11th International Scientific Technical Conference in the Area of Defensive Technologies OTEH 2024

Elida Vasiljević [1)]
Jelena Krsmanović [1)]

The paper describes the activities of the eleventh scientific conference of researchers engaged in defensive technologies, which was organized by the Military Technical Institute and held in October 9-11, 2024, in beautiful and impressive location of Tara mountain in the Republic of Serbia. After the general presentation of the event and three plenary lectures, majority of 130 accepted papers, which admittedly attracted the most interest, were presented in two days sessions.
This year, OTEH 2024 was held for the eleventh time, 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 armament and military equipment, and to discuss future directions in their development.

Key words: **defense technologies, international scientific conference, defense industry, Serbia.**

Introduction

TRADITIONALLY, at the beginning of October, the Military Technical Institute (VTI) held the international scientific-technical conference in the area of defensive technologies, OTEH 2024, for the eleventh time. In comparison to previous years, this time the location has been changed to the beautiful mountain Tara and its famous hotel "Omorika". The organizer of the eleventh scientific conference was VTI, a scientific research institution with more than seventy-five years (founded in 1948) of tradition in development of armament and military equipment. The organization was supported by the Ministry of Defense of the Republic of Serbia, Ministry of Science, Technologies and Innovations of the Republic of Serbia and Defense Industry of Serbia enterprises.

By now, the Institute developed and adopted over 1600 combat and non-combat systems into the operational use with which, together with the Serbian Armed Forces, many foreign armies are equipped as well.

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.

Figure 1 OTEH 2024 International Scientific Conference

During the 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 technology areas. This year OTEH 2024 was held in a traditional way, but in a different location, which was very welcomed by authors, conference participants and guests.

Figure 2 OTEH 2024 Opening Day

[1)] Military Technical Institute, Ratka Resanovića 1, 11132 Belgrade, SERBIA
Correspondence to: Elida Vasiljević, e-mail: elida.vasiljevic@gmail.com

OTEH 2024 had 182 submitted papers out of which 130 were accepted and included in the Proceedings. The papers were classified into eight topics: Aerodynamics and Flight Dynamics (9), Aircraft (8), Weapon Systems and Combat Vehicles (19), Ammunition and Energetic Materials (12), Integrated Sensor Systems and Robotic Systems (14), Telecommunication and Information Systems (17), Materials and Protection (36) and Quality, Standardization, Metrology, Maintenance and Exploitation (15).

Certain novelties were introduced into the organization of the Conference. The Scientific and Organizing Committees decided to introduce two new sections: Poster Section and Section for Young Researches. The idea of the Poster Section proved very efficient since many authors could not attend the Conference live. They have chosen to present their papers in the poster section and answer eventual questions via email address they have provided. The number of papers presented in this section was 41.

The idea of Section for Young Researchers proved to be very inspiring. Many authors under the age of 35 years applied for this section. The total number of papers presented in this section was 21. The idea was to inspire and encourage young authors to participate such conferences, share their ideas and bring some novelties that would attract more attention to this unique conference. It is also important to emphasize that the Committees decided to award the best presented paper in this section.

The exchange of knowledge the OTEH promotes 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 also participated with their papers. There were 15 scientific papers from 11 foreign countries. Foreign authors and coauthors were from: Germany, Bosnia and Herzegovina, Slovenia, North Macedonia, Portugal, Switzerland, Montenegro, The Netherlands, Czech Republic, Libya, Iraq.

The list of all papers and authors, as well as other information concerning the OTEH 2024, may be found on the website: www.vti.mod.gov.rs/oteh.

The Proceedings can also be found on the platform "SCIndeks Zbornici".

International Scientific Technical Conference OTEH 2024 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 days of the conference, participants could have asked the questions, set remarks and have discussion with the authors.

The Conference was opened by the Head of the Department for Defensive Technologies, Brigadier General Slavko Rakić, PhD Eng, who wished the participants a warm welcome and emphasized that OTEH is a platform for maintaining the existing and establishing a new cooperation between the representatives of domestic and foreign research, development, education and manufacturing institutions. He said that expanding the acquaintances, exchange of new knowledge, experience and skills, a more realistic overview of own scientific results in comparison to others, as well as further improvement, are only some of the benefits for the conference participants. Their presence contributes further development and strengthening of certain areas in defense area, which nowadays presents immeasurable significance of support to maintaining the peace and freedom. He also emphasized that the Ministry of Defense will strive to maintain the positive trend of investing into research and development projects, to strengthen the potential of the research and development personnel, to invest into materiel capacities with the accent placed onto improvement of infrastructure and laboratories.

Figure 3 OTEH 2024 Opening Day

According to the Director of the Military Technical Institute, colonel Ivan Pokrajac, PhD Eng, the Conference aims to provide an opportunity for all domestic and foreign participants in the process of development of armament and military equipment to get to know each other, exchange ideas, knowledge and experiences. He highlighted that a large number of papers proved that OTEH presents a significant conference for the exchange of ideas, knowledge and innovations in the area of defense technologies. "The years of existence and the quality of papers led OTEH to be seen as a recognizable spot of gathering of scientists, researchers, engineers and designers", said colonel.

Figure 4 Director of the Military Technical Institute welcoming the participants

After the opening speech and general presentation of this event, the Conference comprised three plenary lectures which admittedly attracted a lot of interest. The tradition of OTEH is to devote the Conference to a certain famous person who is responsible for certain scientific achievements. This year the Conference was dedicated to the famous scientist of Serbian origin, physicist, chemist and academician Pavle Savić. The lecture on that occasion was given by professor Vladimir Cizelj, PhD, from the Vlatacom Institute of High Technology. The second plenary lecture was given by professor Thomas M. Klapotke, PhD Eng, from Ludwig Maximillian University in Germany and it was on energetic materials. The lecture was entitled "New Secondary Explosives and Oxidizers Developed at LMU". The third plenary lecture was given by colonel Boban Sazdić-Jotić, PhD Eng, from the Military Technical Institute, on artificial intelligence and it was entitled "Artificial Intelligence in Military Application:

Opportunities and Challenges (Fight against Drones)".

The opening was attended by representatives of MoD and SAF, overhaul centers of SAF, representatives of factories of Defense Industry of Serbia and numerous institutions from Serbia and abroad.

The agenda of the scientific conference OTEH included a separate round table organized by the Sector for Materiel Resources, Ministry of Defense of the Republic of Serbia. On that occasion a presentation entitled "Modernization of Defense Industry in scope of the Modernization Process of the Serbian Armed Forces" was held. The representatives of MoD, SAF and Defense Industry enterprises had an opportunity to analyze the previous results, role and potentials of defense industry in support of capabilities of SAF through equipping with new armament and military equipment from domestic development and production. The round table was attended by the Head of the Department for Defense Technologies, brigadier general Slavko Rakić and Head of the Department for Development and Planning (J-5), brigadier general Milan Popović.

Figure 5 A plenary lecture on life and work of Pavle Savić given by Vladimir Cizelj

Professor Vladimir Cizelj, PhD, from the Vlatacom Institute of High Technology in Belgrade held the first plenary lecture on life and work of our prominent scientist Pavle Savić. In his presentation he looked back to the most significant dates in life of this amazing academician, mentioning his achievements, scientific and social recognitions and domestic and international awards.

In the end of his presentation Cizelj thanked to the Military Technical Institute for the idea to have this presentation at OTEH. Professor Cizelj also mentioned that the Vlatacom Institute is preparing a monography on life and work of Pavle Savić.

Life and Work of Pavle Savić

Pavle Savić was a great man not only for our science, yet he was also the first atomic physicist from our country and one of our scientists who was nominated for the Nobel prize. He was a researcher, scientist, revolutionary, warrior, professor, academician and famous for having a sharp tongue.

He was born on January 10th, 1909 in Thessaloniki, Greece. Because of the nature of his father's job, the family was living in different places. During the Balkan wars and the First World War they stayed in Svilajnac, where Pavle started his primary education. After the First World War, they moved to Belgrade where he finished primary school and enrolled the Second Belgrade Gymnasium. He finished the first four grades and the junior prom in Belgrade in 1923. His gymnasium education was completed in Požarevac, where he graduated in 1927. As a pupil he was primarily interested in natural sciences, mathematics, physics and chemistry and, driven by curiosity and imagination, he expanded his interests and work outside the school curriculum. At the same time, he was practicing scouting and radio amateurism, writing essays and participating in the pupil's literary societies. After graduating from the gymnasium, Pavle Savić enrolled the Department of Physics of the Faculty of Philosophy in Belgrade to study physical chemistry. He became a volunteer assistant with Professor Miloje Stojiljković, Head of the Department and the Manager of the Institute for Physical Chemistry. He graduated in June and received a diploma in October 1932. After he finished his service in the Royal Yugoslav Army in Sarajevo, he was working as an assistant at the Department of Physics at the Faculty of Philosophy. Due to a personal disagreement with professor Stojiljković, he resigned his position and started to work as an assistant with Professor of Physics at the Medical Faculty in Belgrade, Dragoljub Jovanović, a former associate of Maria Curie at the Radium Institute in Paris. In 1934, up on the recommendation of Professor Jovanović, Savić was appointed permanent assistant at the Radiology Institute of the Medical Faculty in Belgrade.

Figure 6 Pavle Savić

In 1935 he was awarded a scholarship for scientific education in France and at the end of the year he came to Paris with his wife Branka, whom he married in 1934. He worked with Irène Joliot-Curie and Frédéric Joliot on interactions of neutrons in the chemical physics of heavy elements, and they published a number of papers together. This turned out to be an important step in the discovery of nuclear fission. They were nominated for the Nobel prize in Physics, but the prize hadn't been awarded during the Second World War. The same issues were researched by a number of other scientists, including Enrico Fermi, Lise Meitner, Otto Hahn, Fritz Strassmann and others, but in 1944 the Nobel prize was awarded for the discovery of fission to Hahn.

In 1937, at the time when a bloody civil war against profascist coalition broke in Spain, Pavle Savić was the right candidate for the president of the Association of Yugoslav Students. At that time, he met Boris Kidrič. His engagement in the association that lasted more than two years and day and night work in the Radium Institute which was becoming more and more intense were all together very demanding and required a great effort. In June of 1939, just when the difficulties related to the uranium testing on the Radium Institute were at their peak, Savić was admitted to the Communist Party of Yugoslavia. As the international affairs at the time became more turbulent, he was expelled from France

and he returned to Belgrade where he started to work as the full professor at the Physical Chemistry at the Pharmaceutical Department of the Faculty of Medicine. He remained on this position until the beginning of the Second World War in Yugoslavia in 1941 and continued illegal activities at the university as the member of the Communist Party of Yugoslavia. In the laboratory of the Institute for Chemistry at the Faculty of Medicine he constructed illegal radio station which was destroyed in bombing of Belgrade in April 1941. At the beginning of the occupation, he continued his illegal activities in Belgrade. Soon, he and his wife left Belgrade to avoid capture, eventually arriving in the liberated Republic of Užice. From Užice a radio connection with Moscow was established, and Pavle Savić started his duty as a cipher officer in the Supreme Headquarters of the National Liberation Army and Partisan Detachments of Yugoslavia. In the large explosion at the ammunition factory in Užice, which occurred on November 22nd in 1941, Savić suffered burns to face and hands.

In 1942, as a member of the AVNOJ (Anti-Fascist Council for the National Liberation of Yugoslavia) Executive Board, he became a President of the Education Department. The Department immediately started to work. Pavle Savić stayed with the Supreme Headquarters only until July 1943, when he fell into disfavor with the highest leadership and was removed from all his duties. He was again promoted in the military in 1944 and sent on a mission to the Soviet Union. The goal of the mission was to organize the Soviet help for the National Liberation Army of Yugoslavia, obtain credit and distribution of the foreign aid and investigate possibilities of the international recognition of the new government.

Approximately one month upon his arrival to Moscow, Pavle Savić engaged in scientific work and research with the head of the Institute for Physical Problems, Pyotr Leonidovich Kapitsa. Savić spent two years working there. Kapitsa was a great physicist involved in a very wide range of research and a pioneer of the physics of the strong magnetic fields. He developed a method for production of large quantity of liquid oxygen. This invention significantly improved production of high-quality steel in the Soviet Union during the Second World War.

In the institute Savić became interested in liquid helium, unique element whose superfluidity was discovered just before the Second World War. He was conducting experiments related to the phenomena resulting from changes of the properties of thin surface film of the liquid helium. In a very short period, he mastered the technique of working with liquid helium and conducted tens of various experiments.

At the height of the most intensive research, Savić was requested to return to Yugoslavia. In Belgrade, after many years of war, he was reunited with his family members. A year and a half later he returned to the Institute. This time he stayed in Moscow for an approximately one year and continued to research properties of the liquid helium.

Shalynikov was helping him in his experiments, and they observed that at the transient from liquid to super liquid helium, particles floating in the substance lose their stability and fall. In 1958 Pavle Savić was elected a foreign member of the Academy of Sciences of the Soviet Union.

Immediately after the liberation of Belgrade, Savić joined in the renewal of the work at the Belgrade University. In September 1945 he was elected a full-time professor at the Faculty of Philosophy in Belgrade, and later the vice-president of the Belgrade University, corresponding member of the Serbian Academy of Sciences and Arts in 1946 and a full member in 1948.

Figure 7 Pavle Savić in Vinča

In September 1946, when he came back from the Soviet Union, Pavle Savić started to work on the construction of the Institute of Physics in Vinča. He devoted all his strength and will to these works, designed and monitored the construction of the most of the initial laboratories (for physics, chemistry and biology) living close to the building site. Savić was the principal of the Institute Vinča from 1960 – 1966, but due to the political disagreements he left the institute and returned to the University.

Until the very end of the Socialist Yugoslavia, which he outlived, with his great scientific and party authority, Pavle Savić had a prominent role in the sociopolitical, educational and scientific life of the country. His work was internationally acknowledged and rewarded, he was a member of all Yugoslav academies of science, president of SANU (Serbian Academy of Sciences and Arts) from 1971 to 1981, but also a member of the Academy of Science of USSR (1958), New York Academy of Science (1960), Hungarian Academy of Science (1970), Academy of Athens (1975), etc.

He was awarded the French Legion of Honor twice, he received the Lomonosov Gold Medal and Rutherford Medal. He also received prominent awards of the former Yugoslavia, 7th July Award in 1950 and AVNOJ award in 1966.

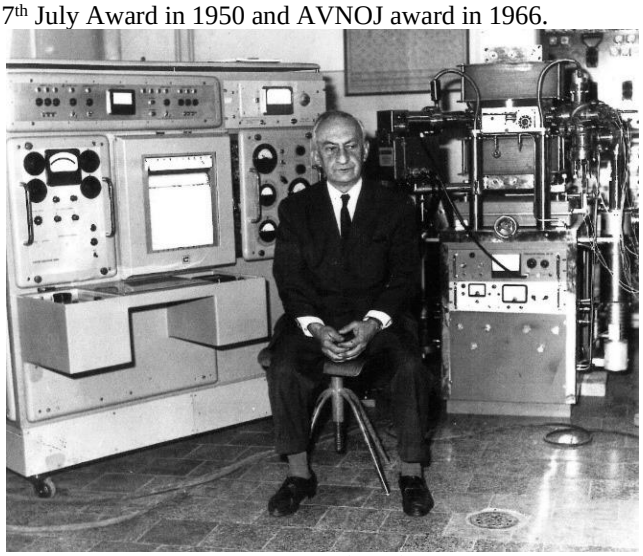

Figure 8 Pavle Savić

In addition to his scientific activities, managing the institute in Vinča, research of the nuclear energy, coordination of the international nuclear cooperation, promotion of peaceful uses of nuclear energy, work at the University and SANU, he was constantly making contribution to creation of the general Yugoslavian scientific and educational politics.

Savić is known for his knowledge and respect for humanist sciences and his philosophy of life that humanist and natural

sciences together can create an opportunity for overall comprehension of the society and the nature. He died at the age of 85 in 1994 in his home and was buried in the family tomb in Belgrade.

The path life of Pavle Savić was demanding and difficult, yet it was definitely amazing. He encountered injustice, but also knew of high recognitions.

Plenary lectures

The second plenary lecture was given by professor Thomas M. Klapotke, PhD Eng, from Ludwig Maximillian University in Germany and it was on energetic materials. The lecture was entitled "New Secondary Explosives and Oxidizers Developed at LMU".

The paper is about the energetic materials research group at LMU that was interested in the synthesis and energetic properties of new explosives and rocket propellant ingredients for many years. Out of the many interesting compounds which they prepared over the years, the most promising candidate compound for use in real-life applications was the secondary explosive TKX-50. An overview of the synthesis and properties of TKX-50 was given, as well as recent aspects investigated. The progress and development of new CHNO-based oxidizers were discussed, focusing predominantly on 2,2,2-trinitroethyl formate (TNEF) and bis(trinitroethyl) oxalate (BTNEO).

Although there is much more work to be undertaken to assess whether TNEF has a future as an oxidizer in applications, initial investigations showed that it has promising properties and is worth investigating further.

Figure 9 Plenary lecture given by a guest from LMU in Germany

The third lecture was given by colonel Boban Sazdić-Jotić, PhD Eng, from the Military Technical Institute on artificial intelligence and it was entitled "Artificial Intelligence in Military Application: Opportunities and Challenges (Fight against Drones)". Nowadays, we are witnessing artificial intelligence and drones shape the most transformative technological field. The central segment of the lecture delved into the utilization of artificial intelligence (AI) within the military with a specific focus on its potential benefits and associated challenges. Additionally, AI applications designed to combat the proliferation of drones were presented.

Section for Young Researchers

There were three sessions organized in scope of the Section for Young Researches including 21 presented papers. The original idea was to award the best presented paper in order to encourage young researchers in expressing their ideas and work. The Election Committee for selecting the best presented paper was made by professors from the Military Academy, Faculty of Mechanical Engineering in Belgrade and Faculty of Technology and Metallurgy in Belgrade. The papers praised by the Election Committee are as follows: "Testing the Roll Stabilization of a Supersonic Surface-to-Air Guided Missile" – by Marijana Stojanović, "Failure Analysis of Welded Joint between Rocket Motor Case and Fins" – by Aleksandar Ćitić, "Design and Verification of a Pneumatic Launch System for a Single-Use UAV with Warhead" – by Marko Bek-Uzarov. The best presented paper was "Probability of Hitting and Destroying a Surface Target for Artillery Rockets" - by Katarina Nestorović.

Figure 10 Awarded young researchers

The best awarded paper deals with medium and long range artillery rockets used on the battlefield for indirect firing of distant targets. Having a large dispersion of hits, they are used for targeting surface areas from multitube launchers. At the same time, the line of sight of the target does not exist, so the firing elements are taken based on the known geographical coordinates of the target and the launcher, using the ballistic computer and firing tables. Long ranges, low initial velocity and long duration of the flight to the target make such rockets very sensitive to the impact of disturbances on the accuracy of hitting. As the range increases, the accuracy of rocket systems decreases even more. At the same time, a large number of rockets is counted for effective coverage of the target area. Firing a target area with a large number of rockets involves a statistical approach to determining the efficiency of the firing. Thereby, statistical indicators of the distribution of impact points are used, such as the circular error probable, which represents the radius of the circle that contains half of all hits. In addition to the number of rockets with which an area is targeted, the probability of destroying all targets in the area also depends on the radius of the lethal effect of the warheads. This paper presents determination of the probability of hitting and destroying a surface target.

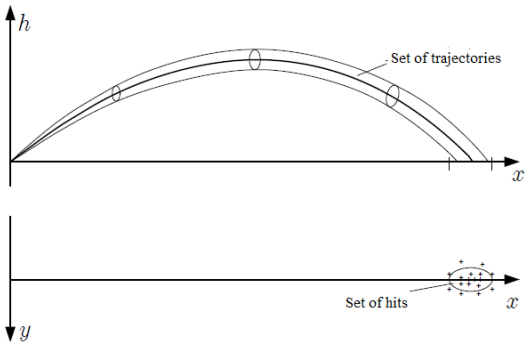

Figure 11 Dispersal of artillery projectiles

A numerical and comparative analysis of the probability of destruction of a surface target with dimensions of 150 x 100 m by rocket artillery was performed. Numerical analysis is

performed assuming that the target destruction probabilities are known and that the number of rockets required in order to neutralize the target is unknown. There were two cases at different ranges under the same conditions. For both cases, the assumption is that probable deviations and standard deviations in range and direction are known.

Simulations and comparative analyses were performed in order to optimize ammunition consumption and to reduce collateral damage for the same target at a different range. As the range of artillery rockets increases, the probability of destroying the target decreases and the number of rockets required to disable the target increases exponentially. A proposal for further research is to focus on increasing the accuracy of artillery rockets at longer ranges. One way to do this is to install special precision guidance kit (PGK) correction modules.

Conclusion

After analyzing months of work on the mission to hold a successful Conference, it can be said that OTEH 2024 has fulfilled the aims which were assigned. There were many challenges we faced and the road was long, with many winding turns. Our team was strong, skilful, dedicated and eager to succeed. Together we did our best to cope with all the barriers we came upon and to succeed. We hope that many friendships and cooperation grew from contacts made at the OTEH 2024 conference, especially since the location of the mountain Tara provided the opportunity to do so. During the 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. The authors presented their papers, and after each presentation a time was given for further discussion and questions.

Next OTEH Conference will be held in 2026. The location is still to be considered. We have a great pleasure to invite all of you to participate. We set goals and we must do even better in the future by increasing the value extracted out of the research and development tasks, using the opportunities the OTEH is providing.

Figure 12 OTEH 2024 session

We would like to express special thanks to all the participants involved in OTEH 2024 organization and especially to our foreign guests. We also want to thank all authors and participants who have shared their hard work and brilliant ideas with us.

Received: 03.03.2025.
Accepted: 14.03.2025.

11. međunarodni naučno stručni skup u oblasti odbrambenih tehnologija OTEH 2024

Rad opisuje aktivnosti jedanaeste naučno stručne konferencije istaživača u oblasti odbrambenih tehnologija, organizovane od strane Vojnotehničkog instituta i održane od 9. do 11. oktobra 2024. godine, na predivnoj lokaciji planine Tara u Srbiji. Nakon opšteg uvoda u događaj i tri plenarna predavanja, većina od 130 prihvaćenih radova, koji su neosporno privukli najviše interesovanja, prezentovani su za vreme dvodnevnih sesija.

Ove godine, OTEH 2024 je održan po jedanaesti put, potvrđujući izuzetne mogućnosti na osvrt na sva dostignuća odbrambene tehnologije, razmenu znanja i iskustva u navedenoj oblasti, jačanje postojećih i uspostavljanje novih oblika saradnje među povezanim institucijama po pitanju razvoja savremenog naoružanja i vojne opreme, kao i diskusiju po pitanju budućih pravaca njihovog razvoja.

Ključne reči: **odbrambene tehnologije, međunarodna naučna konferencija, odbrambena industrija, Srbija.**