

10th International Scientific Technical Conference in the Area of Defensive Technologies OTEH 2022

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The paper describes the activities of the tenth scientific conference of researchers who are engaged in defensive technologies, which was organized by the Military Technical Institute and held in October 13-14, 2022, in Belgrade. After the general presentation of the event and three plenary lectures, majority of 103 accepted papers, which admittedly attracted the most interest, were presented in two days sessions.

This year, OTEH 2022 was held for a tenth time and, after the previous one which was held online due to Covid 19 pandemic, this one had a traditional character, confirming an excellent opportunity to review all achievements in defense technology, exchange knowledge and experience in this field, strengthen the existing and establish new forms of cooperation between related institutions on the development of modern weapons and military equipment, and to discuss future directions in their development.

Introduction

TRADITIONALLY at the beginning of October, in Belgrade, SERBIA, the Military Technical Institute (VTI) held the International scientific-technical conference in the area of defensive technologies OTEH 2022 for the tenth time. As well as in previous years, the organizer of this scientific conference was VTI, a scientific research institution with more than seventy years (founded in 1948) of tradition in development of weaponry and military equipment.

By now, the Institute developed and adopted over 1400 combat and non-combat systems into the operational use with which, together with the Serbian Army, many foreign armies are equipped as well.



Figure 1. OTEH International Scientific Technical Conference

Realization of the Conference

OTEH is a highly important international scientific-technical manifestation which is regularly held every second year and which comprehensively and multidisciplinary considers current situation and further development trends in the area of military technical sciences.

During two days of conference duration, a great number of quality and authentic papers was presented, which originated out of the current projects researchers are working on, as well as the papers which already have a practical use or at least refer to assumptions and further development trends of certain military technologies areas. This year OTEH 2022 was held in a traditional way, which was very welcomed by authors and guests after the COVID 19 pandemic period.



Figure 2. OTEH 2022 opening day

OTEH 2022 had 128 submitted papers out of which 103 were accepted and included in the programme. 87 papers were from Serbia, 18 were from abroad (14 countries in total). The papers were classified into eight topics; Aerodynamics and Flight Dynamics (6), Aircraft (7), Weapon Systems and Combat Vehicles (9), Ammunition and Energetic Materials

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(10), Integrated Sensor Systems and Robotic Systems (18), telecommunication and Information Systems (12), Materials and Technologies (35), as well as Quality, Standardization, Metrology, Maintenance and Exploitation (6).

The exchange of knowledge the OTEH propagates deepens the international cooperation in the area of education, research, development and production of armament and military equipment. The international character of this conference is confirmed from year to year. Together with domestic, foreign authors and coauthors participated with their papers. There were 18 scientific papers from 13 foreign countries. Foreign authors and coauthors were from: Slovenia, Bosnia and Herzegovina, Algeria, Bulgaria, Belarus, North Macedonia, Portugal, Germany, Iraq, Kazakhstan, United Arab Emirates, United States of America and Croatia.

The list of all papers and authors, as well as other information concerning the OTEH 2022, may be found on the website: www.vti.mod.gov.rs/oteh

International Scientific Technical Conference OTEH 2022 has intended to provide opportunities for scientists and engineers, researchers, designers and university community from many countries to share ideas and technical information, as well as to build new relationships. During two online days of the conference, participants could have asked the questions, set remarks or even contact the authors through their emails.



Figure 3. OTEH 2022 opening day

The Conference was opened by then Deputy Prime Minister and Minister of Defense, Nebojsa Stefanovic, PhD, who emphasized that a total of 61 domestically developed weapons and types of military equipment have been introduced into the armament of the Serbian Armed Forces over the past two years. At the beginning of his opening address, Minister of Defense expressed special thanks to the Military Technical Institute for hosting such an important conference and for being the backbone of the domestic defense industry and a true integrator of various complex systems, which are now part of our weapons and military equipment. According to the Minister, events taking place worldwide today show very clearly that conflicts and wars are not a thing of the past and that humanity has not yet put them in museums. – The way they affect the global situation and stability has clearly shown the importance of continuous strengthening of own armed forces. These turbulent times and global upheavals that we are witnessing, have confirmed in many ways that our decisions about Serbia’s path have been made in a serious, responsible and wise way. Our path, which includes strengthening our military and increasing the production of equipment and weapons, has proven to be the right one as well. It was, and still is, directed towards only one goal – preserving the peace and stability in our country and in

our region.

Serbia has never been one of the world’s greatest powers, nor among extremely rich countries, but we are the nation of Zivojin Misic, Stepa Stepanovic, Nikola Tesla and Mihajlo Pupin, the Minister reminded in his address to the audience.

Our military is now equipped with “Nora” self-propelled howitzers, digital modular “Oganj” rocket systems, modernized “M-84” tanks, pasars air defense systems, “Lazar 3” and “Milos” armored combat vehicles, “Mali Milos” robotic platforms, and numerous other domestically produced items, which have buyers all over the world.

According to the Director of the Military Technical Institute, colonel Bojan Pavkovic, PhD Eng, the conference aims to provide an opportunity for all domestic and foreign participants in the process of development of weapons and military equipment to get to know each other, exchange ideas, knowledge and experiences. – It gives me a great satisfaction that OTEH has an international character this year as well, which has been confirmed by a large response from our colleagues and friends from abroad who have joined this conference. The impressive number of projects that we will see over the next two days indicates that the commitment to scientific work in the field of defense technologies is still at a high level, and the presence of high-ranking officials at this opening ceremony is a proof of the wholehearted support of the Ministry of Defense and state institutions for scientific research – said the Director of the Military Technical Institute and added that, traditionally, each OTEH is dedicated to one of the greatest Serbian scientists.



Figure 4. A plenary lecture given by professor Slobodan Ninkovic

After the opening speech and general presentation of this event, we had three plenary lectures which admittedly attracted a lot of interest. This year the Conference was dedicated to the famous scientist of Serbian origin, Rudjer Boskovic, who achieved remarkable success in physics, astronomy, diplomacy, philosophy and art. The lecture on that occasion was given by professor Slobodan Ninković, PhD, from the Astronomical society Ruder Bošković. The second lecture was given by Miljan Vučetić, PhD Eng, from the Vlatocom Institute in Belgrade on artificial intelligence. The lecture was entitled “Artificial intelligence in the function of developing innovative products”. The third lecture was given by professor Constanca Rigueiro from the Polytechnic Institute of Castelo Branco in Portugal and it was entitled “High performance multi-function panels for extreme loading events”. This paper presents a framework of the research already done related to metallic structural systems and their applicability. Since they have enormous potential to be multifunctional, able to protect critical infrastructures (as already been used by oil and gas sector) and mitigate the

extreme climatic effects. The research under development pretends to propose a design of new kind of lightweight multi-layer sandwich structure with improved mechanical properties and high blast resistance.

Due to the research already developed it can be concluded that the design of new kind of lightweight multi-layer sandwich structure with improved mechanical properties and high blast resistance requires an accurate blast information. This demands the validation of model and constants by the correlation, with experimental results, of water blast and stainless steel plate deformation, showing the role of the resistant blast wave wall.

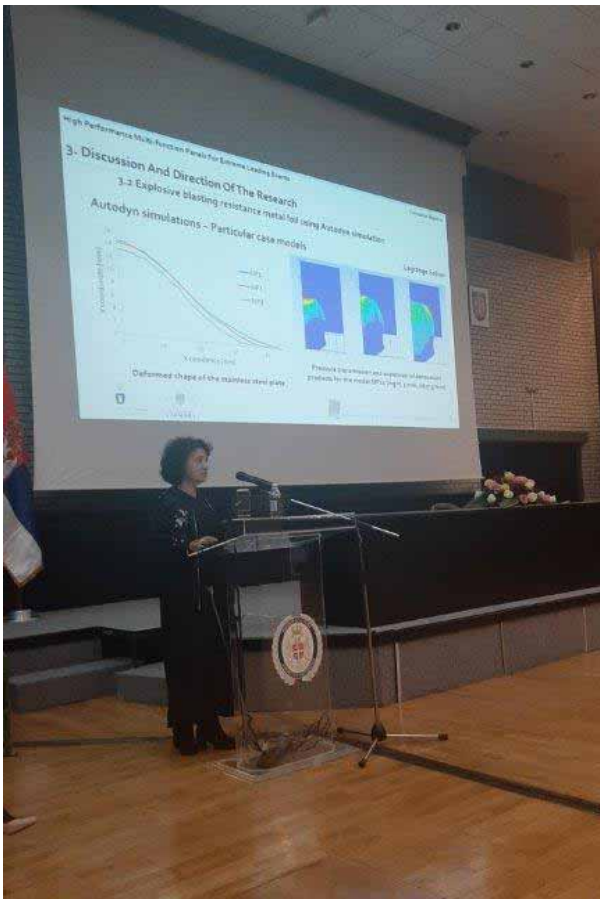


Figure 5: A plenary lecture given by professor Constanca Rigueiro

Life and Scientific Activity of Ruder Bošković

Rudjer Boskovic, one of the most illustrious minds of the world science, was born on 18th May 1711 in Dubrovnik, during the peak of the Republic of Ragusa (or the Republic of Saint Blaise as it was also called). The city of Dubrovnik/Ragusa got all the attributes of a republic owing to Louis I of Hungary on the basis of a peace treaty signed by him and the Republic of Venice in 1358, and lost them under the Napoleon occupation in 1808. At the end of 17th century Rudjer's father Nikola, an Orthodox Serb from Orahov Do near Trebinje in Herzegovina, came to Dubrovnik as a merchant where he got married with Paola Bettera from a prominent Italian noble family. Rudjer was the seventh child out of eight (five sons and three daughters). Interestingly, none of all children got married except for one sister, who was also childless, and the lineage of Nikola Boskovic died out with this generation.

At the age of 8, Rudjer was sent for schooling to the local Jesuit Collegium Regusinum where he acquired elementary knowledge and the knowledge of Latin. His father died when

he was 10, and four years later, in 1725, his mother, following the recommendation of his teacher, sent him to Rome to continue his education in a Jesuit school, Collegium Romanum. His extraordinary gift for natural sciences started to flourish in his studies of mathematics, physics and philosophy. He was satisfied with his life among Jesuits in the beginning. However, when he criticized the Collegium Romanum for not giving enough attention to mathematics, he experienced many unpleasant moments from the rather intolerant environment where theology was considered to be far above natural sciences.



Figure 6: Rudjer Boskovic

In Rome he studied Aristotle's physics and mathematics, Euclid's mathematics, astronomy, ethics and logic. His first scientific works come from the field of applied mathematics. Geometry preoccupied him at that time as well, differential geometry and the theory of continuity and infinity in particular. Many years devoted to mathematics would later give numerous scientific dissertations, books and manuals.

Having finished his studies of theology, Rudjer became a member of clergy. However, he did not devote his attention to theology and missionary work but he worked as a professor at the Collegium Romanum until 1760. At the age of 22 he started teaching mathematics at lower grades of the Collegium Romanum. Two years later, he went to Fermo to teach at a Jesuit Collegium and upon his return to Rome at the age of 29, in 1740, he took over the chair of mathematics from his favorite professor Borgondi. Several important works in mathematics, mechanics, geophysics, optics, astronomy and geodesy had already been finished by then, including "*Application of telescope for the determination of celestial bodies*" and "*Movement of bodies thrown into space without resistance*". In 1735, literally gifted as his mother's father Bartolommeo, he expressed his ideas about the Solar and Lunar eclipses through a 300-verse poem "*De Solis ac Luna defectibus, libri V, cum ejusdem auctoris adnotationibus*", the final version of which was enlarged and published in London in 1760 in six volumes. In an original way, Boskovic's verses show what happened during the eclipses. For example, stars are visible during a solar eclipse while during a lunar eclipse, the Moon either becomes so dark that it is invisible or it turns deep red. At a solar eclipse, the Moon prevents sun rays from reaching the Earth. At a lunar eclipse, the Earth prevents sun rays from reaching the Moon. Since both phenomena are connected with the Skies, Rudjer evokes the Sun as the ruler of everything in this system. Most of his scientific works and hypotheses were expressed in verses.

One of his first significant dissertations, published in Rome in 1737 under the title “*De Maculissolaribus*” (*About Sun Spots*) caused a lot of attention and controversy in the scientific circles of the time. Since he was the first to explain this phenomenon, he would refer later to his discovery: “As early as in 1737, in one dissertation about Sun spots printed in Rome, I gave two methods for determining the elements of the Sun revolution based on the three positions of one of his spots, where one method was based on graphic construction and the other one on trigonometry”. In 1742 he was consulted, with other mathematicians, to offer the best means of securing the stability of the dome of St Peter’s in Rome in which a crack had been discovered and a year later he dealt with the stability of the apsidal part of the same church. Maria Theresa asked him to help with the static problems of the Royal Library in Vienna. His knowledge of hydraulics also helped in the reconstruction of the ports of Rimini and Savona.

In his two-volume work “*On light*” in 1748, he was a visionary claiming that light could not be proved to propagate in a straight line, especially in the intergalactic space where “some forces” as he said, could change the trajectory of light particles. It took 150 years to pass for this theory to be proved – shapes of light ray paths are influenced by the gravity of a celestial body light rays pass by.

In his geodesic research, Rudjer studied the shape and the form of the Earth as well as the differences in the gravity in different parts of the world. He traveled to Brazil with a Portuguese expedition to measure one degree of the arc of the meridian, but was persuaded by Pope Benedict XIV to stay in Italy to measure an arc of two degrees between Rome and Rimini and to make a new map of the Papal States. With an English Jesuit, Christopher LeMaire, he completed the operation in two and a half years. An account was published in 1755 under the name “*De Litteraria expeditione per pontificiamditionem addimetendos duos meridianigradus et corrigendam pappam geograficam*”. His geodesy knowledge helped him to measure meridians in Austria, Hungary and Piedmont. When a dispute arose between the republics of Tuscany and Lucca over the frontier waters, Rudjer supported the claim of Lucca before the Austro-Hungarian monarch, Franz I, in Vienna. During his stay in Vienna (1757-1758) he finished and published his most important scientific work “*Theoriaphilosophiaenaturalisredactaadunicamlegemvirium innaturaexistentium*” (*Theory of Natural philosophy derived to the single Law of forces which exist in Nature*), which was going to have several editions up to the present day. Having returned to Rome at the end of 1758, Rudjer faced many problems coming from Jesuits, many of whom he knew in person. His work “*Theory of Natural Philosophy*” encountered misunderstanding, disapproval and dispute. The scientific postulates from theoretical physics published in his most complex and most famous work provoked many arguments since they clashed with the Jesuit ideology. Although he explicitly stated the dual nature, both spiritual and material, of the Nature, Jesuit dogma could not accept this concept.

Boskovic used every opportunity to emphasize that all his research of life, spirit and liberty was confined to the field of natural philosophy without entering the domain of religion. Unfortunately, his explanations seemed to cause even more increasing criticism and he left Rome in 1759, never to return. On one occasion he wrote to his benefactor marquis Romagnoli that he thought he would never return to Rome and that he could hardly wait to go to Constantinople where the Turks would treat him much better than Christians. During his stay in Paris, he frequently visited the French Academy of

Sciences a correspondent member of which he had been since 1748. He was also a member of academies of sciences of Rome, Bologna and Holland. Lomonosov himself was present when he was elected a member of the Academy of Science in Saint Petersburg. In England, he was made a fellow of the Royal Society to which he dedicated his poem „*De solis ac Lunaedefectibus*“. Interestingly enough, most of the countries of his residence bore animosity towards Jesuits; nevertheless, Rudjer was everywhere respected as a scientist.

June 1761 was very important for astronomers of the time since the passing of Venus was expected in front of the Sun and, at the urging of the members of the Royal Society, Boskovic travelled to Constantinople to observe this phenomenon. He was too late to observe Venus, but he took the opportunity to examine the ruins of Troy. He applied mathematical and astronomic parameters into his observations and challenged the then-popular idea of Troy’s location, stating that it was further inland – which was confirmed at the end of 19th century by a famous German archaeologist Heinrich Schliemann.

Not yet fully recovered after serious illness, he travelled from Constantinople to Poland via Bulgaria, Romania and Moldavia, having to give up going to Saint Petersburg. He described this almost two-year journey in a diary „*Giornaledi un viaggio da Constantinopoli*“, published in 1762 in Italian and soon afterwards in French, German and Polish. Not only is this travel book an interesting adventure novel about the Balkan region in the middle of the 18th century, but also it offers abundance of data on the Balkan peoples of that period. A successful mixture of science and literature, it depicts the ethnology, ethnography, history, geography, geomorphology, folklore and religion of the region in a terrible state under the Turkish tyranny.

Having travelled all over Europe for four years, in 1763 he returned to Italy, but not to Rome, to work as a professor at the University of Pavia. He was soon offered a post with the directorship of the construction of the astronomic observatory of Brera in Milan as well. He afterwards assumed the optics and astronomy chairs in Milan. Intrigues and a lack of understanding for his work led him to accept an invitation from a friend from Paris to come to the city which had always had appreciation for his research. He was appointed Director of Naval Optics of the French Navy where he devoted himself to perfecting the achromatic telescope. In this period, he participated in heated scientific discussions, both in oral and in writing, with Dalambert and Laplace. In 1782 he returned to Italy and spent two years at Bassano where he published five books about his research during his stay in Paris. Due to illness, he never returned to France. In October 1785 he went to Milan where the first signs of his mental illness appeared. Since the state of his illness aggravated, he died of pneumonia on 13 February 1787 and was buried at the Santa Maria Padone in Milan. In his work, Bošković investigated various fields of science, being ahead of his time in many of them thus encountering a lack of understanding. He left a significant trace in mathematics, physics, statics, astronomy, geodesy, optics, archaeology, philosophy, and even poetry. He is considered to be the first scientist who clearly stated that the matter “is composed of the same particles” and that only “different laws of force make it different”. He claimed that a dimensionless particle is the source of force and that time and space were relative, contrary to Newton, which rightfully makes him the predecessor of Albert Einstein and his theory of relativity. A physicist J.J. Thomson, Nobel laureate, took Boskovic’s “atom model” (1907), which was central for the Bohr Model of the Atom (1913).

Another Nobel laureate, Leon Lederman, wrote in 1993: “Rudjer Boskovic had an idea, completely insane for the 18th century, and may be for any other century. He claimed, no more no less, that the matter consists of particles with no dimensions! Twenty years ago, we found a particle which fits the description. And we called it a quark.” One crater on the Moon has been given Rudjer Boskovic’s name for his extraordinary merits in science, especially in astronomy.



Figure 7: Monument of Rudjer Boskovic by Ivan Mestrovic

In general, there are many organizations (societies, institutes, schools, etc.) which have been named after him. Among them is the Belgrade society –Astronomical Society Ruđer Bošković.

Conclusion

Looking back, it can be said that OTEH 2022 has fulfilled the aims which were assigned. There are many challenges we face and the road is long, with many winding turns. Our community is strong, skillful, dedicated and eager to succeed. Together we can and we will make a difference. We hope that many friendships and cooperation will grow from contacts

made at the OTEH2022 conference. During the two-day Conference, many high-quality and original papers from current research projects were presented, as well as the papers on the research already applied in practice in particular military technology areas.



Figure 8 : One of many presented scientific papers at OTEH 2022

Next OTEH Conference will be held in Belgrade in 2024. We have a great pleasure to invite all of you to participate at the 11th OTEH. We must do even better in the future. Increase the value extracted out of the research and development investments, using the opportunities the OTEH is providing in terms of synergy and accessibility.

Specially thanks to all the participants that were involved in OTEH 2022 organization and especially to our foreign guests. We also want to thank all authors and participants who have shared their work and ideas with us.

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10. Međunarodni naučnostručni skup iz oblasti odbrambenih tehnologija OTEH 2022

Ovaj rad nudi opšte informacije o 10. Naučnostručnom skupu OTEH 2022 organizovanom od 13-14 oktobra 2022. godine u Vojnotehničkom institutu u Beogradu. Takođe je dat sažet pregled istaknutih i interesantnih radova po tematskim oblastima, prezentovanim i prodiskutovanim na konferenciji.

Ključne reči: odbrambena tehnologija, vojna industrija, međunarodni naučni skup, Srbija.