his book, *Valovi i zrake (Waves and Rays)*, published in 1903 in Zagreb. The first instructions on how to handle roentgen devices were published in 1917 by Professor Dr. Laza Popović. He wrote the first monography, **Clinical Roentgenology**, which was published in four volumes from 1923 to 1935. The first attempts of radiotherapy were made as early as 1902. During 1913, Dr. Herzog introduced radiotherapy in the Hospital of the Sisters of Mercy in Zagreb, and in 1923 Dr. Vidaković introduced radiotherapy in the gynaecological department of the Clinic for Women's Diseases and Obstetrics in Zagreb.



*Very first Roentgen apparatus have been installed in Croatian hospitals at the end of 19th and beginning of 20th Century.*

Professor Dragutin Gorjanović-Kramberger was the first researcher in the world who used roentgen rays for his research in paleontology. He began his research in 1902, during his visit to Munich, by taking x-rays of the jaws of the early man from Krapina. He continued his work together with Dr. M. Čačković, Dr. K. Hühn and Dr. Ivanek in Zagreb. An extensive report on these investigations was published in 1906, in a book entitled, **Der Diluviale Mensch von Krapina in Kroatien**.

In the first decades after their discovery, the acceptance, the beginnings and the development of the application of roentgen rays in Croatia followed the achievements and trends in Europe and in the world. At that time, experimental physics was at its peak and many physicists all over the world were researching into the properties of the newly discovered rays. They were lucky, because the equipment for the conducting of experiments could be found in any averagely equipped laboratory of physics.

Dražen Aničić

# Conference News

## The Fourth Multidisciplinary Conference

### Port as a Complex System

Rijeka, November 25 and 26, 1999

The Fourth Conference, *Port as a Complex System*, is conceived to attract the attention of the decision-makers in the spheres of economy and politics, as well as of the wider public, to the importance of a maritime orientation for Croatia as a whole, and particularly the Croatian economy, in the conditions of modern, global, economic transformations. We wish to point out especially, the important role of ports in the economy of a maritime country, through the contributions of the participants in the multidisciplinary gathering. Discussions lead by experts focused on the perception of knowledge necessary for the innovative management of port operations, technologies and development, as well as the capability of the Croatian ports.

As the focal point for the development of various economic activities, the contribution of ports is very important, and so, beginning with the systems approach, we are able to discuss the best possible solutions for our economy and to analyse the useful experiences of other countries, as well as their practice, in order to use those models as a standard.

The focal interest of the Fourth Conference is the Port of Rijeka as the main Croatian port. Therefore, we will also initiate a discussion on creating the economic co-operability of Rijeka and Zagreb, using the facilities of the Port of Rijeka. We believe that if Rijeka and Zagreb are connected wisely, they could become the economic focus for both Croatia and Europe, as well as the basis for carrying out the harmonious development of all the Croatian regions.

We will create a dynamic gathering by linking the short speeches of selected experts to the discussion, and also encourage the participants to contribute, through dialogue. The understanding of the role and importance of the Port of Rijeka in the economic development of Croatia is the key question of the Conference.

The general topics are the following:

- Transport and Economic Importance of the Port of Rijeka
- The Croatian Ports System – Situation and Perspective
- The Port of Rijeka Situation and Traffic Fluctuation Analysis for the Period 1990–1999
- The Port of Rijeka Development Policy
- The Co-operation of the Adriatic Ports as a Condition and the Possibility of the Development of the Port of Rijeka
- The State Policy Measures in the Development Initiatives for the Port of Rijeka
- The City and Ports System Interaction in Rijeka
- Croatian Shipowners in the Development and Commercial Function of the Port of Rijeka
- The Land Transport (Traffic) Infrastructure of the Port of Rijeka

Prospective authors are invited to submit original and previously unpublished papers according to the listed topics. Abstracts in advance, clearly explaining the contribution, its originality and the relevance of the work, are expected.

Submitted abstracts should be restricted to a maximum length of one page and have to be submitted in paper form. The speaker should be clearly identified.

The abstracts will be reviewed by the Programme Committee. The authors of accepted papers will be asked to submit a full paper of 10 pages to be included in the printing of the Conference Proceedings. Detailed information for authors will be provided with acceptance.

**Deadline for receipt of abstracts:**  
February 24, 1999

**Notification of acceptance:**  
April 4, 1999

**Deadline for ready-for-press papers:**  
July 6, 1999

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