



Editor-in-Chief's Word

Dear Readers,

One of the essential tasks of the Croatian Academy of Engineering as an association of prominent Croatian scientists and teachers in the fields of technological and biotechnological sciences as well as a number of international members, is publishing achievements of the Croatian scientists in the fields of scientific research, innovation and other technical accomplishments.

Having that goal in mind, the Academy, among other activities, continuously publishes its bulletins „Tehničke znanosti“ in Croatian and „Engineering Power“ in English, respectively.

I am particularly happy that the efforts of our Academy in that respect include cooperation with other scientific institutions in Croatia. This issue of „Tehničke znanosti“ / „Engineering Power“ is a fine example of our cooperation with the Croatian Academy of Medical Sciences. We are also very proud of this cooperation as an example of scientific interdisciplinarity.

I believe that you will read with interest this issue dedicated to the life and work of the Croatian Nobel Prize winner **Leopold Ružička**, and gain new insights on this great man of the Croatian science.

Editor-in-Chief

Vladimir Androžec, President of the Croatian Academy of Engineering



Euro-CASE



CAETS



Editor's Word

As it has been announced in Editorial of the first issue of “Tehničke znanosti / Engineering Power” published in new format (Vol. 19(1) 2015), subsequent releases of the journal will offer a number of thematic papers focused on selected topics that will be edited by the specially invited Guest Editor. In most cases, such invited topics will be selected to reflect current scientific production of the Academy members. However, our editorial goal is also to pay tribute to remarkable scientists in Croatian history, offering special editions devoted to their exceptional achievements.

With this aim in view, I am especially proud to announce selected topic of this issue that focuses on the first Croatian Nobel Prize winner, Prof. **Leopold Ružička**, in the year of the 40th anniversary of his death. His work inspires researchers to current days, not only in the field of synthetic organic chemistry, but also in a number of related fields of engineering, medicine and applied sciences. The fact that several research projects financially supported by the Croatian Science Foundation are also based - directly or indirectly - on the scientific legacy of **Leopold Ružička** reveals how deep his work is rooted in the current research activities of the Croatian scientists. The heroic town of Vukovar - the birthplace of Prof. **Ružička** - is especially proud of its distinguished citizen: a college of applied sciences opened in the year 2005 bears his name and traditional scientific conference “Ružičkini dani” (“Ružička Days”) is organized in Vukovar on the annual basis.

These issues, among the others that reflect extraordinary scientific and personal profile of Prof. **Ružička**, will be covered by the string of papers under umbrella of this edition's selected topic. The Guest Editor is a distinguished member of our Academy, Prof. Emer. Zlatko Kniewald, Ph. D., Secretary of HATZ Department of Bioprocess Engineering.

Editor

Zdravko Terze, Vice-President of the Croatian Academy of Engineering



Welcome Letter from Guest Editor

Distinguished Readers,

The Croatian Academy of Engineering has been established in 1993 and since then its activity is recognized in Croatia and worldwide within the international associations of CAETS and Euro-CASE. A great part of its activity since 2006 is oriented towards promotion of Croatian scientists worldwide, known for their discoveries recognized by the international scientific community. Therefore we have celebrated the 150th birth anniversary of Nikola Tesla in 2006, 150th birth anniversary of Andrija Mohorovičić in 2007, 300th birth anniversary of Ruder Bošković in 2011, and now we can proudly say a few words about the first Croatian Nobel Prize winner, Prof.

Leopold Ružička, in the year of his 40th death anniversary. In this edition of “Engineering Power” you can find some commonly known, but also unknown facts about the life and work of Prof. **Ružička**.

This edition of “Engineering Power” is prepared in English. In the last 15 years we have been remembering Prof. **Ružička** annually through scientific meetings called “Ružička Days” predominantly held in Vukovar, his birthplace. This year the 16th Ružička's Days will be held. Today a polytechnic in Vukovar is named after Prof. **Ružička**, a fact which shows how important he still is to the people who live there.

I am personally honored to be elected the Guest Editor by the Presidency of the Croatian Academy of Engineering, considering the fact that my entire published scientific research is based on the androgen hormone metabolism, which I started in 1969 at The Institute of Pharmacology, University of Milano, Italy, under the leadership of Prof. Luciano Martini. A part of my research interest was also a study of the influence of insecticides on steroid hormone mechanisms in the reproduction of vertebrates.

The paper published in The Medical Journal in 1940 describes all Prof. **Ružička's** discoveries from sexual hormones to insecticides at that time and this research has been continued in Croatia up until today.

Thank you for your attention.

Guest Editor

Zlatko Kniewald, Secretary of HATZ Department of Bioprocess Engineering



Vladimir Mrša¹

LEOPOLD RUŽIČKA'S SCIENTIFIC LEGACY IN CROATIAN ORGANIC CHEMISTRY

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Leopold Ružička was born on September 13, 1887, in Vukovar. After the early death of his father in 1891, he returned with his mother to her birthplace, Osijek. There he attended the primary school and the classical gymnasium. He was generally a good pupil but he found his real interests in physics and mathematics. There was no chemistry in the curriculum at that time, still he decided to study this subject due to his interests in the composition of natural products. He chose the Technische Hochschule at Karlsruhe, where he started his chemical studies in the year 1906. This step proved to be decisive for his future. He completed his laboratory courses in less than two years and immediately started his doctoral work on ketenes with Professor Staudinger who was, at the age of 27, less than seven years older than him. After two years of research **Leopold Ružička** obtained the title "Dipl. Ing", and two weeks later "Dr. Ing". Together with Staudinger he started to work on at that time quite unexplored field of active compounds called pyrethrins – isolated from Dalmatian insect powder, a plant product, toxic to insects and other coldblooded animals. They thus opened a new chapter of alicyclic chemistry. These early discoveries will eventually have set the basis for the Nobel prize award **Leopold Ružička** has been awarded in 1939.

In October 1912 he followed Staudinger who became professor at ETH, Swiss Federal Institute of Technology at Zurich. For the accomplishment of his habilitation work in 1917 he received support of the oldest perfume manufacturers in the world, in Germany and the results of their collaboration were the total synthesis of fenchone and the interpretation of the Wagner rearrangement. After his habilitation in 1918 the firm of Ciba, Basle, became interested in his work on the synthesis of quinine-like compounds. In collaboration with his research group, first synthesis of β -collidine and of linalool, the partial synthesis of pinene, and a series of investigations in the monoterpene field were carried out.

In 1921, the Geneva perfume manufacturers Chuit, Naef & Firmenich, asked him to work with them. By this time the investigations of higher terpenes have already been started and **Ružička** contributed with the total syntheses of nerolidol and farnesol, and the establishment of the

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structure of jasmone. But for the perfumery industry the most important were the elucidations of the structures of the naturally occurring musk perfumes, civetone and muscone. Following these discoveries **Ružička** and his co-workers were able to prepare the whole series of alicyclic ketones with 9 to over 30 carbon atoms as ring members.

From October 1926 till 1929 **Leopold Ružička** was Professor of Organic Chemistry at the University of Utrecht but then decided to accept the invitation to return to ETH Zurich again. In 1930, the Ciba renewed the contact with his laboratory. This association led in a few years to scientifically as well as industrially important successes in the field of the male sex hormones. From 1937 the Rockefeller Foundation financially supported the research on natural compounds, especially the triterpenes and steroids.

Professor **Ružička** was for his discoveries in the field of synthetic organic chemistry awarded eight honorary doctorates, 7 prizes and medals, including the Nobel prize, 24 honorary memberships of different scientific societies, and 18 memberships of scientific academies. **Leopold Ružička's** work opened new fields in synthetic organic chemistry in which many of his students and successors, like Vladimir Prelog, found their starting points on their journey into chemical science. Both **Ružička** and Prelog established strong roots of organic chemistry in Croatia that have resulted in a number of most prominent Croatian chemists rightfully called „Croatian school of organic chemistry“. Although in the meantime techniques and fields of investigation of organic chemists changed, Croatian universities and research institutes still find their place at the world science map in this field of chemistry. A look in the list of projects financially supported by the Croatian Science Foundation reveals ten projects dealing with the synthesis of organic compounds, or with investigation of their structures (<http://www.hrzz.hr/default.aspx?id=78>). This makes a significant share of financed projects, not only in the area of chemistry. Below, we bring several abstracts of works for which we could clearly say they are, together with our knowledge on other life science disciplines, based also on the scientific legacy of **Leopold Ružička**.

Milena L. Mandić¹,Srećko Tomas²,Drago Šubarić³

FROM THE FIRST RUŽIČKA DAYS
(Borovo, December 7 – 8, 1978)
TO THE SIXTEENTH RUŽIČKA DAYS
(Vukovar, September 21 – 23, 2016)

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In the period between 1901 and 2014, the Nobel Prize for chemistry was awarded 106 times (it was not awarded for 8 years during that period), and among the laureates were two Croats, **Leopold Ružička** (1939) and Vladimir Prelog (1975). **Ružička** was born in Vukovar, in September 1887. His father's name was Stjepan, a cooper by trade, and his mother's name was Amalija, nee Sever. His father was of Croatian and Czech descent, but a true Croatian patriot, and his mother was of Croatian and German descent. Stjepan Ružička died when **Leopold** was four, after which the Ružička family moved to Osijek, the birthplace of his mother. **Leopold** attended elementary school and classical grammar school in Osijek (Royal Great Grammar School in Tvrđa (fortress), now Mathematical Grammar School).

After completing grammar school in Osijek, **Ružička** decided to continue his studies outside of Austria-Hungary because of the disadvantaged position of the Slavic population in the country. Due to his modest financial means, **Ružička** decided to complete his studies as quickly as possible, and after only two years of studies he graduated from the Institute of Technology in Karlsruhe with a diploma paper titled "The Reaction Kinetics of Ketene" (1908). Immediately after graduating he continued working on his doctoral dissertation from the area of preparative organic chemistry at the same institution of higher education. He received his PhD in 1910 with a dissertation titled "Über Phenylmethylketen". From 1912 he worked at the Federal Institute of Technology (ETH) in Zurich, Switzerland and became a Swiss citizen in 1917. In 1918 he became a private assistant professor at ETH and in 1920 an assistant professor at the University of Zurich. He became a titular professor at ETH in 1923. After that, his cooperation with the commercial sector also intensified. In 1929 he became the head of the Laboratory of Organic Chemistry, and he remained at that position until he retired in 1957.

Near the end of his life he started writing an autobiography, but he managed to publish only an autobiographical article "In the Borderline between Bioorganic Chemistry and Biochemistry".

Ružička's success, indirectly linked with Prelog, made it possible for researchers from Croatia, for doctoral students and other specialists to temporary work in the Laboratory of Organic Chemistry throughout Prelog's working life at the ETH, from 1942 to 1976, but also after his retirement. **Ružička's** other associates, besides Prelog, were Oscar Jeger and Stanko Borčić. Stanko Borčić (1931-1994) wrote his dissertation under **Ružička's** and Prelog's mentorship. He was an excellent organic chemist who gave his contribution to the Ruder Bošković Institute at first, and later as a university professor at the Faculty of Pharmacy and Biochemistry in Zagreb.

Branimir Gašpert (1928) and Vitomir Šunjić (1939) also shared their experiences from the ETH to the Ruder Bošković Institute. Gašpert (he was in Zurich in 1967/68) belonged to the second generation of Prelog's students and in the group were also Dušan Dvornik, Mirko Ternbach, Berislav Glunčić (1929-2013), Rade Marušić i Žarko Stojanac. The third generation of Prelog's students included Vitomir Šunjić, Davor Bedeković, Nada Šarčević, Mladen Žinić, Krunoslav Kovačević, Stjepan Mutak, Miljenko Dumić and Mićo Kovačević. Results of scientific research were patented by many of them. When talking about Pliva's scientists and Croatian scientific biography (CROSBI), the name of Berislav Glunčić has been related to 11 patents, published in the Croatian Patent Bulletin. The owner of those patents, along with Glunčić, has often been Krunoslav Kovačević, who also worked in **Ružička's** and Prelog's Laboratory of Organic Chemistry in Zurich.

Vitomir Šunjić resided in Zurich from 1969 to 1970. Mladen Žinić (1947), another prominent Croatian scientist, resided in Zürich in 1977 and 1978. Davor Bedeko-

vić, one of Prelog's last postgraduate students, worked at ETH University from 1972 to 1976. He also worked at Ciba-Geigy AG and then as a professor in Canada.

Encouraged by the Society of Chemists and Technologists in 1989, University of Osijek awarded Vladimir Prelog with an honorary doctorate. The 6th Ružička Days, opened by Prelog, were held at that time in Osijek. One of the most touching moments during Prelog's stay in Osijek was the award of an honorary doctorate at the University of Osijek, as well as the exhibition of the medallions awarded to two Nobel Prize winners in the lobby of the grammar school, attended by the Nobel laureates **Leopold Ružička** and Vladimir Prelog. Since the medallions are still exhibited in the lobby of the grammar school in Osijek, it is likely to be expected that in every generation of pupils at least one will be inspired for enthusiasm and diligence in further education.

With his work, **Ružička** established his reputation not only as a great scientist but as a true Croatian patriot. That was the reason why a group of scientists during the 1970s got the idea to commemorate the exceptional scientist, Nobel Prize winner, **Leopold Ružička**, so he can remain in our memories and be an inspiration for future generations. That is how Ružička Days were started in 1978.

During spring of 1977 an idea about organizing a scientific conference Ružička Days was born, according to the Academician Nenad Trinajstić, at a meeting at the Faculty of Food Technology and Biotechnology, University of Zagreb, attended by Vera Johanides, Nenad Trinajstić, Leo Klasnic and Vlado Horvat in Professor Johanides' office, a native of Vukovar. The Conference was to be organized in Vukovar, the birth town of the first Croatian Nobel Prize winner.

The idea about holding Ružička Days in Vukovar was proved to be excellent since even the military aggression on Croatia in 1991 could not prevent its implementation. During the aggression on the Republic of Croatia, the Seventh Ružička Days were held at the Bizovac Spa in 1993, instead in Vukovar in 1991. The Eighth Ružička Days were also held at the same location in 1996. After the peaceful reintegration of the Croatian Danube Region, the Ninth Ružička Days could be organised in Vukovar in 1998, where the conference is still held.



Participants of the First Ružička Days

Overview of the Ružička Days

	Year and place of organisation
I	1978 Vukovar
II	1980 Vukovar
III	1982 Vukovar
IV	1984 Vukovar
V	1986 Vukovar
VI	1989 Osijek
VII	1993 Bizovac Spa
VIII	1996 Bizovac Spa
IX	1998 Vukovar
X	2000 Vukovar
XI	2004 Vukovar
XII	2008 Vukovar
XIII	2010 Vukovar
XIV	2012 Vukovar
XV	2014 Vukovar

The First Ružička Days, 1978

The papers from the 1st Ružička Days were not printed in the conference proceedings.

The Second Ružička Days, 1980

The Second Ružička Days had a theme: *Medium and long term approach to resolving raw material bases and industrial polymer processing*. Based on previous experience, this time the presentations were printed in the proceedings.

The Third Ružička Days, 1982

Initiators of Ružička Days were active here as well. So the head of the Organizing Committee was Vladimir Husar and the moderator of the round table was Vera Johanides. The theme was *Industry research and cooperation with scientific and scientific-teaching institutions*. The Ružička Days were clearly gaining momentum, so the presentations by professionals and scientists from Croatia, Slovenia and Serbia were held.

A noted presentation titled *Ružička's cooperation with industry* was presented by the special guest of the Conference, Nobel Prize winner Vladimir Prelog.

The Fourth Ružička Days, 1984

This year, the theme was not defined upfront. The book of papers was published, and among section chairs were Dragutin Fleš and Ivan Bitula. Plenary lecture was held by Academician Ivan Jurković, while Zvonimir Janović, a member of the Croatian Academy of Engineering, held

a lecture entitled "Experiences and perspectives of the development of a personal technology in the field of polymer materials". Experts from other parts of former Yugoslavia also participated at the conference.

The Fifth Ružička Days, 1986

The theme of the Fifth Ružička Days was *Dependency of the development of chemical industry on energy and raw materials*, and the topic of the round table was *Personnel until the year 2000*. Plenary presentation titled *Thoughts about the energy perspective of Yugoslavia* was delivered by Hrvoje Požar.

At the round table, the introductory discussion was presented by Uroš Peruško, Igor Dekanić, Ante Milović, Mirko Krnić, and Dušan Gajari. The registered participant in the discussion was Egon Bauman, and the moderator was Ivan Butula.

The Sixth Ružička Days, 1989

At the time when the Sixth Ružička Days were to be organized, the will to organise such an event at the company Borovo was lacking. At the same time, the Society of Chemists and Technologists Osijek was celebrating the 25th anniversary of its founding, so, along with all the other events marking this commemorating worthy milestone, they took over the organization of the Sixth Ružička Days. Other organizers of the conference were: Union of Chemists and Technologists of Croatia, Union of Societies of Engineers and Technicians Osijek, Society of Chemists and Technologists Belišće, Society of Engineers and Technicians Borovo, Faculty of Food Technology Osijek, Faculty of Agriculture in Osijek, Institute for Health Protection Osijek, and the Scientific Department for Clinical-Medical Research of the Osijek General Hospital.

The following presentations were also delivered:

- E. Schwinum, Bayer AG Leverkusen, BRD: The increasing importance of special rubbers in western Europe;
- V. Prelog: Chemistry in Osijek 1919 – 1921.

The Seventh Ružička Days, 1993

This Conference was held in Bizovac since Vukovar was still occupied by the enemy, and the war was still present in the surrounding area of Osijek. The event included the 7th Ružička Days, the 4th Conference of Chemists and Technologists of Slavonia and Barania, and the 6th Professional Meeting of Chemists-Analysts of Slavonia and Barania. The organizers were the Society of Chemists and Technologists Belišće in cooperation with societies from Borovo and Osijek and the Croatian Society of

Chemical Engineers and Technologists. The honorary chairman was Vladimir Prelog.

The plenary presentation *Ružička and Paracelsus* was delivered by a true patriot, former Olympic athlete, Žarko Dolinar MD, who worked in Switzerland and cooperated with Ružička and Prelog. On that occasion he said and wrote: *Ružička was the honorary president and donor of the Croatian Foundation against the Homeland War, as well as the honorary chairman of the first branch of Matica Hrvatska in the period 1968/1969, so we communicated in the final years of his very vital and fulfilled life. During all meetings, correspondences, or telephone conversations Ružička was immensely eloquent, enterprising, vital, impatient, with abundance of comparisons, corrections, and critiques.*

The Eighth Ružička Days, 1996

This conference was also held in Bizovac, sponsored by the Ministry of Science and Technology of the Republic of Croatia, Ministry of Development and Reconstruction of the Republic of Croatia, Osijek-Barania County, Vukovar-Srijem County, University of Osijek. The co-organizers were the Society of Chemists and Technologists Belišće and the Society of Chemists and Technologists Osijek.

The conference work was divided into sections: *Chemical synthesis, Chemical analysis, Analysis of groceries and general products, Chemical and biochemical engineering, Food technology and biotechnology, and Environment Protection*. In addition to presentations, several sections introduced posters.

From the 7th and 8th Ružička Days onward, the Faculty of Food Technology Osijek was increasingly taking initiative concerning the organization, while Ružička Days were awaiting their return to Vukovar and Borovo.

The Ninth Ružička Days, 1998

The conference, held in 1998, returned to Vukovar! It was organized by the Croatian Society of Chemical Engineers and Technologists and the Society of Chemists and Technologists Borovo. The conference was sponsored by the Ministry of Science and Technology of the Republic of Croatia.

The outstanding members of the Honorary Committee were: Smiljko Ašperger, HAZU; Žarko Dolinar, University of Zurich; Count Jakob Eltz of Vukovar, Member of Parliament; Dragutin Fleš, HAZU.

Especially noted were the following plenary presentations:

- Phillippe Sauvegrain: Microcyclic musks: from Nobel Prize to 21st century;
- Richard Braun: Plant biotechnology.



Members of the HATZ, Srećko Tomas, winner of the 2006 Rikard Podhorsky Award and Žaneta Ugarčić, winner of the 2009 Power of Knowledge Award, held a plenary lecture at the Fourteenth Ružička Days

The Tenth Ružička Days, 2000

The conference was organized by the Croatian Society of Chemical Engineers and Technologists and the Society of Chemists and Technologists Borovo. The organizers extended a special gratitude to Vera Johanides and Dragutin Fleš for their valuable advice and assistance in organizing the special 10th Ružička Days. On this occasion, the prologue was written in Croatian but, for the first time, also in English.

The conference was sponsored by the Croatian Academy of Sciences and Arts.

During the special 10th Ružička Days the following plenary presentations were delivered:

- Pavao Pavličić, HAZU, Zagreb: Ružička and Vukovar;
- Albert Eschenmoser, ETH, Zürich: Remembering Leopold Ružička - The journey from terpenes to nucleic acids;
- Jasna Kniewald, PBF, Zagreb: Pesticides and the environment – presence and risks.

The Eleventh Ružička Days, 2004

Since the conference was taking place in 2004, the time when food safety issues and the motto “from farm to table” first appeared in public forums in Croatia, the presentation by Ljiljana Primorac from the Faculty of Food Technology Osijek attracted attention.

It was organized by the Croatian Society of Chemical Engineers and Technologists, Society of Chemists and Technologists Borovo, Faculty of Food Technology Osijek, Society of Chemists and Technologists Osijek, and the Society of Chemists and Technologists Belišće.

The Twelfth Ružička Days, 2008

It was held under the motto “Science and new technologies used for development of the economy”. The Chairman of the Scientific and Organizing Committee was Srećko Tomas, who was also the head editor of the Proceedings and abstracts. Srećko Tomas started with opening remarks and then Ivan Hubalek gave an overview of the eleven Ružička Days held until then, Filip Kljajić delivered a presentation titled “Vladimir Prelog and Ružička Days”. The conference also commemorated the 30 year anniversary since the first Ružička Days were held.

In addition to outstanding Croatian scientists, the following foreigner scientists delivered their presentations:

- Hartwig Höcker: Cyclics and macrocyclics-a personal review in honour of professor Leopold Ruzicka;
- Valery P. Kukhar: Biomass-renewable feedstock for organic chemicals-„white chemistry“;
- Jasmin Hirschmann and associates: Intact spore mass spectrometry for fungus identification by vacuum maldi time-of-flight mass spectrometry.

The Thirteenth Ružička Days, 2010

The power of the idea about holding Ružička Days was reinforced by the fact that since the *Thirteenth Ružička Days* in 2010, the conference has become an international congress, because, along with HDKI and the Faculty of Food Technology Osijek, the European Federation of Food Science and Technology (EFFoST) became a co-organiser. Since the beginning, the conference has made big progress due to the fact that 110 plenary and 150 other presentations were delivered, 600 posters were displayed, 6 round tables were held by Nobel Prize winners, academicians, university professors, scientists, and engineers from our country and abroad. Meetings

were organized by scientific and professional committees, with 325 members in total, and there were about 2500 participants. All of that was and still is an encouragement for development of the economy and society in general, especially in the areas of chemistry, chemical and biochemical engineering, food technology, medical biochemistry, pharmacy, environmental protection, and others areas in Croatia, but also worldwide, and that is the power of knowledge working through the right ideas. *Ružička Days* is one of the ideas successfully realised.

Proceedings were published regularly, as *Ružička Days* were held, without the reviews with regards to paper categorisation. However, since the Thirteenth conference, when it became an international conference, the Proceedings have been published separately from the Book of Abstracts. All papers reviewed after the conference which elevated the conference to a new level of quality.

The Chairman of the Scientific and Organizing Committee was Drago Šubarić, a member of the Croatian Academy of Engineering (HATZ), Department of Bioprocess Engineering, who suggested the motto of the Thirteenth *Ružička Days*, which was accepted for the Fourteenth and the Fifteenth *Ružička Days*: Today Science – Tomorrow Industry. Drago Šubarić found this motto in some of *Ružička*'s materials. Vice-chairmen were Srećko Tomas, member of HATZ, Department of Chemical Engineering, and Ante Jukić. Out of the other 17 members of the Scientific and Organizing Committee, three of them were members of HATZ: Jurislav Babić, Damir Ježek, and Milena Mandić, all from the Department of Bioprocess Engineering. Many members of the Honorary Committee were also members of HATZ: Marin Hraste, Zvonimir Janović, and Gordana Kralik. This Conference, as well as the next one, was held with the support of the Croatian Academy of Engineering.

The Fourteenth Ružička Days, 2012

Along with the European Federation of Food Science and Technology (EFFoST), the Conference was held with the sponsorship of the European Association of Chemical and Molecular Science, so it attracted even more scientists to deliver section presentations and display posters.

Members of the Scientific and Organizing Committee were: Ante Jukić, chairman, vice-chairmen Drago Šubarić and Srećko Tomas, both members of HATZ, as well as 17 other members. The conference, the same as all the previous conferences, was sponsored by the Croatian Academy of Sciences and Arts. This conference, among others, was held with the support of HATZ. An exceptionally inspired presentation was delivered by a member of HATZ Srećko Tomas, with the topic Nobel Prize winner *Ružička* as a source of inspiration.



Chairman of the Scientific and Organizing Committee, Member of HATZ, winner of the 2012 Rikard Podhorsky Award Drago Šubarić (Department of Bioprocess Engineering), greeting the attendants of the 15th *Ružička Days*

Plenary presentations were delivered by Croatian and international scientists:

- Dietrich Knorr: Emerging food processing technologies: from science to applications;
- Ulrich Schubert: New sol-gel materials: from the laboratory to applications;

The Fifteenth Ružička Days, 2014

Drago Šubarić, a member of Croatian Academy of Engineering (HATZ), was the Chairman of the Scientific and Organising Committee. Srećko Tomas, Department of Chemical Engineering, also a member of HATZ, and Ante Jukić were the vice-chairmen of the Conference. The members of the Honorary Committee were Vladimir Andročec, the president of HATZ, and Marin Hraste, Zvonimir Janović and Leo Klasinc, also members of HATZ.

The conference was held with the support of one more European association: European Hygienic Engineering & Design Group, emphasizing, thus, the international prominence of *Ružička Days*.



Member of HATZ, Deputy Secretary of the Department of Bioprocess Engineering, and the envoy of the President of HATZ, Milena Mandić, greeting the attendants of the 15th *Ružička Days*

Since the conference was held with the support of HATZ, on behalf of the president Vladimir Andročec, Milena Mandić, vice secretary of Department of Bioprocess Engineering, greeted the attendants and wished productive work.

Plenary lectures were delivered by:

- Vitomir Šunjić, HAZU: From science to industry – and back;
- Josip Šimunović, Food, Bioprocessing & Nutrition Sciences, North Carolina State University: Development and commercialisation of new aseptic technologies for processing of foods and biomaterials: continuous flow microwave sterilisation and integrated systems for particle flow monitoring;
- Takano Higashiyama, Senior Manager, Global Product Development, NAGASE (EUROPA) GmbH: Trehaloza: Multifunctional sugar and its applications;
- Silvana Raić-Malić, University of Zagreb, Faculty of Chemical Engineering and Technology: Challenges in positron emission tomography: from synthesis to testing on mice;
- Ljubica Glavaš-Obrovac, Faculty of Medicine Osijek: Current trends in activity and selectivity profiling of therapeutic molecules.

Conclusion

Ružička was, to a bigger or a lesser extent, directly and indirectly, a source of inspiration to numerous Croatian and world scientists. Academician Nenad Trinajstić wrote a book *100 Croatian chemists* where he presented, in short, life and work of 100 chemists – according to him, the most prominent chemical engineers in the current Croatian history. For 90 of them, as well as for many of those who did not manage to get into the group of the chosen ones, it can be said that the first Croatian Nobel laureate was for them, was in some way, a source of

inspiration and encouragement for their future life and work.

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English translation Antonija Šarić and Lidija Obad, Faculty of Food Technology Osijek, Croatia.

Mirko Smoljić¹

COLLEGE OF APPLIED SCIENCES “LAVOSLAV RUŽIČKA” IN VUKOVAR

¹ Dean of the “Lavoslav Ružička” Polytechnics in Vukovar

At the end of September of 2005, the President of the Croatian Government formally opened the College of Applied Sciences “Lavoslav Ružička” in Vukovar and in his statement for the occasion he said that Croatia was not just as strong as Zagreb, as its centre, but as strong as its outlying areas.

The College bears the name of the first Croatian Nobel Prize winner **Leopold Ružička**, who was born in Vukovar in 1887, the fact we are especially proud of, and in order to commemorate his name and his scientific achievement, a roundel with his bust was erected in front of the College building.

The College began its activities in the historic Jirkovsky Palace, and its three professional studies are attended by 196 enrolled students. The dedication and direction of the College is to offer the highest quality knowledge and skills to the students, and to prepare them for the labour market and a successful future through its three study programmes.

The physiotherapy study is one of the most attractive studies in the Republic of Croatia; students who complete it can immediately find employment and are capable of independent work. The teachers at the study are top experts in various clinical areas, and practical classes are held in healthcare institutions and our excellently equipped Trauma and Fitness Centre. The syllabus structure for the undergraduate study programme in physiotherapy is based on the specific professional area of physiotherapy and clinical content, with obligatory basic sciences and additional healthcare content. Education of students at the undergraduate study level means adopting knowledge and skills related to the assessment of the condition, setting



Polytechnic started its activity in the historic Palace of Jirkovský, and to his three professional study enrolled 196 students. Committed to through its three study programs provide students with expert knowledge and skills and to prepare them for the labor market and successful future.



goals, and planning and applying physiotherapy, according to the age, needs, and dysfunctions of the individual.

The specialist graduate professional study Preventive Physiotherapy is a new and innovative study programme, a mix of biomedicine and kinesiology, and after completing the two-year programme, the students are competent in organisation, analysis, and research of applied physiotherapy models in sports, recreation, and wellness. This qualifies them to work independently in healthcare institutions, health and rehabilitation centres, professional sports clubs, centres for recreational sports activities and institutions of higher education, wellness centres, and other health tourism facilities, as well as professional and scientific research projects in the area of physiotherapy. The proposal for starting this specialist graduate professional study in the area of preventive physiotherapy in sports, recreation, and wellness is aimed at continuous suitable education for persons deciding to work in the area of biomedicine and healthcare of physically active individuals.

Students at the professional Administrative Study programme acquire theoretical knowledge, and through their practical work in various state and local administration bodies, they acquire the necessary skills and become qualified for professional and independent work in various administrative and legal areas of state administration, local and regional self-government, public sector institutions, commercial companies, and similar bodies that require these types of professionals. Some of our students are employees of various state administration bodies like the police, customs administration, administrative departments of counties and cities, companies, and a significant number of teachers come from just those types of institutions and



offer students practical and specific knowledge required in administration bodies and other similar institutions.

Students at the professional Business Study programme learn techniques and workplace skills for modern and practical management of commercial and other related commercial activities, i.e. for conducting all types of commercial activities and executing various activities and economy related services, marketing, entrepreneurship and operational management, transport, forwarding, warehouse services, product knowledge, commercial public warehouse services, commercial activities in state administration bodies and institutions, and similar. Through their professional practice in many commercial companies, students acquire practical knowledge and skills, and after completing the study, they can successfully become established in that area of economy, they can find jobs without difficulty and successfully advance through the ranks.

The College went through several stages of development, and currently new specialist and professional studies are being established. Those studies will enable the students to continue with their education and develop professionally in the areas of biomedicine, kinesiology, administration, food technology, and commerce.

As an homage to “Lavoslav Ružička“, the College is intensively working on a new undergraduate professional study programme in food technology and chemistry in agriculture, related to production and processing of fruit and vegetables, which is compatible with development goals of the Vukovar-Srijem County.

With the help of European funds, the College is building a gymnasium and a student dormitory to provide better conditions for students.



The state as the founder and the management of the College are aware of the great responsibility for the education of young people from Vukovar and the Vukovar-Srijem County, and beyond, who will use the knowledge they acquire at the “Lavoslav Ružička” College to develop the local economy, find their place at the labour market, provide for their families, and avoid economic migrations.

A young person’s decision to enrol into any of the study programmes at the College means that they want quality education, because theoretical and practical parts of the courses will guarantee they will have great opportunities for employment and advancement. Our teachers and associates are mostly people with experience in economy, state administration, and healthcare, and they use a proactive approach for transferring practical knowledge to the students and helping them become professionals in their field.

Today there are nearly 900 students enrolled in the three undergraduate professional programmes and one specialist graduate study programme, and we expect that this number will be over a thousand students, once the new study programmes are established.

Today the College is also a scientific institution, because it is engaged in a large scientific and research programme in the area of biomedical sciences with the Institute for Anthropological Research from Zagreb, and it is also a participant in several international projects, especially in IPI Interreg with Hungary and Serbia. It also has a well organised quality system, which conforms to ESG guidelines and international ISO standards, it achieves great results in the area of student sports and it has been selected to participate in the European University Games Zagreb-Rijeka 2016.

English translation Antonija Šarić, Faculty of Food Technology Osijek, Croatia



A SELECTION OF PROJECTS FOLLOWING RUŽIČKA'S RESEARCH

The projects have been selected by Vladimir Mrša, Faculty of Food Technology and Biotechnology
University of Zagreb, Member of the Croatian Academy of Engineering

*Nives Galić et al.*¹

Aromatic hydrazones: synthesis, structural analysis, biological activity and analytical application

¹University of Zagreb, Faculty of Science in Zagreb

The main goal of the project is to develop new methods for metal ions determination as well as new extraction chromatographic materials for separations of some important radionuclides. The active components in such systems will be aromatic hydrazone derivatives. They will be synthesized by condensation reactions of hydrazide and differently substituted aldehydes or ketones. Since different tautomeric and isomeric forms of hydrazones can have diverse chelating properties, the detailed study of the corresponding equilibria is important for successful application of these compounds and will be performed within the project. Protonation properties and kinetics of hydrolysis of hydrazones in solvents containing water will be examined. For structural characterization of ligands in solution mass spectrometry, liquid chromatography, and different spectroscopic techniques (NMR, UV-Vis, fluorescence, IR and Raman spectroscopy) will be used. The computational studies will be carried out as well. The

complexation reactions of hydrazones with selected metal ions and radionuclides will be investigated in solution. Whenever possible, complex stability constants will be determined and solid complexes will be isolated. Based on the results obtained, spectrophotometric and/or spectrofluorimetric methods for metal ions determination will be developed. The selectivity of the proposed methods will be further improved using extraction procedure. The influence of surfactants on the extraction systems will be explored. Furthermore, hydrazones abilities as extraction chromatographic resins towards selected radionuclides will be investigated. Prepared hydrazones and their complexes will be screened for biological activity on selected microbial species and fungi. Finally, the correlation of the hydrazones structures and their physico-chemical properties will be proposed, which is of great importance for successful applications of such compounds as bioactive agents or analytical reagents.

*Branka Zorc et al.*¹

Design, synthesis and evaluation of novel anticancer agents based on primaquine, vorinostat and sorafenib scaffolds

¹University of Zagreb, Faculty of Pharmacy and Biochemistry in Zagreb

The long-term goal of the proposed research is development of novel compounds with a potential for development to drug lead(s) and anticancer drug(s). The project will focus on rational design, synthesis and biological screening of novel derivatives of three marketed drugs: antimalarial primaquine and two antitumoral drugs vorinostat and sorafenib. The potential for discovery of new anticancer agents among antimalarials was first noted when commonly used antimalarials showed significant anticancer activity (7 of them have reached a clinical stage of development). We have focused our attention to primaquine, the antimalarial agent with quinoline moiety. In our several papers novel urea and semicarbazide primaquine derivatives with strong antiproliferative activity and/or high selectivity were reported. The highest selectivity against MCF-7 cells and practically no activity against other tested cancer cell lines showed hybrid of two primaquine ureas. Based on these results we intend to

design, synthesize and evaluate novel primaquine hybrid compounds as potential anticancer agents. First objective is to design and prepare novel twin drugs based on primaquine and vorinostat scaffolds 3-6. These compounds will differ in length of aliphatic chain and/or functional groups: compounds 3 are esters, 4 are carboxylic acids and 6 hydroxamic acids like vorinostat itself. Reduction of compounds 4 would generate amines 7 and amides 8. Further on, we plan to prepare primaquine amides 9 with substituted cinnamic acid and sorafenib analogs 14 based on pyrazine structure, hoping that additional nitrogen atom would increase the binding interactions. To study how the amide part of the molecule affects the activity and physico-chemical properties of the new pyrazine analogs, the preparation of a number of amides is planned. All new compounds will be screened for cytostatic activity in vitro on several human cancer cell lines, inhibition of specific enzymes and antioxidative activity.

Igor Jerković *et al.*¹

Research of natural products and flavours: chemical fingerprinting and unlocking the potential

¹University of Split, Faculty of Chemistry and Technology in Split

The proposed project develops up-to date topic in the subject area, offers high-quality research of natural products (NPs) and flavours (FLs) and tends to impact the biodiversity, traceability and authentication issues of targeted samples (major EU concerns), as well as to unlock the potential (useful activities of the samples/NPs). Targeted samples are unexplored or insufficiently investigated honeys, honeydews, bee-products, wines, cheese, others. While characteristic NPs (secondary metabolites) already possess flavours, other flavour compounds can derive from precursors during processing, fermentation, dry-curing, heating, others (e.g. Maillard reactions, Strecker degradations, retro-aldol reactions, Amadori rearrangements, heterocyclizations, lipid oxidations and others). NPs/FLs isolation involves application of selective preparative procedures followed by the organic analysis applying modern chromatographic and spectroscopic techniques. Specific project goal is to deter-

mine reliable chemical fingerprints of targeted samples depending on biodiversity of natural sources in different regions. Varieties of acetate, shikimate, mevalonate and/or deoxyxylulose biosynthetic pathway derivatives are expected to be found. Among them, it can be possible to find specific or nonspecific chemical biomarkers characterizing certain sources. In addition, the obtained NPs or selected samples will be evaluated in order to unlock their potential, particularly antioxidant activity by different assays and corrosion inhibition potential with in-situ and ex-situ electrochemical/non-electrochemical techniques. Project work plan includes: 1) the samples selection and preliminary characterisation; 2) set-up of preparative/chromatographic/spectroscopic methods followed by elaboration of the obtained chemical fingerprints; 3) set-up of antioxidant/corrosion inhibition assays followed by unlocking the samples/NPs potential; 4) training of young researchers/cooperation.

Krešimir Molčanov *et al.*¹

Novel metal-organic systems based on the oxalate and quinoid ligands with tuned properties suitable for applications

¹Institute Ruđer Bošković in Zagreb

The project targets at efficient and progressive design of novel and advanced functional materials based on metal-organic complexes. Combination of metal centres with polydentate organic ligands provide colossal, structurally-diverse, platforms possessing a variety of magnetic, electrical, thermal, optical and other properties. In the proposed project, two analogue bridging ligands, oxalate and substituted 2,5-dihydroxyquinonate (DHQ), will be used in the preparation of the coordination polymers of different dimensionality and topology. Their interactions with transition metal cations involve a variety of magnetic phenomena, which can be tuned by highly sensitive selection of structural fragments. The oxalate-based complexes will be studied not only as potential magnetic materials ordering at a certain temperature, but also as the single-source precursors for the preparation of technologically important mixed-metal oxides through the thermal decomposition process. This

method of preparing oxides, as compared to conventional solid-state reactions, has several advantages: shorter thermal treatment at lower temperature, without repeating grinding procedures, and the products are more homogeneous. The DHQ complexes will be studied due to their potential for charge transfer, which may lead to materials with reversible magnetic transition. Also, promising class of the ligands are stable semiquinone radicals derived from variously substituted DHQs. So far, their complexes with transition metals are little-known and have not been exploited for design of functional materials. The interdisciplinary nature of the project requires a variety of methods to characterise these advanced materials: single-crystal and powder X-ray diffractions including X-ray charge density studies, thermal analyses (TG/DTA), IR, UV/Vis and EPR spectroscopies, etc. The results obtained will be used to correlate their structure and properties.

Guest Editor's Notice:

I wish to bring to the readers' attention that Professor Ružička is known in the scientific and professional literature under the names Lavoslav and Leopold, respectively. Since the articles in this Bulletin are both in Croatian and English, we have decided to use the name Lavoslav Ružička in the Croatian texts, and the name Leopold Ružička is used in the English texts. We kindly ask you to take this explanation into account.

HATZ NEWS

Since the 31th Annual Assembly of the Croatian Academy of Engineering, which was held on May 11, 2016 at the University of Zagreb, the current Academy membership count is the following:

Members of the Academy	109
Emeriti of the Academy	71
International Members of the Academy	11
Associates of the Academy	63
Honorary Members of the Academy	10
Supporting Members of the Academy	49
TOTAL	313

In the previous period the new Bylaw on the Election to Membership of the Academy as well as the new Bylaw on Awards and Recognitions of the Academy have been passed. The Academy had opened and completed the Competition for 2015 HATZ Awards and Recognitions and selected the laureates. The awards, medals and recognitions were granted to the laureates at the 31st Annual Assembly.

The Internal Call for Transition of Members of the Academy to Emeriti of the Academy and Advancement of Associates of the Academy to Members of the Academy, opened and completed this year, resulted in 8 new Emeriti of the Academy and 13 new Members of the Academy. The membership of two Associates of the Academy turning 70 in 2016, who did not apply to the Internal Call, has ceased. Four new Supporting Members have been admitted to the Academy membership. We have already informed our members and all interested parties in more detail on these developments in the News section on our website: <http://www.hatz.hr/category/novosti/>

The Departments have been particularly active in their project work and in the competition and election procedures concerning new Members and Emeriti of the Academy as well as the 2015 HATZ Awards and Recognitions Laureates. Among the 2015 activities reports especially interesting is the project „The City of Zagreb Earthquake Risk – Infrastructure, Population, Structures and Cultural Heritage“. HATZ Department of Civil Engineering will be responsible for the project and cooperate with the City of Zagreb

Another prominent project is the BIOCENTER at the University of Zagreb - Borongaj Campus, which pertains to the scope of Department of Bioprocess Engineering. The Department will organize round table discussion on this subject together with HATZ Biotechnical Center. Also, this newest issue of HATZ Bulletin „Tehničke znanosti“ and „Engineering Power“, respectively, was also prepared by the Department of Bioprocess Engineering in cooperation with HATZ Biotechnical Center. The Bulletin is co-published by our Academy and Croatian Academy of Medical Sciences and dedicated to the first Croatian Nobel Prize winner **Leopold Ružička**. The Guest Editor of this issue is Prof. Emer. Zlatko Kniewald, Ph. D., Emeritus of the Academy and Secretary of the HATZ Department of Bioprocess Engineering. Department of Systems and Cybernetics as well as some members from other HATZ Departments are particularly active in the field of biomedical engineering. Since certain Departments have stated in their 2016 activity plans the organization of lectures of distinguished lecturers from abroad, the inclusion of lectures of International and Honorary Members of the

Academy from abroad has also been proposed, especially those with notable international scientific careers.

The most active HATZ Committees are: Committee for Economic and Regional Cooperation, which has organized several round table discussions and workshops on the topics of connecting science, industry and the economy; Committee for International Cooperation, especially through SAM (Scientific Advice Mechanism), as an assignment from the Euro-CASE; Committee for Awards, which has successfully realized an extensive task of carrying out the Competition for 2015 HATZ Awards and Recognitions, the evaluation of candidates and selection of laureates. We should also mention the activity of the Committee for Scientific Fund, which, together with the Governing Board of the Academy, provides for funds for the awards.

Generally, the majority of Departments and Committees as well as Centers actively participate in the realization of the Academy Program by organizing meetings, participating in public discussions of interest for technological and biotechnological sciences and the economy, participate in preparation and publishing of HATZ Annuals in English and bilingual HATZ Bulletin „Tehničke znanosti“ and „Engineering Power“. In 2016 the Academy published „Annual 2015 of the Croatian Academy of Engineering“, which, apart from the new papers, also includes reprints of the best papers of our members. The Academy also published „Engineering Power“ Vol. 11(19) 2016, which was prepared under the editorial leadership of Guest Editor Prof. Emer. Ana Marija Grancarić, Ph. D., Member of the Academy in the Department of Textile Technology. The issue has been dedicated to the European projects in the field of textile technology. A number of our distinguished experts from the Faculty of Textile Technology, University of Zagreb participate on the projects. This year the Academy also copublished, together with the Public Open University Zagreb, the 2nd Extended Edition of the Monograph „Life and Inventions of Faust Vrančić“ by Prof. Gojko Nikolić, Ph. D.

The members of certain Departments particularly actively advocate the regulation of engineering professions and founding of the Croatian Chamber of Engineers; formulation of the Transport Strategy of the Republic of Croatia and its operationalization within the framework of Croatia's EU membership as well as the quality strategic transport integration and stronger economic integration of the European North and South, as it has been demonstrated in the successfully finalized European project „SETA – South-East Transport Axis Baltic-Adriatic“. The Academy participates on this project via HATZ Center for Transport Engineering.

The Scientific Council of the Academy discussed at its sessions on the important issues concerning Academy's publications and projects, evaluation of scientific and professional work and other themes dealing with promotion of scientific and professional excellence. The Council formulated a number of proposals for improvement of the criteria and rating in the process of membership advancement and awards granting. It also proposed a list of candidates for new memorial busts in the courtyard of the HATZ House (Vatroslav Lopašić, Rikard Podhorsky, Vladimir Muljević, Andrija Mohorovičić, Ivan Supek...). The bust of Prof. Vatroslav Lopašić, Honorary Member of HATZ since 1994 (died in 2003), is

currently in creation by a team of notable Croatian artists and masters, and so are the preparations for the ceremony of its unveiling, which will take place in October 2016.

Through its Euro-CASE and CAETS membership the Academy wishes to contribute to a stronger European and international positioning of technological and biotechnological sciences in Croatia as well as better positioning of our country in general.

The representatives of the Academy participate at all major meetings of these international associations and thus the HATZ President Prof. Vladimir Androćec, Ph. D. and Vice-President Prof. Zdravko Terze, Ph. D., have attended the Euro-CASE Board Meeting and meetings concerning the European project SAPEA (Science Advice for Policy by the European Academies), which were held in Paris, France, in May, 2016. The Academy is engaged on this project via Euro-CASE.

Together with its sister academies (Croatian Academy of Medical Sciences, Croatian Academy of Legal Sciences and Academy of Forestry Sciences), our Academy has undertaken very intensive activities with the aim of regulating the scientific status of our academies and issues of reaccreditation procedure conducted by the Agency for Science and Higher Education. The results of these joint efforts are the decree of the Ministry of Science, Education and Sports of the Republic of Croatia and the Agency for Science and Higher Education on temporary exemption of professional academies from the reaccreditation procedure, which is in its current form adjusted almost exclusively to scientific institutions such as universities, faculties and public institutes, and the notice that this issue will be resolved by passing future legislative acts regulating this substance.

Acquiring and retaining, respectively, of the status of scientific organization entails that our academies may apply for and lead important European and international projects and thus withdraw funds from the European and international sources in the Croatian science and the economy, i.e. the National Budget, from which our academies are funded minimally and exclusively from earmarked funds.

In 2016 the Academy is patron and coorganizer of numerous scientific and professional meetings. Herein are the most important of them.

Auspices in 2016

- Faculty of Textile Technology in Zagreb - 9th Scientific and Professional Colloquium Textile Science and the Economy 2016 – „Creative Mixer“, Zagreb, January 26, 2016,
- Croatian Systems Society (CROSS), Jubilee Conference on the Occasion of 25 Years since the Founding of the CROSS, Zagreb, January 27, 2016,

- Faculty of Chemical Engineering and Technology in Zagreb – 11th Meeting of the Junior Chemical Engineers and Technologists, Zagreb, February 18, 2016,
- Faculty of Food Technology in Osijek – 2nd International and 6th Scientific and Professional Meeting „Water for All“, on the Occasion of the World Waters Day, Osijek, March 18, 2016,
- International Colors Day 2016, Zagreb, March 21, 2016,
- International Conference ZIRP (Science and Development of Transport), „Perspectives of the Croatian Logistics Industry in the Attraction of International Goods Flow“, Zagreb, April 12, 2016,
- International Scientific and Professional Conference 16th Ružička Days „Today Science – Tomorrow Industry“, Vukovar, September 21-23, 2016,
- 24th International Scientific Conference SoftCOM 2016, Split, September 22-24, 2016,
- 9. međunarodni znanstveno-stručni skup „Hranom do zdravlja“, Osijek, 13. listopada 2016.;
- International Scientific Conference on Smart Systems and Technologies 2016 (SST 2016), Osijek, October 12-14, 2016,
- Croatian Energy Society - 25th Forum: Energy Day in Croatia „The United Energy and Climate Policy in the Open Energy Market – A Year After COP21“, Zagreb, November 18, 2016

(Co)organization of Meetings in 2016

- Joint Session of the Council and Coordination of Four Academies: HATZ, AMZH, APZH and AŠZ, Zagreb, January 27, 2016,
- HIS – Round Table Discussion „Engineers on Energy Industry“etici“, Zagreb, February 25, 2016,
- HIS, HATZ and FER – Croatian Engineers Day, Zagreb, March 2, 2016,
- FER - Brain Week 2016; Zagreb, March 14-20, 2016,
- HATZ Department of Graphical Engineering, Center for Graphical Engineering – International Conference „Printing&Design 2016“, Zagreb, March 30, 2016,
- FSB, HATZ – Presentation of the First Robotic Neurosurgical Operation (RONNA), Dubrava Clinical Hospital Amphitheater, Zagreb, March 31, 2016,
- FSB, HATZ – Round Table Discussion „Croatian Innovation System within the European Framework“, Zagreb, April 14, 2016

HATZ News Editor
Melanija Strika,

Business Secretary of the Croatian Academy of Engineering

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