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Seventh Decade of the Military Technical Institute (1948. – 2013.)

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This year the Military Technical Institute of the Republic of Serbia marks 65 years of its existence. The realized projects make it the most significant scientific-technical institution in Southeastern Europe and one of the most renowned worldwide. Since its formation, 3rd November 1948, numerous weapons and military equipment items based on the Institute's projects have been introduced into operational use not only in the Serbian Army but also in many other armies throughout the world. The main achievements have been in the area of aviation, classic and rocket artillery as well as combat and non-combat vehicles.
This text presents the major realized projects stemming from this scientific-technical institution of Serbia.

AFTER the international recognition at the Berlin Congress in 1878 preceded by two uprisings at the beginning of the 19th century (1804 and 1815), Serbia finally overthrew almost 5 centuries of Turkish occupation and tyranny and started to create its regular army based on the most sophisticated European military doctrine and materiel of the time. The planned equipping of the Serbian army with armament and military equipment (NVO) of domestic production started soon after the conference in the former Serbian capital of Kragujevac in 1837, when Prince Miloš Obrenović's initiative to build a foundry there was endorsed. The main objectives were to equip the Serbian army independently from the political infuence of foreign countries, to reduce expenses for equipment and to put the population to work.

Figure 1. VTI Headquarters

The setting up of a foundry in 1851 in Kragujevac can be considered as a birth of modern military industry not only in Serbia but also in the Balkans region, even in the middle Europe. The first cannons branded with the Serbian coat-of-arms came out of from the foundry in 1853, which means that this year Serbia also marks the 160-th anniversary of military industry, followed next year by the 90th anniversary of aviation in the region.

In the Kingdom of Yugoslavia (1921. – 1941.), which stemmed from the Kingdom of Serbia after WW1, Serbia was considered to be the leader of military industry development. One of the best combat airplanes of that period, IK-3, very successfully defended the skies over Belgrade against far overpowering Hitler's aviation in 1941. Owing to its maneuverability as well as the patriotism and skill of its pilots, IK-3s achieved a kill ratio of 4:1 [10]. At that time, the world was also taken by surprise by Belgrade's work on an electromagnetic gun [4].

Being an imperative for the political and military independence of the country, equipping the Army with NVO from domestic production was always a priority, and soon after the end of WWII, the Military Technical Institute (VTI) was founded on November 3rd 1948 in the former FNR Yugoslavia, with Serbia as its integral part, by a decree of the then Chief of General Staff of the Yugoslav army and the Assistant Defense Minister – General Koča Popović.

The VTI has always been the leader of the development and production of modern NVO in the region, and judging by the projects realized so far, it is one of the most renowned scientific institutions of its kind in the world. After having its headquarters at Katanićeva Street 15, Belgrade, it relocated outside Belgrade, to Žarkovo, in 1992, where it merged with its aeronautical part.

Figure 2. VTI Wind Tunnel Complex

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Since the foundation of the VTI, over 1,000 weapons and military equipment items have been introduced into operational use in the Serbian Army and different armies on different continents. The major achievements were in the areas of military aviation, classic and rocket artillery, combat and non-combat vehicles, infantry armament, ordnance, infantry and artillery ammunition, protection equipment, telecommunications, rocket propellants, special materials, etc [1-3,5].

Classic armament

During these 65 years, the VTI has developed a number of small arms of different calibers. After WWII, the development of small arms - 7.9 mm rifle M48, 7.62 mm automatic gun M49 and M56, 7.62 mm pistol M57, 7.9 mm machinegun M53- stemmed from the fact that after the war a huge amount of ammunition of these calibers remained in the country and could be used, and from the fact that the production of particular ammunition models, 7.9 mm above all, had already been conquered during the war.

Figure 3. Machinegun M72 with passive night sight

The end of 1950s saw the cooperation with ZASTAVA, Kragujevac, on the development of 7.62 mm small arms - the semi-automatic rifle M59/56 was followed with a bolt-action automatic weapon family such as kalashnikov (automatic rifle M70A and machinegun M72). At the beginning of the 1980s, a generation of light small arms of small caliber (5.56 mm and 5.45 mm) with great stopping power was developed.

At the beginning of 21st century, the development of the 9mm M97 submachine gun intended for special operations units and the 5.56 mm M21 automatic rifle with the 40 mm underbarrel grenade launcher was successfully completed and they were introduced into service in the Serbian Army. Besides the silencer and the laser target indicator, compatible ammunition has been conquered for both weapons as well as for the underbarrel grenade launcher.

Figure 4. Automatic rifle M21 with the underbarrel grenade launcher and the optical sight

The development of classic artillery for fire support represents one of the most significant and most fruitful expert areas that the VTI has been dealing with. During these 65 years, three generations of artillery weapons have been developed and introduced into the operational use in the Serbian army and many other foreign armies.

Figure 5. 9mm submachine gun M97

The first generation of artillery weapons for fire support includes: 76 mm M48 mountain gun, 120 mm M52 mortar and 105 mm M56 and 155 mm M65 towed howitzers. The second generation includes: 82 mm M69 mortar, 120 mm M74 and M75 light mortars, 122 mm D30J towed howitzer and 152 mm towed gun-howitzer NORA-A. The third generation includes: 152/155 mm M46/86 converted gun on the gun-carriage for the 130 mm M46 towed gun, 152 mm self-propelled gun-howitzer NORA-C and 152/155 mm self-propelled gun-howitzer NORA-B on the chassis of an 8x8 terrain wheeled vehicle. The latest artillery weapon under development is the 122mm self-propelled howitzer SORA mounted on a 6x6 chassis.

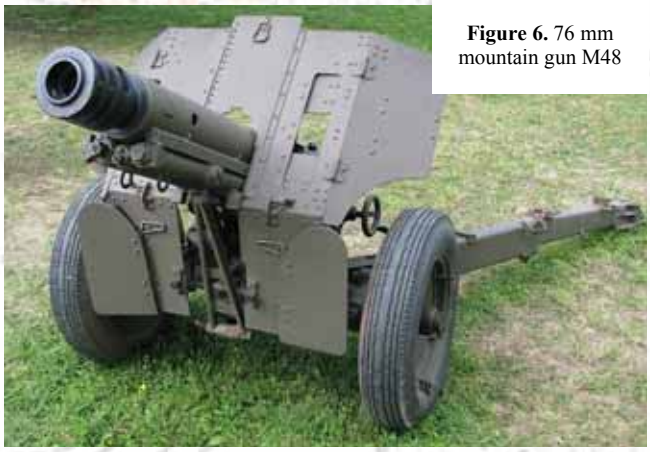

Figure 6. 76 mm mountain gun M48

The development of the first artillery weapon, the 76.2 mm M48 mountain gun, started in 1947 when the entire country was under immediate danger of war from the countries belonging to the Warsaw Pact. This gun, with a maximum range of 8,600 m, with its tactical-technical characteristics, reliability and simplicity of maneuvering, was considered for a long time to be one of the most successful solutions in its class in the world and as such was introduced into operational use in many foreign armies. In 1950s, this gun was the first export deal of the former Yugoslav military industry.

Immediately after the end of the first phase of the development of the M48 mountain gun, the development of the 105 mm M56 howitzer started with a goal to design a 14km-range weapon. In a relatively short period, by the end of 1957, the development was completed and the decision to introduce it into operational use was made. The latest modernization resulted in a 33 caliber barrel. This howitzer

has been the most exported model of the Yugoslav military industry from the category of artillery weapons and is still operational in several foreign armies.

Figure 7. 105 mm howitzer M56

Through the programs of modernization and enhancement of artillery firepower, based on the 155 mm M1 American howitzer and the 122 mm D30 Soviet howitzer, domestic versions of these howitzers were developed., Besides its work on the development of new weapons, the Institute followed the trends in modern artillery and worked on the conversion of the 130 mm M46 gun into the M46/86 converted gun. The mounting of 152 mm and 155 mm barrels onto the gun carriage of the M46 towed gun resulted in a very reliable and robust modern artillery system with respectable ballistic performances and significantly higher effectiveness.

In the middle of the 1970s, the VTI started developing the 152 mm M84 towed gun-howitzer with an extended range, introduced into operational use under the name NORA-A in 1984. In the category of 39 caliber barrel length artillery weapons, NORA-A represented a weapon with respectable fire support achieving the maximum range of about 24 km with a muzzle velocity of V_0= 810 m/s.

The story of NORA does not end here. The 152 mm self-propelled version NORA-B on the chassis of a modified, serial, terrain vehicle FAP 2832 was the first to be developed, and then the chassis on the vehicle KAMAZ was developed in cooperation with the company JUGOIMPORT-SDPR on demand for foreign customers.

Figure 8. 152 mm towed gun-howitzer NORA-A (M84) at a fire position

This weapon currently represents the main exporting item of the Serbian military industry.

The 155 mm self-propelled gun-howitzer NORA-B52 with 52 caliber barrel length was intended for general fire support of units with direct or indirect fire up to 41 km of range. This weapon was realized, depending on the customer request, with closed or open installation of weaponry (without turret) and mounted on the chassis of an 8x8 truck A high-efficiency muzzle brake and a breechblock with a horizontal sliding-wedge breech mechanism were fitted. The chamber self-sealing system was installed so that caseless ammunition can be used. This weapon with a mass of 31000 kg in the marching position has a maximum speed of 70 km/h and an autonomy of 500 km.

Intended for fire support to units up to the brigade level, the self-propelled howitzer SORA is in the final development phase. It represents a modified and upgraded version of the well-known 122 mm towed howitzer D-20J. Mounted on the modified platform of the FAP2026 6x6 all-terrain wheeled vehicle, with a total weight of about 18000 kg, this artillery system has an operational range of over 500 km. The maximum range is about 21,500 m with a fire rate of 6 rounds/min. Besides the automatic feeding and a combat kit of 40 different-purpose rounds, the weapon has a system for automatic combat to march position switching.

Figure 9. Self-propelled 155 mm gun-howitzer NORA-B52

Figure 10. 122mm self-propelled howitzer SORA

The 120 mm mortar M52 was tactically very useful for application and transport owing to the use of a recoilless device, firing from wheels and easy dismantling for transport on towing animals. Being one of better technical solutions in 1950s worldwide this mortar was used for fire support in the Yugoslav army as well as in many foreign armies for more than two decades.

Figure 11. 120 mm mortar M95

In the middle of 1970s, mortars of this caliber were upgraded, and light mortars M74 and M75 were developed and introduced into service. They became the basic fire support for infantry battalions and led to the 120 mm towed long-range mortar M95.

Figure 12. 82 mm recoilless gun M79

The development of classic antitank weapons started with the development of portable mortars RB M49 and RB M57 and the 82 mm towed recoilless gun M60 with compatible projectiles. Mounting two recoilless guns onto the armored personnel carrier OT M60 resulted in a self-propelled variant for antitank protection of mechanized units. The mobile 82 mm recoilless gun M79 with a new optical sight was developed in the 1970s.

Figure 13. 100 mm antitank gun TOPAZ

In the middle of 1980s, a unique procedure was applied in the development of the 100 mm antitank gun M87 TOPAZ which had strong firepower, high accuracy and high firing speed. The ballistic solution of the gun followed the solution for the 100 mm gun T-12. The three-trailed carriage obtained by the modification of the 122 mm howitzer D30J carriage enables the weapon to be quickly traversed through 360° and through a field of -5° to 18° by elevation. A special day/night fire control system M91 enables a moving target first-hit probability higher than 70%. With a muzzle velocity of V_0= 1575 m/s, the effective range of the TOPAZ with moving targets 2 m high is 1,880 m, and for targets up to 3 m in height it is 2,230 m. The maximum range is 8,200 m.

The 100 mm coastal gun TON was developed and introduced into service in coastal defense, in stationary and towed variants with semiautomatic ammo reload. The SUVOA fire control system was developed for automated coastal artillery.

Figure 14. Stationary version of the 100mm coastal gun TON

In addition, the VTI has developed and upgraded the entire range of anti-aircraft guns with calibers 20, 30 and 40 mm in towed and self-propelled versions that showed to be very effective in close anti-aircraft defense. They proved particularly successful in the defense of Serbia from the NATO aggression in 1999 when dozens of TOMAHAWK missiles and UAVs were shot down.

Figure 15. 20/3mm self-propelled anti-aircraft gun BOV-3

The VTI started to develop anti-aircraft artillery in the 1950s, first in 20mm. After the single-barrel 20/1mm M55 and the three-barrel towed version 20/3 M55, the coastal four-barrel version, 20/4 mm M75, and the self-propelled three-barrel version mounted on a 4x4 armoured vehicle, the 20/3 mm BOV-3, were developed. The latest modernization, with eight turret-mounted STRELA-2M rocket launchers, enhanced the range of this self-propelled version from 2,000 m to 4,200 m in azimuth and 2,500 m in elevation.

Figure 16. 100mm round with a subcaliber projectile and a hard-core penetrator

There is a long tradition in the production of small arms and artillery ammunition in Serbia. Even during WWII in Western Serbia, in Užice, in the autumn of 1941, in the then only free territory in the occupied Europe, small arms ammunition was being produced. Continuing this tradition, the VTI developed and offered expertise help to military industry with the development and conquering the production of different calibers of ammunition intended for classic armament.

Figure 17. 125 mm projectile for the M-84tank

New propellant charges and modern HE and cluster projectiles with gas generators were developed for artillery weapons. In the area of antitank combat, 100 mm and 125 mm shaped charges, anti armour and sub-caliber projectiles were developed. The introduction of ERA led to the development of sub-caliber projectiles with hard-core penetrators and projectiles with tandem-shaped charge warheads. For all these projectiles, entire families of special fuses were developed [1-3, 5-7].

Rocket armament

In 1955, the VTI started with research and development in the area of rocket technology, with a 57 mm unguided air-to-ground rocket. In the area of missiles, the first projects were the two-stage ground-to-air missile VULKAN with a range of 30 km and the antitank missile SKAKAVAC with a range of 1,600 m.

Figure 18. Firing a PLAMEN rocket from the M63 rocket system

The first experiences in the design of multiple rocket launchers are connected to the towed rocket system M63 PLAMEN, a weapon with 32 launching tubes from which 128 mm projectiles were fired at 8.6 km. With the modernization of this system, a self-propelled version of a multiple rocket launcher with a range of 12.6 km was developed under the name M94 PLAMEN-C and introduced into service in the Serbian army.

Figure 19. Self-propelled rocket system M94 PLAMEN-C

The next step in the development of this kind of weapons was a self-propelled multilaunch rocket system M77 OGANJ with a range of 20 km. This powerful fire support system is mounted on a 6x6 vehicle FAP2026, with a 32-tube launcher and a charger that enables firing of two 128 mm rockets

Figure 20. Self-propelled rocket system M77 OGANJ during firing

subsequently. A single-barrel portable long-range rocket launching system, suitable for partisan warfare, was developed from the same system.

The last in the development series of this kind of weapons is a long-range self-propelled multilaunch rocket system – M87 ORKAN. The development of this completely automated rocket system with great maneuvering capabilities and with a range of 50 km enlisted our country in a group of few countries in the world that developed and produced similar systems; therefore, it is no wonder that since 1988 it has been included into the armament of some foreign countries. Owing to its TV corrector, the ORKAN system has a 262 mm rocket of a particularly high precision which can follow four different ballistic trajectories for the same range of activating aero-dynamic brakes. The rocket is highly effective at a target owing to a cluster bomb with bomblets and antipersonnel obstacle mines.

Figure 21. Self-propelled multilaunch rocket system M87 ORKAN

The upgrade of the original version of the ORKAN system mounted on an 8x8 wheeled vehicle from the Serbian manufacturer of special terrain vehicles FAP resulted in a four-cylinder system M96 LUNA mounted on a Russian 8x8 terrain wheeled vehicle MAZ, with similar ballistic characteristics.

Figure 22. Self-propelled multilaunch rocket system M96 LUNA at a firing position

Continuing the tradition of developing multiple rocket launchers, the VTI has been working on the development of the modular self-propelled rocket launcher LRSVM (Morava) which is capable of launching a number of rockets of different calibers and ranges for maximum impact at the battlefield. The launching platform has two launching containers with 12 or 16 launching tubes, depending on the rocket type and caliber.

Figure 23. Modular multi-launch self-propelled rocket system LRSVM (MORAVA)

At the beginning of the 1970s, the VTI started the development of antitank unguided rocket systems intended for close antitank combat. Portable rocket launchers OSA and OSA were introduced into service by the end of 1970s. In OSA launchers, the application of composite materials and aluminum alloy has given higher performances with reduced mass and a possibility of firing up to 1,000 rounds from the same tube. When fired from this launcher, the 90mm rocket with a hollow-charge warhead penetrates up to 400 mm into homogeneous armored steel over the effective range of 350 m.

Figure 24. 90 mm portable rocket launcher M79 OSA

The 64 mm rocket launcher M80 ZOLJA belongs to a class of portable, single-use antitank rocket launchers firing hollow-charge warhead rockets with the penetrability of over 300 mm and the effective range up to 200 m. In 1990, this family of short-distance anti-armour launchers got a new member, the 120 mm M91 with 800 mm of penetrability and 250 m of effective range.

Figure 25. Antitank launching kit MALJUTKA-2T with the tandem warhead

By the end of 1960s, in the area of antitank guided rockets, the Institute was the leader in conquering the production of MALJUTKA rockets using the licensed documentation. During the production and exploitation, the system was upgraded with the semiautomatic guidance system and enhanced penetrability. The rocket armed with the cumulative tandem warhead penetrates 800 mm into homogeneous armor. Beside the basic mobile variant, the system is used on GAZELA helicopters (XH-42M) and combat armoured vehicles (POLO-M83) intended for antitank combat up to 3,000 m. The system is also mounted on a turret of the infantry fighting vehicle BVP M80A1.

Figure 26. GAZELA (HN-42M) helicopter for antiarmour combat

The antitank rocket system BUMBAR is a light portable antitank weapon intended for combat up to 600 m (1,000 m with a modification). Although being primarily an anti armour weapon, the BUMBAR has a much wider range of combat capabilities.

Figure 27. Antitank guided rocket system BUMBAR

The multifunctionality of the BUMBAR system is achieved by applying alternative warheads against bunkers and other fortifications. The minimum effective range of 60 m and its use from confined space make this system very practical for urban combat and antiterrorist actions. The system consists of the 136 mm rocket of 250 m/s speed and the tandem warhead capable of penetrating over 1,000 mm of RHA. The rocket can be launched from the shoulder in standing or kneeling position as well as from a tripod while lying, which improves effectiveness. The BUMBAR is equipped with an anti-jamming system based on sequential-differential image processing and time-frequency and space discrimination.

The VTI has currently been developing two robotized combat systems, a mobile one, MILICA, and a stationary one, APOS. The MILICA is a wireless remote-controlled system for anti-armour combat and tactical level destruction of fortifications, mounted on a crewless tracked vehicle. It is 1,900mm long, 800mm high, weighing about 250kg and with an operational autonomy of 2h. The system is of a modular type, with easily changeable purpose and armament types. The wireless remote-controlled platform is armed with a 90 mm anti-armour missile system OSA with two launchers and a surveillance sighting camera or with a 120mm anti-armour missile system M-91. The MILICA can be deployed in all weather conditions and in all terrains, from a 500m remote commanding post that can serve several such systems.

Figure 28. Mobile modular robotized anti armour system MILICA

The APOS is a stationary wireless remote-controlled system for close anti-armour combat and destruction of fortifications at the tactical command level. Its main purpose is to replace a gunner at dangerous tasks of launching missiles from distances closer than 250 m. The system is of a modular type with the operational autonomy of up to 6h and a commanding post distance up to 1,000 m.

Figure 29. Stationary modular robotized ant armour system APOS

From 1970 and 1990, based on the licensed documentation, the VTI started with conquering the production of the light mobile anti-aircraft system STRELA-2m and the self-propelled system STRELA-10M2. At the beginning of the 80s, the STRELA-2M rocket was modified in order to enhance the effectiveness of the warhead with the miniaturization of the homing head electronic block and by introducing digital signal processing. The miniaturization was achieved by developing specially integrated circuits. The warhead effectiveness at target was increased for 30%, which resulted in introducing this system into operational useI in 1984. This mobile antitank rocket system proved to be very effective in the defense of Serbia against the NATO aggression.

Figure 30. Self-propelled anti-aircraft rocket system STRELA-10M2J

The self-propelled anti aircraft rocket system STRELA-10M2J was the modification of the basic version. The complete combat system is mounted on an amphibian tracked vehicle. The installed subsystems for target acquisition and identification allow manual and automatic fire-and-forget rocket launch in the infrared and photo channel. The combat kit consists of 10 rockets, which represents an increase of 20% when compared to the licensed solution. The effective range is 5,000 m in azimuth and 3,500 m in elevation.

The VTI also worked on the development of HE air-to-ground missiles MUNJA and GROM with radio guidance and GROM-B with TV homing. Special purpose rockets were also developed, such as: flare rockets SVITAC and KOMETA and the rocket target simulator ISKRA.

An important place in the development of aircraft equipment has been reserved for rocket motors for ejector seats in ORAO and G-4 SUPER GALEB aircraft since 1997. The conquered production of these rocket motors makes the VTI one of rare scientific institutions in the world that has successfully solved the problem of ejecting pilot seats in case of danger.

Figure 31. Missile system RL-4M

While Serbia was defending its right to existence in 1999, when 19 NATO members headed by the USA attacked it without any UN decision or declaration of war, and while their actions over civilian (maternity wards, hospitals, convoys of refugees, passenger train, buses, densely populated areas, TV stations, etc.) and military objects primarily included air strikes, the experts from the VTI with the help of the "Moma Stanojlović" Aircraft Overhaul Facility experts, carried out modifications on IR A-A homing missiles to enable their launching from the ground. After only 40 days from the beginning of the aggression, two such systems (RL-4 and RL-2) were introduced into service, proving to be very efficient and confusing for the enemy since A-A missiles were launched without any aircraft around.

Both of these systems were realized on the PRAGA vehicle from which 30 mm guns (30/2) were previously removed. The RL-2M system is based on the RL-60MK missile, and the RL-4M system on the R-73 missile. Since there was no initial boost from the aircraft, booster engines were incorporated into missiles in order to provide a sufficient range. Interestingly enough, many countries have followed this design principle in ground anti-aircraft missile systems based on air-to-air missiles [1-3, 5-7, 12].

Combat and non-combat vehicles

In the area of combat vehicles, the VTI has been engaged in developing tanks, armored personnel carriers, infantry fighting vehicles and their modifications. The Institute started with tank development in 1954 after the decision had been made at the highest level to develop a domestic medium tank.

Figure 32. M-636 tank

Based on the Institute's own design solution and on the best tank from WWII, T-34, two different prototypes, M-628 and M-636, were produced. All further activities concerned the M-636 model. The experience gained in these projects was invaluable for the creation of expert scientific staff who later worked on a top quality M-84 tank.

The T-84 tank was created at the beginning of the 1980s as a result of extensive research that led into significant modifications of the licensed T-72 tank. Over 20 new types of materials were conquered as well as a new fire control system; ballistic protection of the front parts and the turret was increased; new tracks with disassembling rubber footboards for on-road drive were developed as well as a new cooling system, two-part air purifier, fuel explosion and fire protection device and many other systems and subsystems. With its significantly lower silhouette, a power-to-weight ratio of 18 kW/t, increased mobility and extreme maneuverability owing to its 735kW engine and modern transmission, with a 125 mm smoothbore gun with automatic loader, this tank was among the best tanks of its generation and, consequently, in operational use in many armies.

Figure 33. M-84 tank

The modification of the M-84 tank in 1994 resulted in the M-84K command tank; this version was equipped with different telecommunication systems, depending on its type, battalion or brigade one.

The beginning of this millennium brought the modified M-84 with increased fire power, maneuverability and ballistic protection.. The tank labelled M-2001 (M-84AB1) is as sophisticatied as the T-90S tank and it can compete successfully with Abrams, Leklerk, Leopard, etc. When compared to the M-84, this tank has the easily exchangeable 125 mm gun barrel,(without turret removal) which, besides standard projectiles, fires laser-guided projectiles with the effective range extended from 2,500 m to 5,000 m.

Figure 34. M-2001 tank

The M-2001 tank has a new system of dynamic protection installed into armor, a system of optoelectronic neutralization of STORA guided projectiles and a 1,200 hp power group. It is equipped with a number of new systems and devices that will make this tank very up-to-date in the decade to come.

The first combat vehicle developed in the VTI and introduced into operational use in 1961 was the armored personnel carrier OT M-60. The carrier with a specific power of 9.6 kW/t could reach a maximum speed of 43 km/h and carry a 10–member fighting group. During serial production, the vehicle was modified and the improved variant with new commands and a new planetary gear mechanism appeared in 1971 under the name OT M-60P.

Figure 35. Armored personnel carrier OT M-60PB

The demand of a foreign customer to increase firepower resulted in mounting two recoilless 82 mm guns on the turret. These carriers, OT M-60PB, had a significantly improved cooling system for an operational use under desert conditions

When the infantry fighting vehicle BVP M-80 was introduced into service in 1979, it was among the best in its own generation because of its general conception, constructional solutions of circuits, aggregates, subsystems and the entire vehicle, technical-technological level of solutions, maneuverability and tactical-technical characteristics. The BVP M-80 formation armament (20 mm gun, 7.62 mm machinegun and two launchers of antitank missiles), modern solutions for sighting and surveillance, its day/night action, communication devices, NBC protection device, etc, allow its crew and six-member fighting group to wage classic and nuclear warfare under different climactic and weather conditions.

Figure 36. Infantry fighting vehicle BVP M-80A with the 30mm gun

In 1980, the first modification of this vehicle was carried out resulting in a new model BVP M-80A. The main modification concerned the installation of a more powerful power group with a maximum speed of 65 km/h and an increase of a power-to-weight ratio from 13.6 kW/t to 17 kW/t. This vehicle with its amphibian properties was listed as one of the best among world's fighting vehicles of its generation.

In 1991, on basis of BVP M-80A, the development of commanding fighting vehicles at the level of company, battalion, brigade and division was completed. A developed sanitary vehicle BVP M80-A SN was also based on this vehicle, with the purpose of rescuing, seating and medically treating 4-8 injured. The basic variant of this vehicle was also used for the production of tank-hunters equipped with six MALJUTKA antitank rocket launchers, self-propelled mine depositing vehicle and a light anti-aircraft weapon.

The last modification of this infantry fighting vehicle, the BVP M-80A1, included an installation of a 30 mm gun-mounted turret stabilized in both vertical and horizontal axis.

Figure 37. Universal engineering vehicle MUNJA

While working on the conversion of the existing weaponry items, the VTI developed a universal engineering vehicle MUNJA based on the T-55 tank. Besides the blade, this vehicle is equipped with other necessary engineering kits placed in containers outside or inside the vehicle, for different engineering tasks such as negotiating natural and man-made obstacles, blocking, road repairs, demining, etc. The important piece of equipment is a computer system with a GPS-integrated software, digital compass, laser range finder and digital camera. It is also equipped with a 30mm automatic grenade launcher and a 7.62 mm machinegun which proved to be an ideal combination in counter-terrorist actions for neutralizing spot targets while engineers conduct prescheduled tasks.

In the area of non-combat vehicles, the VTI experts have dealt with research, development, upgrade and realization of cross-country, towed and trailing vehicles for different purposes

Figure 38. Sanitary vehicle TAM 110 T7 BV

The Institute was also a leader in the development and realization of other significant projects such as a family of vehicles TAM 110 T7 - its basic 4x4 version of 1.5 t capacity was the foundation for developing an entire family of special cross-country vehicles including: ambulance, NBC laboratory, communication vehicle and terrain minibus The basic variant of the 6x6 terrain vehicle TAM 150 T11, with a capacity of 3 t, led to the following special purpose vehicles: water auto-tank, decontamination auto-tank, mobile technical workshop for light repairs and command and communication vehicle.

Based on the terrain vehicle from a Serbian manufacturer in Priboj, 6x6 FAP 2026 BC/AV with a capacity of 6 t, a family of special terrain vehicles was developed, the most important among them being: vehicle for the installation of the 128mm multilaunch rocket system OGANJ as its mounting platform, logistic vehicle for OGANJ and ORKAN rocket systems, fuel auto-tank, fire-fighting vehicle, vehicle with a surveillance-acquisition radar, vehicle with a water purifying device, vehicle with a drill for mine wells and vehicle equipped for the production of physiological solutions.

Figure 39. Towed vehicle FAP 3232 with a low-carrying semi-trailer with a capacity of 45 t

The all-terrain vehicle FAP 2832 BS/AB with a 6x6 configuration and a capacity of 9 t that entered service in 1988, served as a mounting platform for the 262 mm multilaunch rocket system ORKAN and for the 152 mm self-propelled gun-howitzer NORA. In addition, owing to the cooperation of the Institute and the manufacturer, this all-terrain vehicle was adjusted for towing low-carrying semi-trailers with a capacity of 45 t.

Figure 40. All-terrain vehicle FAP 1118

In cooperation with the FAP manufacturer, the VTI experts worked on 4x4, 6x6 and 8x8 trucks, the platforms of which proved to be suitable for mounting various combat and non-combar systems. The most recent one is the 4x4 FAP 1118 vehicle with a capacity of 5t. This 4x4 off-road vehicle successfully crosses 60% gradients and side slopes of 35% owing to its low center of gravity with no risk of overturning. The fording depth is 80cm. With the operational range of 700km, FAP 1118 is designed to operate in the temperature range from -30°C to +50°C.

Figure 41. Family of TARA military utility vehicles

The all-terrain 4x4 vehicle TARA with a capacity of 0.75 t was developed at the beginning of

the 1990s, together with a whole family of these vehicles, from military to civilian purpose types. The most interesting and the most complex one is the command vehicle VK-0.75, equipped with various systems, communication ones in particular, and intended for operation at the commanding level of batallion, brigade and corps in all combat conditions.

Figure 42. All-terrain vehicle ZK 1.4t

The VTI has been currently working on the development of a 4x4 all-terrain vehicle ZK 1.4 t in cooperation with the ZASTAVA company. Intended for the transport of personnel and load up to 1.4t, this 3,000 kg vehicle can be used for towing (mortar M95, rocket system M63 PLAMEN, etc) with the payload capacity up to 1.7t. The extended cab accommodates a driver and 5 passengers. The 96kW Diesel engine provides a maximum speed of 110km/h and an operational range of about 600km [1-3, 5-7,12].

Aircraft and aeronautic systems

The tradition of producing military aircraft in Serbia dates since March 1924, when the factory IKARUS developed its first training military airplane ŠB-1. Between two world wars, Serbia, as a part of the Kingdom of Yugoslavia, produced many different models of airplanes, rom fighters to bombers. Continuing this tradition, immediately after WWII, a newly formed Aeronautical Technical Institute (10 August 1946), which later became an integral part of the VTI, began to develop new military airplanes and other air vehicles.

Figure 43. Fighter-bomber S-49C

In the period of 1951-1957, the Institute, in cooperation with different constructor groups in the country, designed and tested many different airplane models, among which the S-49C fighter-bomber stood out with its characteristics. It was the first domestic aircraft armed with air-to-ground projectiles. In the same period, the first wind tunnels were constructed on the basis of national constructors' solutions.

Figure 44. Trainer-fighter G-2 GALEB

Starting from 1957, research, design and tests in the field of air defence were conducted within the Institute, and as a result the year 1961 saw the first national jet aircraft G-2 GALEB of original construction. This trainer-fighter tandem-seat aircraft was intended primarily for initial and combat training of military pilots. The G-2 is designed as a modern low-winged aircraft with a small telescopic landing gear, engine in the fuselage, good overview and excellent fuselage shape. Its completely metal, aluminium-based light

alloy structure makes it lightweight, tough and resistant, easily maintainable and long-lasting (almost 40-year long lifespan).

The adopted structural concept of the two-seater G-2 enabled a quick development of the single-seat attack aircraft J-21 JASTREB that flew for the first time in 1963. A reconnaissance (IJ-21) and a two-seat training (NJ-21) version of this aircraft were later developed.

Figure 45. Fighter J-21 JASTREB

As very successful projects, GALEB and JASTREB aircraft drew attention and received important recognition at international air shows in Great Britain and France as impressive technical achievements in their categories. Consequently, many foreign countries introduced these aircraft into their military use.

Soon after the G-2, the Institute designed and developed the light fighting piston-propeller aircraft J-20 KRAGUJ that took off in the summer of 1962. The airplane was intended as a fire support to ground units and for combat against helicopter landing troops. This light airplane armed with two 12.7 mm machineguns and two 57 mm rocket launchers with 12 rockets, could even take off from meadows.

Figure 46. Aircraft J-20 KRAGUJ

By the end of the 1960s and the beginning of the 1970s, in cooperation with Romania, the development of the jetfighter-bomber ORAO started and the first prototype had a successful flight in 1974. It was the first national airplane that could fly faster than sound. This two-engine, highwinger with the classic construction in order to shorten the landing track, is equipped with a braking parachute. It can carry a wide range of weaponry including: two 23 mm twobarrel guns, guided and unguided rockets, and air bombs of different sizes and purposes.

The ORAO aircraft has a 30-year lifespan. There are four versions: J-22 single-seat attack-jetfighter, IJ-22 single-seat reconnaissance, NJ-22 tandem-seat training airplane and INJ-22 tandem-seat reconnaissance.

Figure 47. J-22 aircraft ORAO in action from 23mm guns in flight

The first prototype of the trainer-fighter G-4 SUPER GALEB took off on 17 June 1978. Although it kept the name GALEB, the G-4 represented a completely new airplane, unlike the G-2 version. With remarkable maneuvering capabilities, excellent behavior at high attack angles and spins, with arrow-like wings, favorably shaped fuselage, hydraulic commands for wings and tail and with good ergonomics, SUPER GALEB is adapted to high subsonic and slightly transonic speeds in a broad range of altitude, which allows the pilot training in similar fighting conditions.

The robust landing gear enables taking off from grass runways, while starting rockets and braking parachutes provide short-distance take-off and landing if necessary. With solid rocket and gun weaponry, the G-4 proved to be good for fire support and for fight against helicopters.

Figure 48. G-4 Trainer-fighter SUPER GALEB

Modern design solutions made SUPER GALEB very suitable for further development and at the beginning of the 1990s the G-4M version was designed. The modernization mainly includes equipping the aircraft with new digital avionics with modern navigational-attacking, identification and communication equipment.

Since 1985 when it first appeared at the Le Bourget Air Show in France and at any world air show afterwards, the SUPER GALEB has caught remarkable attention and received compliments. Good behavior of the aircraft at low

speed and at spins was mainly emphasized, as well as remarkable maneuvering capabilities, and it is of no surprise that this aircraft is still among the best in its category. A certain number of these aircraft had been exported before unjust brutal sanctions against Yugoslavia, i.e. Serbia, stopped already contracted export deals.

Figure 49. LASTA aircraft

In order to reduce expenses of initial pilot training, the Institute launched the development of a piston-propeller aircraft for the initial and basic pilot training. It belongs to the category of a single-piston engine, low-wing aircraft with the retractable ticycle landing gear. It can fly at a maximum altitude of 6,000 m. Besides the flight training, ita can be used to perform combat training missions using its guns, rockets and bombs. The LASTA aircraft can be armed with 7.62 mm or 12.7 mm machinegun, 57 mm rocket launcher or avio bombs up to 100 kg. Despite the fact that during the 1999 aggression all prototypes were destroyed in the plant, the project was successfully completed and in 2010 it was the first aircraft Made in Serbia to enter into service of a foreign airforce before entering Serbia's own army.

Figure 50. KOBAC aircraft

The current cooperation with the UTVA company from Pancevo concentrates on the realisation of an attack trainer turboprop aircraft for higher basic flight-combat training. Besides its primary purpose, the KOBAC aircraft is suitable for antiterrorist, antidiversant and counter insurgency missions at difficult terrains such as gorges and narrow river valleys. The completion of this project which provoked a great interest from abroad is expected in 2014.

Besides aircraft, the Institute worked on the design and development of other types of air vehicles. The glider KORUND is considered to be a very successful solution. A mini UAV VRABAC and a tactical UAV PEGAZ are currently in the final design and flight testing phases.

Figure 51. Mini UAV VRABAC

The mini UAV VRABAC is intended for day/night surveillance and close range reconnaissance, for target identification and designation, for protection of major infrastructure objects such as pipelines, power lines, important roads, bridges, forest areas (fire detection), etc. It is a high-wing monoplane made of composite materials with the opearational range of 10 km and flight altitude of 500 m. It is hand launched and lands with a parachute.

Figure 52. Tactical UAV PEGAZ

The tactical long-range drone PEGAZ is intended for day/night surveillance, reconnaissance and target designation at distances of 100 kmIts payload is 40 kg, its flight autonomy over 12 hours and it sends data from the height of 3,000 m. It performs tasks along a pre-programed flight.

While developing aircraft models, the Institute was also developing elements of aeronautical equipment and weaponry. A special attention was dedicated to communication, navigation and control systems, systems of counter-electronic protection, systems for radar, speech and TV signal processing, parts of pilot equipment and weaponry systems.

Figure 53. LVB-230F laser-guided bomb

In order to realize all these projects in the area of aeronautics, i.e. aerodynamics, it is necessary to perform

appropriate wind tunnel tests. Over the last 60 years, the Institute developed, mostly independently, a powerful wind-tunnel complex, usually found only in industrially and technologically most advanced countries, which includes the following: T-32 small subsonic wind tunnel, T-33 water-cavitation wind tunnel, T-34 hypersonic wind tunnel (in cooperation with the Faculty of Mechanical Engineering, Belgrade, Serbia), T-35 large subsonic wind tunnel, T-36 transonic-supersonic wind tunnel and T-38 trisonic wind tunnel (in cooperation with the Canadian company DSMA).

Figure 54. T-38 wind tunnel

The wind tunnel complex and the expert team from the Institute often help foreign companies in their projects which require this type of testing. Besides testing for military purposes, these wind tunnels are used for tests in the areas of civil engineering, transportation, etc [1-3, 5-11].

Telecommunications, radars, computers and optoelectronic devices

Scientific research in the area of telecommunications was conducted simultaneously with developing new resources and communication systems, including many scientific and technical areas, such as: methods, techniques and transfer systems (wiring and optical cables, radio relays, VF and VVF systems of radio transfer, analogue and digital multi-channel systems, etc.), commutation and commutation systems (telephone, telegraph and digitally integrated ones), methods and techniques of synchronization and signalization in digital telecommunications, analogue and digital signal processing, coding and compression, etc.

The beginning of the VTI activity in the area of telephony was connected to the modifications of trophy devices, from which more complex devices followed, including the induction telephone central unit MP-10 and the telephone set PTI-49. In order to increase capacity and automation of telephone and telegraph communications, as well as to integrate telephone mobile and combat radio-network, the automated telephone central units ATC-1 and ATC-2 were developed and introduced into service. In the 1960s, a radio-relay device for transferring 4-frequency distributed telephone channels HVT-1 was developed, followed by a generation of RRU-9 intended for communication with supreme command – army – division, and in the 1990s the model RRU-D was realized (30 digital channels) with integrated functions of surveillance and control. The most recently developed model was the RRU-1.

Figure 55. Radio-relay device RRU-1

The development in the area of devices and systems of radio-contact included research and development of radio devices with signal transmission in extended spectrum. Independently or in cooperation with the industry, over 30 types of radio devices and a large number of antennas and antenna devices were developed and introduced into service. A special achievement was developing VVF radio devices with frequency hopping and integrated speech and data crypto-protection, RU-5 and RU-50.

By the end of 1990s, the DISC (Digitally Integrated System of Communication) system was developed with a purpose of creating a modern digital telecommunication system that meets military requirements regarding high quality and fast verbal and nonverbal communication of stationary and mobile users, with tactical and technical flexibility and a high level of protection and data transfer resistant to electronic warfare. The DISC is designed as a system of modular structure, organized into three levels: magistral, accessing and user one.

Activities on electronic protection systems resulted in a solution for a PC-based integrated system of technical protection. A developed microprocessor alarm central unit is intended for complete protection of stationary objects. It uses different types of sensors, including fire protection sensors. The mobile system for movement identification PRESEK was also developed, allowing identification and classification of violations in protected spaces (pedestrian, group of pedestrians, vehicles, animals), as well as the determination of movement trajectory, direction and speed.

Figure 56. Radio-direction finder RG-2/3

The VTI started research in electronic warfare in telecommunications a few decades ago and at the very beginning it developed the system for the analysis of telegraph signals ATC-1 and the automated radio-reconnaissance system ARIS. Research into automated search processes and signal analysis, receiving, tracking, direction finding, data acquisition and processing resulted in many types of radio-jammers and direction finders.

By the end of 1990s, prior to the aggression of NATO on Serbia, the work on the application of microprocessor technology and software control resulted in the radio-direction finder RG-1 for VVF/UVF band range of 50-500Mhz which proved to be very effective in war conditions. The direction finder RG-1 and its successor RG-2/3 determine a direction of a radio-transmitter based on the modern method MUSIC that allows direction finding of multiple simultaneous, active emissions in the same channel, which is not possible with classic methods.

Figure 57. GIRAFFE radar system

The development in the area of radar technique started immediately after the founding of the VTI in 1948. From the very first days, an emphasis on three radar areas of research was established: primary radars, radar jammers and secondary radars (identificators). The development of the first national surveillance radar was completed in 1955. It had a frequency of 220 MHz, impulse power of 100 kW and a range of 150 km. At the beginning of the 60s, in cooperation with the industry, the mobile surveillance-acquisition radar FRUŠKA GORA was realized and its serial production lasted until 1973. In the 80s, on the basis on licensed documentation, the VTI started with the realization of a modified 40mm AA artillery system which also included a modification of a self-propelled variant of the surveillance and sighting radar – this led to a YU variant of a well-known GIRAFFE radar.

Research and development in the area of computer technology started in 1952 with the development of analogue computers. By the mid- 60s, developed computer systems have found their use mostly in fire control systems of AA guns.

Figure 58. Control board of the surveillance-acquisition radar P-15 in the SONIC system

Having conquered microprocessor and multi-microprocessor technology by the end of 70s, the VTI developed the system for detection of low-flying targets SONIC. The technical solution for this system is based on a VTI design of an integrated system with distributed data processing. The SONIC operating system, intended for anti-aircraft regiments and divisions, detects targets and integrates target surveillance, selection, tracking and monitoring. By the beginning of the 1990s, the horizontal, digital panoramic display for automated display of primary and secondary radar image processing and target tracking entered service. The radar P-15 was modified as well.

For the M-84 fire control system, a computer subsystem with original software for real-time performance was developed in the 80s. Together with the other fire control subsystems the computer provides the first-hit probability higher than 50% at a distance of 2000 m.. Based on these experiences in design and system development in real time, computer fire control subsystems in 40 mm and 30/2 mm AA guns were developed.

Figure 59. M- 84 tank fire control system components

During the work on the fire control system for the M-84 tank, the VTI developed adequate optical and optical-electronic equipment which was a vital part of day/night sight with an integrated laser rangefinder. This knowledge was applied in the development of the fire control system of the TON coastal cannon, TOPAZ antitank gun, OGANJ and ORKAN rocket systems and T-55 modernized tank.

One of recent VTI projects is the MIP-11 multi-sensor intelligent platform intended for passive surveillance, reconnaissance and data acquisition of stationary and non-stationary objects during day/night, low visibility conditions, on the move or at the halt. The system consists

of various sensors which simultaneously observe the area of interest and form its electronic image in different parts of the electromagnetic spectrum. The obtained multispectral image corresponds to a real situation in the field and can be distributed in real time to other users. The remotely-controlled sensor system is mounted on telescopic pylons of different height and is capable of elevation-over-azimuth tracking.

Figure 60. MIP-11 multi-sensor intelligent platform

As far as electric power sources are concerned,, the VTI had also significant success over the last 60 years. Many electric power sources, power generators and electro-chemical power sources were developed. This period saw a large number of training aids such as training devices for tank drivers, training devices for radiotelegraph and teleprinter operators, mini training shooting ranges, etc [1-3,5,7].

Devices of nucler-biological-chemical protecton

In the area of nuclear-biological-chemical (NBC) protection, the VTI conducted research into the effects of NBC weapons, together with the development of detection and measurement methods, equipment and devices as well as individual and collective NBC protection.

The nuclear protection research included war dosimetry and radiometry as well as technical nuclear protection. In war dosimetry and radiometry, the following methods and devices for detecting and measuring nuclear radiation were developed: general purpose detector of radioactive radiation DRZON and radioactive contamination measurement device M87. These devices, based on the gamma method, were used during the NATO aggression on Serbia when some of its regions were hit by depleted uranium ammunition.

Figure 61. Radioactive contamination measurement device M87

Figure 62. Protection overalls, protection filtrating suit and protective cloak

Development in the area of detection of nerve gasses resulted in designing detection devices and kits operating on the electro-chemical principle. An automated chemical detector is an efficient device for continual environment monitoring in order to detect nerve agents (sarin, soman, VX), choking agents (phosgene) and nerve blood agents (hydrogen cyanide). The personal decontamination kit M3 was developed for a single use and quick decontamination of exposed body parts, personal weaponry and items of clothes and equipment. The group decontaminator AGD-1 is capable of decontaminating 4-5 m2 of contaminated surface with a single charge of decontamination liquid TD-1.

Figure 63. Phonic protection mask with a drinking water kit

Within the protection against effects of nerve gasses, the VTI has dealt with detection and devices of individual and collective protection and decontamination. The research results enabled the development of many generations of body and respiratory organs protection devices of different types (filtration, insulation and ventilation). The phonic mask with a drinking water kit was developed as an efficient device for individual protection of respiratory organs, eyes and face against NBC contamination in the form of droplets, gasses, vapours, solid and liquid aerosols and contaminated dust particles.

A filtrating protection suit, protection overalls M5, protective cloak M3, boots, gloves and socks were developed and introduced into service as individual NBC protection equipment.

Figure 64. Special NBCvehicle SANIJET

The modification of the FAP 1118 4x4 platform resulted in a special NBC vehicle SANIJET. It is a fully-equipped, mobile radiometric, dosimetry and decontamination station for NBC purposes [1-3, 5-7]

Engineering equipment

In the area of negotiating water and dry obstacles, the VTI achieved significant results in the theory of calculus of bridge constructions. The VTI created its own calculation methods for systems of suspending bridges with the span of up to 117 m and pontoon bridges as well as theoretical solutions for problems in prefabricated systems of BAILEY bridges, thus increasing their span 2-3 times, and their carriage capacity up to 10 times. The knowledge gained in designing BAILEY bridges with large span and carriage capacity was used for rebuilding bridges destroyed in the NATO aggression that had primarily targeted civilian infrastructure objects. The several hundred-meter-long railway-road bridge MD-88 near Novi Sad was erected over the Danube river in only 100 days.

Figure 65. MD-88 Bridge over the Danube near Novi Sad

Methods for laboratory and field testing of soil, stone aggregates, concrete and asphalt mixtures were conquered as well as methods for testing carriage capacity, roughness and damage of driveway constructions in the domain of building military roads and airports. A large number of engineering toolkits and devices of different purposes was developed together with methods and equipment for quick repair of airport runways. VTI experts have successfully implemented acquired knowledge of repairing airport runways in military and civilian airports in the region of former Yugoslavia and in foreign countries.

Figure 66. M70 drilling kit for mine wells

Different methods and techniques of demolishing various objects were mastered for the purpose of road and area blocking. One of the important realized designs was the development of a mine well drilling kit mounted on the vehicle FAP 2026 BS/AV-KBMB. For area blocking with antitank mines, a self-propelled armored mine layer was developed on the chassis of the fighting tracked vehicle M- 80. This vehicle carries 288 mines which can be either dug in or spread on the ground.

Many equipment models for manual and mechanized demining were developed. A mechanized minesweeper intended for opening passageways and demining antipersonnel and antitank minefields was developed for T-55 and M-84 tanks.

Figure 67. TORO robotised demining vehicle

A special roborised demining vehicle TORO is currently in the final development phase. This low-silhouette remote-controlled wheeled vehicle with a mechanised demining arm is intended for special, anititerrorist missions of army and police forces.

The VTI gave remarkable contribution in designing, developing and equipping special protective constructions such as military and civilian shelters, revetments, special purpose structures (commanding posts, communication

centers, etc.). Projectile direct impact and explosion blast waves were investigated. It was proved that reinforced bars in concrete constructions were not essential for concrete resistance, that they do not react with concrete in the impact area and that too many reinforced bars in the direction of projectile penetration can have opposite effects. Remarkable results in designing special protection equipment for this type of objects were achieved, such as filtrating-ventilation devices as well as an entire family of antishock valves for shutting exterior hatches in shelters.

Figure 68. Water station for complex water purification

The VTI dealt with water supply systems from its early days. Several different types of water tanks, families of manual filters for simple and complex water purification, water stations of different capacities and well drilling kits were introduced into civilian and military service. The Institute successfully applied this knowledge, in cooperation with other relevant national partners, throughout the country as well as abroad, eg. in the sub-Saharan part of Africa.

In the initial period, from 1948 to 1960, the VTI,used the experiences from WWII in conquering camouflage equipment for the protection of important military and economic facilities. For the last 30 years in the area of camouflage, intensive research has been conducted with significant results in testing and determining spectral qualities of the characteristic types of terrain in the country, camouflage characteristics of different natural and manmade materials and the possibility of their application in camouflage. Camouflage techniques and procedures were studied in ultraviolet, visible and close IR spectrum, as well as deception techniques..

Figure 69. Ship concealed under a camouflage net.

Many types of camouflage equipment were developed such as camouflage uniforms for all weather conditions, cloaks, tent wings, camouflaging nets, camouflaging paints in three different systems (alcide, acrylic and dispersive), etc. In the area of deception equipment, remarkable results were achieved and demonstrated during the war in 1999 [1-3, 5-7].

Naval systems

Military shipbuilding in the VTI continues a long and rich tradition of the former Naval Institute which remained in the part separated from the rest of the country after Yugoslavia had broken apart. Since 1992, the Institute has primarily been dealing with the River Naval Army requirements. The Institute was mainly engaged in modernization and re-armament of mine hunters, tank carriers and landing boats of the Serbian river fleet.

Besides participating in the modernization of the existing river naval fleet of Serbia, the VTI actively participated in equipping the latest river mine hunter NOVI SAD that entered the Serbian River Navy service during the war in 1999. This is the latest and the most sophisticated river naval ship in the Danube Basin, probably in the entire Europe, which showed its fighting prowess and vitality during 78 days of the NATO aggression. It is no wonder that some countries, even from the NATO alliance, showed interest in purchasing it, especially when its previous version, NEŠTIN, had already been introduced into river flotillas of several ountries.

Figure 70. River mine hunter 341 NOVI SAD

The NOVI SAD represents a very powerful and effective fighting system owing to its low draft, reduced physical fields (thus allowing safe passage over minefields), ability to dock to natural river banks, transport of 100 crew members with their weapons and equipment, diverse weaponry and ability to camouflage near the bank, etc. This ship with displacement 57.31/79.60 т is armed with two 20 mm 4- barreled artillery systems M75 and the launcher with 4 STRELA-2M rockets [1,2,5,6].

Information support and information technologies

The primary task of the information support in the VTI is the support of research and development projects in the areas of armament and military equipment. The heterogeneity of these projects requires a very complex information support.

In order to keep up with the scientific development in the world and to satisfy the information needs of the VTI researchers, a Military Automated Scientific Technical Information System or VANTIS was designed in 1978 for processing VTI's own and foreign bibliographic and information data basis.

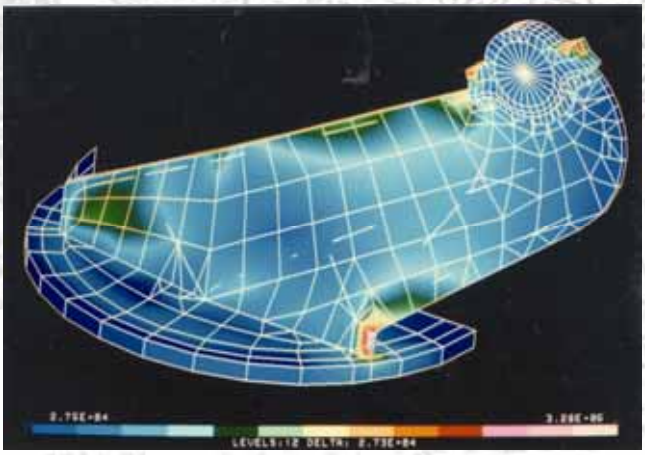

Figure 71. Calculation of the static tilt for the howitzer carriage with the Finite Element Method

Well-organized librarian-information-publishing activities of the Institute have accompanied all VTI's projects. The library of the Institute has over 200,000 monographs, nearly 30,000 special documents, over 2,000 magazine titles, etc. The following serial publications have been published: SCIENTIFIC TECHNICAL REVIEW (since 1950), distributed in 17 countries, SCIENTIFIC TECHNICAL INFORMATION (since 1963), monograph series to mark its 50th anniversary of continuous publishing this year and WEAPON DATA (since 1977), a special monograph series.

Figure 72. Weapon data**,** Scientific Technical Information

The Institute possesses the most technologically advanced computer systems for design, structural analysis and production (CAD/CAM/CAE). The application of these computer systems and relevant computer tools has allowed design of individual assemblies and elements for most advanced models of weaponry and military equipment. Modern numerical methods, mostly based on the finite element method, are used for different calculations and analyses [1,2,5,6].

Conclusion

All these projects would not have been realized if it had not been for preliminary tests and verifications in 28 specialized laboratories within the VTI. Some of the presented laboratories are of international importance, some are unique in the West Balkan region, and most of the Military Technical Institute's laboratories exceed military importance and can be regarded as a national resource of the Republic of Serbia.

The laboratory potential of the Military Technical Institute has been created for six and a half decades and it is a neverending process. These laboratories fulfill the quality system requirements regulated by SRPS ISO/IES 17025 and SRPS ISO 9001 standards [2,6].

The Laboratories are:

- for Experimental Aerodynamics,
- for Experimental Modal Analysis, Signal Analysis and Balancing,
- for Experimental Strength
- for Special Armament Measurements,
- for Solid Propellant Rocket Engine Testing,
- Explosive Materials Testing Laboratory,
- Hardware In The Loop (HIL) and Telemetry Measurements Laboratory,
- for Inertial Sensors,
- for NBC protection,
- for Nuclear Radiometry and Dosimetry,
- for Analysis of Toxic and Hazardous Chemicals,
- Electromagnetic Compatibility (EMC) Laboratory,
- for Optics and Optoelectronics,
- TV Guidance Laboratory,
- for Fuels and Lubricants Testing,
- Vehicle Subsystems Laboratory,
- Metrological Laboratory,
- for Applied Spectrophotometry,
- for Polymeric and Corrosion Protective Materials,
- for Metal Materials,
- for Hydro-acoustics,
- for Physical-technical Measurements,
- for Testing Devices in Environmental Conditions,
- for Telecommunication Networks,
- for Digital Signal Processing,
- for Radio Equipment and Radio Systems,
- Antenna Laboratory, and
- Prototype Laboratory.

Figure 73. Engine test stand with 1900 kW power rate

On the occasion of the sixty fifth anniversary of the VTI, this editorial presents the most important realized projects in this period. The Institute as an institution, as well as all its researchers and other employees who worked and still work in it should be proud of their success. At some time in the past, the VTI got the name of Yugoslav NASA – and with reason.

Also, at the and of this text, it is necessary to emphasize educational activities of the MTI in the field of military tehnics and technologies due to many years of implementing the programs of master and doctoral studies for domestic and international audiences. Every other year, the MTI is organizes an International Symposium on Defense Technologies OTEH (next in October in 2014) [12].

Figure 74. VIHOR tank

Figure 75. N/A aircraft

In the end, we cannot avoid mentioning that the international community directly and indirectly influenced the development of new modern and advanced models of weapons and military equipment by its decision to break apart the multinational Yugoslavia and by introducing unjust and unjustified sanctions to Serbia which was the driving force of Yugoslavia's development. We will mention only three most important projects that were put to halt due to the breakdown of Yugoslavia by the end of the twentieth century. These projects are the VIHOR tank, the multipurpose supersonic fighter N/A and the project EDA concerning a rail electromagnetic gun [5,11].

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Sedma decenija Vojnotehničkog instituta (1948. – 2013.)

Vojnotehnički institut Republike Srbije u ovoj godini obeležava 65 godina svog postojanja. Na osnovu realizovanih projekata to je sigurno najznačajnija naučnotehnička institucija na prostorima jugoistočne Evrope, a i jedna od najznačajnih u sveckim okvirima.

Od formiranja 03. novenbra 1948. godine pa do današnjih dana, na osnovu projekata koje je razvio institut u operativnu upotrebu Vojske Srbije, a i vojski drugih zemalja na raznim kontinentima, uvedeno je mnogo sredstava i komponenti ratne tehnike. Institut je najznačajnija dostignuća ostvario u oblasti vazduhoplovstva, klasične i raketne artiljerije kao i u oblasti borbenih i neborbenih vozila.

U ovom tekstu dat je prikaz najznačajnijih realizovanih projekata ratne tehnike iza kojih stoji naučno istraživačka ustanova jedne male zemlje kao što je Srbija.

Седьмое десятилетие сербскому военно-техническому институту (1948. – 2013.)

Военно-технический институт Республики Сербии в этом году отмечает 65 лет своего существования. На основе выполненных проектов, это безусловно самое важное научное и техническое учреждение в регионе юго-восточной Европы, а также и одно из самых важных в мире.

С момента формирования 03 ноября 1948 года и по сей день, на основе проектов, разработанных в Институте для оперативного использования в Армии Сербии и в армиях других стран на разных континентах, мы ввели много средств, ресурсов и компонентов военной техники.Институт добился самых значительных достижений в области авиации, классической и реактивной артиллерии и в области боевых и небоевых машин.

В данном документе приводится обзор наиболее значимых реализованных проектов военной техники при поддержке научно-исследовательского учреждения - нашего Института в такой маленькой стране как Сербия.

La septième décennie de l'Institut militaire technique (1948. – 2013.)

L'institut militaire technique de la République de Serbie célèbre cette année 65 ans de l'existence. Sur la base des projets réalisés on peut dire que c'est un établissement technique et scientifique le plus important dans la région de l'Europe de sud-est et l'un des plus signifiants dans le monde.

Depuis sa création le 3 novembre 1948 jusqu'à nos jours, se basant sur les projets développés par l'Institut pour l'utilisation opérationnelle de l'armée de Serbie ainsi que pour les autres armées à travers le monde , on a introduit beaucoup de moyens et de composantes de la technique militaire. L'institut a réalisé ses plus grands succès dans les domaines de l'aéronautique, de l'artillerie classique et de l'artillerie lance-fusée ainsi que dans le domaine des véhicules utilitaires et des véhicules de combat.

Dans ce texte on a présenté les plus importants projets du domaine de la technique militaire réalisés par cet établissement pour les recherches scientifiques d'un petit pays qui est la Serbie.