WIEDZA OBRONNA
2022, Vol. 280 No. 3
ISSN: 2658-0829 (Online) 0209-0031 (Print)
Journal homepage: http://wiedzaobronna.edu.pl
DOI: https://doi.org/10.34752/2022-n280

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UNMANNED LAND VEHICLES - DIRECTIONS OF RESEARCH AND DEVELOPMENT

ABSTRACT: The article presents the historical background and development of unmanned land platforms in selected countries, including Russia, Germany, the US and Poland. The author points out the technical problems of combat use of unmanned land platforms, among others, related to the difficulty of operating in the field, control of armaments, and their lower effectiveness compared to unmanned aerial vehicles. In his opinion, the most desirable directions for the development of unmanned land platforms in the areas of operations support and logistics, and the need to turn to higher-weight platforms. In conclusion, the author postulates the thesis that full autonomous combat use of unmanned land platforms is likely to be economically unjustified as well as unprofitable in terms of the combat value of these vehicles in the next few to several years. The author points out the need to develop this technology and use a technological benchmark mainly of US solutions.

KEYWORDS: Unmanned land platforms, Unmanned vehicles, armaments, autonomization, robotization,

INTRODUCTION

"Unmanned vehicles" are beginning to play a dominant role in modern armed conflicts. Even a cursory analysis of the conflict in Ukraine shows that it has become crucial to have a sufficient number of unmanned aerial vehicles (BSPs) to gain operational advantage. A high saturation of unmanned vehicles was characterized by recent operations in Afghanistan, Iraq but also Syria, which was a testing ground for the Russian military. Reconnaissance BSPs along

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with satellite means, which we also consider as "Unmanned vehicles" have taken over the domain of military reconnaissance in Ukraine. And it is the data from reconnaissance that drives the entire machinery of warfare, shapes the course of operations, determines scenarios for the use of means of warfare, indicates targets, recognizes the routes of potential approaches or directions for the execution of counter-strikes. The enemy's flare-up, as the Ukrainian experience shows, is increasingly being carried out using BSPs, and it can even be said that much of the war propaganda has been centered around unmanned effectors, because of the image they convey of moments of reconnaissance, targeting and flare-up of the target. The Turkish Bayraktar[2] has become a symbol of Ukrainian combat capabilities, despite the relatively small number of targets it has destroyed in the conflict in Ukraine. Not insignificant in recognizing and flaunting Russian targets are the Polish Flyeye[3] and Warmate[4], produced by WB Electroniks group companies. Their success, although not as media spectacular as the Bayraktar, is noticeable and reflects well on the combat capabilities of the Polish Armed Forces.

But BSP is only one of the 3 domains of unmanned means use, what about the other two marine and land? Here, unfortunately, there are few reports of widespread use and effectiveness. Because of the title of the paper, in the remainder of the article I will focus on unmanned land platforms (BPLs), whose use when it comes to saturating the battlefield with unmanned means is second only to BSPs.

From a technical point of view, the use, in particular, efficient and effective operation of an unmanned land platform in the field is much more difficult than an aerial or even marine platform. This is a direct result of the presence of terrain obstacles, which need to be recognized, assessed in real time, and the movement parameters inflicted on the vehicle in order to successfully overcome them. Such limitations are virtually non-existent in the air and to a much lesser extent on and under water. This raises quite significant limitations and difficulties in the widespread use of BPLs. BSPs win in competition with BPLs, especially in terms of combat effectiveness. The BSP will reach the target faster, recognize it and flare. In addition, the price of an unmanned aerial vehicle (BSP) will be lower in relation to its potential

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[2] Bayraktar TB2 –Unmanned Combat Aerial Vehicle, UCAV), MALE class - Medium-Altitude Long-Endurance production Baykar Makina.

[3] Polski BSL rozpoznawczy https://www.wbgroup.pl/produkt/bezzalogowy-system-powietrzny-klasy-mini-flyeye/ (access 15.09.2022)

[4] Polska amunicja krążąca prod. WB Electroniks https://www.wbgroup.pl/produkt/system-amunicji-krazacej-warmate/ (access 15.09.2022)

effectiveness on the battlefield than a BPL. All of this makes the use of BPLs in the conflict in Ukraine very limited.

SOVIET RUSSIA BACKGROUND AND EXPERIENCE OF UGV USE ON WAR IN UKRAINE

The historical background of the use of BSPs is interesting. Soviet Russia was one of the first countries to attempt the use of remotely piloted tanks. Russian experience with unmanned vehicles dates back to 1930, and in February of that year the first tests of the RENAULT FT 17 tank (Figure 1) took place, without the use of a crew inside the vehicle.

In 1939, during the Winter War with Finland, Soviet Russia used 2 battalions of remote controlled T-26 tanks (Figure 2), to push the Mannerheim Line, without success. Similarly, in 1941, in the war with Germany, the use of the same vehicles did not yield combat results. However, work on these systems was revisited, hoping to achieve a combat application.

Figure 1. RENAULT FT 17 on its basis the Russians made the first attempts at remote control

Source: http://www.muzeumwp.pl/galerie/180,-8222-czolg-zwyciestwa---8211--renault-ft-17--8221--w-muzeum-wp.php (access 10.08.2022)

Figure 2. The T-26 tank, an unmanned version of the tank first used unsuccessfully by the Soviets in the 1939 Winter War against Finland.

Source: https://en.wikipedia.org/wiki/T-26#/media/File:T-26_in_Kirovsk.JPG (access 10.08.2022)

The Russian T-26 tank was built on the same license base of the British Vicers as the Polish 7-PT. An interesting fact is the little-known issue of the reversible periscope technology developed in the 1930s, for the 7PT and TKS tanks, by Polish engineer Maj. Eng. Rudolf Gundlach. After being patented in 1935, Gundlach sold the periscope plans to the British - Vicers-Amstrong. After that The Americans, in turn, handing over Gen. Scherman Mk 5 tanks with reversible periscopes to the Soviets as part of the Lendlise operation. Poland, in turn, in the 1950s received a license from the Soviet Union for the production of the T-54 tank, and with it the documentation for a reversible periscope, which Major Rudolf Gundlach had developed 20 years earlier. The use of reverse engineering was characteristic of Soviet Union and Russian military technology solutions, and as long as it involved mechanical components it worked well.

Russia's technological and combat experience in the area of unmanned platforms emphatically shows that it does not currently have technology at the level of the United States, leading NATO countries, Japan, China or South Korea. More than 10 years of efforts put into the development of URAN-class unmanned platforms, should bring visible results. Unfortunately, these shortcomings, the URAN-9 vehicle (Figure 3), hopefully heralded as an export product since 2015, has already proved to be a piece of equipment with a number of flaws during combat tests in Syria in 2018. Some problems slowed with the crawler chassis and weapons control. This includes significant time lag in conducting surveillance and fire. Finally, there are no reports of the use of this armament in the war in Ukraine, which may indicate problems of combat readiness of the URAN system.

Figure 3. Russian unmanned combat platform BMRK/RROP (Boyevo mnogofunkcyonalnyy robototiechniczeskiy kompleks - robot-technical combat multi-role system/Robot razvedki i ogniewoj poddierżki - reconnaissance and fire support robot Uran-9

Source: https://zbiam.pl/artykuly/rosyjskie-moduly-bojowe-cz-2/ (access 10.08.2022)

GERMAN EXPERIENCE

The self-propelled mines was had use by the Wehrmacht during World War II, including the fights during the Warsaw Uprising in 1944, as well as during the battle for Wrocław in the spring of 1945. Goliath vehicles (Figure 4), which were produced by the end of the war with 7,726 units, including 2,650 electrically powered and 5,079 diesel-powered.

In 1945, there were still more than 2,500 of these weapons in German warehouses[5]. It is likely that the Germans failed to utilize these vehicles because they were better suited for offensive rather than delaying operations, which were the hallmark of the Wermacht and SS in the final stage of the War, from June 1944 onward.

[5] Op. cit. access 10.08.2022 r.

Figure 4. Mobile mine vehicle - Leichter Ladungsträger Sd.Kfz.302, 303, „Goliath”

Source: https://pl.wikipedia.org/wiki/Goliath_(mina)#/media/Plik:Goliath.jpg (access 10.08.2022)

Germany, already a member of NATO, including in international consortia, has continued work on land-based unmanned vehicles. As a result, in recent years Rheinmetall AG has unveiled the Rheinmetall Mission Master family of modern modular unmanned vehicles (Figure 5). The armed version of the Mission Master SP has been equipped with a multi-rocket fire module of 70 mm missiles from THALES (Figure 6) and is probably to successfully pass fire tests in remote control mode.

Rheinmetall's Mission Master solutions appear to be a model and should be expected to be deployed relatively quickly to the SZ, at least in action support segments. Compared to the heavier Russian URAN-9 tracked solutions already on the Russian army's equipment, the Rheinmetall Mission Master appears more reliable and brave in the field, through the ownership of tires designed directly for unmanned missions, rather than adapting solutions from manned vehicles, as is the case with the Russian URANs.

Figure 5. Rheinmetall Mission Master family of vehicles

Source: https://defence24.pl/sily-zbrojne/roboty-rheinmetall-mission-master-analiza access (10.08.2022)

Figure 6. Rheinmetall Mission Master SP fire support vehicle

Source: https://www.auto-swiat.pl/wiadomosci/aktualnosci/rheinmetall-mission-master-sp-bezzalogowy-pojazd-wojskowy-sterowany-za-pomoca-tabletu/6nq049r (access 10.08.2022)

CURRENT STATUS OF DEVELOPMENT OF LAND-BASED ROBOTIC SYSTEMS IN THE US ARMY

U.S. solutions are heading in a slightly different direction than the development taken by Rheinmetall. Work on autonomization of existing vehicles has already been going on for many years, this is the case, for example, with Oschosh vehicles or M113 transporters (figure 7). This direction seems very legitimate and cheaper to implement. The crucial issue, however, is the susceptibility of the vehicles to remote control or, in the longer term, autonomization.

Figure 7. Modified unmanned M113 transporter with mounted Arnold Defense LAND-LGR4 remote-controlled missile launcher containing laser-guided APKWS missiles

Source: https://tech.wp.pl/pomysl-usa-na-przestarzaly-sprzet-autonomiczny-m113-trafil-na-poligon,6771238059248608a (access 15.09.2022)

The Pentagon is spending billions on driverless programs, but it is security that remains an obstacle to putting truly autonomous vehicles into service. The technology itself is not far off, however, as this summer the Army tested various types of robotic combat vehicles at Fort Hood, Texas. During these exercises and tests, soldiers tested the capabilities of RCVs (Robotic Combat Vehicle) (figure 8), using a variety of terrain conditions commonly encountered on the battlefield[6]. Maneuver tests were conducted on RCV-L prototypes at the Camp Grayling military training facility in Michigan throughout 2021 to assess the feasibility of integrating unmanned systems into ground combat vehicle formations. The US Army is expected to begin the engineering and production development phase of the RCV-L program in 2023.

In parallel, the Americans have taken delivery for testing in 2020, a shipment of medium RCV RIPSAW M5 Figure 8. Note the geometric similarity of this vehicle's turret to the ZSSW-30 turret kit on the ROSOMAK KTO and BORSUK BWP designed for chassis.

There were also photos of tests of the 2022 RCV vehicle in the UA ARMY's 4th Infantry Regiment built on a Rheinmetall chassis (Figure 9).

[6] https://www.chip.pl/2022/09/autonomiczne-pojazdy-w-wojsku-usa (access 14.09.2022)

Figure 7. Robotic Combat Vehicle-Light (RCV-L) small and expandable unmanned combat vehicle.

Source: https://www.army-technology.com/projects/robotic-combat-vehicle-light-rcv-l/ (access 14.09.2022) r.

Despite the aforementioned actions on the part of the US Department of Defense, it can be concluded from the US experience that UAVs are much more promising and combat effective compared to ground vehicles. This is reflected in current operations taking place in Ukraine where flying platforms dominate the battlefield, especially in the field of reconnaissance.

Figure 8. Ripsaw M5 medium robotic RCV introduced for US Army testing in 2020

Source: https://www.defensedaily.com/textron-team-readying-delivery-first-rcv-m-prototypes-received-deal-electric-variant/army/ (access 14.09.2022)

Figure 9. US Army 4th Infantry Regiment testing a small RCV under the ORIGIN project adapted to work with infantry subdivisions

Source: https://www.joint-forces.com/exercise-news/55765-project-origin-rcv-on-combined-resolve-xvii (access 14.09.2022)

DEVELOPMENT OF LAND-BASED UNMANNED SYSTEMS IN POLAND

Some solutions in the field of BPL are already being developed in our country and are advanced solutions of ready prototypes as well as technology demonstrators of unmanned systems integrated with armaments.

A successful deployment to the Polish Armed Forces back in the days of the PKW in IRAQ, was the remote-controlled anti-mine minesweeper BOZENA 4 (figure 10), which is currently on the equipment of the Polish Armed Forces in the number of 15.

Figure 10. Polish remotely operated mine sweep design BOŻENA 4

Source: http://polska-zbrojna.pl/home/articleshow/29265 access (10.08.2022)

The first Polish solution integrated with armaments was Leviathan, developed by WB Electronics, WAT and Hydromega S.A. and presented at MSPO in 2009 - Figure 11.

Figure 11. Polish unmanned structure LEWIATAN with unmanned turret system KOBUS from ZM Tarnów

Source: https://www.altair.com.pl/e-report/view?article_id=140 access (10.06.2022)

The Industrial Research Institute for Automation and Measurements (Łukasiewicz-PIAP), which is currently part of the Łukasiewicz Research Network structure, has the most experience in building small unmanned platforms in our country. It has been producing and selling robots for uniformed services, mainly with applications for explosive ordnance disposal, for several years with good results. Currently, Lukasiewicz-PIAP offers 9 small robots for special applications mainly remote-controlled with applications in C-IED operations, reconnaissance and remote surveillance, border and infrastructure protection, search and rescue, CBRN threat detection and analysis, which are sold in Poland and a dozen countries around the world. As finished products, however, they are not weaponized designs.

a)

b)

Figure 12. Polish unmanned weapon-carrier designs a) Łukasiewicz-PIAP robot armed with GROM missiles b) PERUN robot armed with a WKM with an optoelectronic warhead

Source: https://milmag.pl/instytut-piap-na-mspo-2019/ (access 10.08.2022) https://www.wojsko-polskie.pl/wat/articles/aktualnosci-w/2020-09-18d-perun-uzbrojony-pojazd-do-zadan-bojowych (access 10.08.2022)

Combat solutions at the level of prototypes are proposed by two consortia: Łukasiewicz-PIAP with Telesystem-MESKO Sp. z o.o. and the Military University of Technology with ZM Tarnów S.A., shown in Figure 12. However, these are, in the author's opinion, systems not fully prepared for the battlefield, in terms of the size of the weapon carriers, and can prove themselves in urbanized terrain or patrol missions, rather than in the open, where operations with large forces are likely to take place.

Solutions for mounting weapon systems are slightly heavier platforms of the PAWO (DMC about 1000 kg) or HANTER (DMC about 3500 kg) type Figure 4, developed by Lukasiewicz PIMOT and Lukasiewicz PIAP, but so far not integrated with armaments.

a)

b)

Figure 13. Polish unmanned designs a) PAWO platform b) HANTER platform

Source: https://portal-mundurowy.pl/index.php/component/k2/item/11333-platforma-autonomiczna-wsparcia-operacyjnego-pawo access 10.08.2022)

Still, the chassis of the PERUN, PAWO and HUNTER demonstrators are solutions suitable for use as carriers of light and, after modifications, medium (HANTER platform) weapon systems with caliber up to 12.7 mm in the case of PERUN and PAWO, and 23 mm in the case of HUNTER. Carrying missile systems on this type of chassis may involve PPK-type solutions, e.g. SPIKE RL or very short-range anti-aircraft set launchers of the PIORUN/GROM type.

Poland is well on its way to becoming highly capable of building unmanned, remotely controlled, and in the future autonomous, chassis and their integration with weapons systems. Currently, more than 10 scientific and industrial entities in our country have experience in building such platforms.

ANALYZE THE DIRECTIONS OF DEVELOPMENT OF MEDIUM-SIZED UNMANNED REMOTE-CONTROLLED AND AUTONOMOUS LANDING GEAR AND THEIR INTEGRATION WITH VARIOUS WEAPONS SYSTEMS

According to the author, the target designs should be adapted to carry at least medium weapons systems currently installed on BWP or KTO class vehicles, and in the future heavy ones with calibers above 100 mm. The parameters for medium sets will provide chassis comparable to high-mobility trucks, with a GVW in the range of about 12,000 to 16,000 kg. For heavy sets, there will be wheeled and tracked chassis with a DMC in the range of 18,000 to 40,000 kg, with this particular segment tending to use the transition to remote control of existing manned systems.

Currently, the most important challenge turns out to be the integration of the vehicle with armaments, a fast human-machine interface, as well as the possibility of cooperation of the vehicle with an unmanned aerial vehicle BSP as a means of reconnaissance, monitoring the operational situation and indicating targets. We see this direction in U.S. solutions such as the Robotnic Combat Vehicle-Light - Figure 7 and the Ripsaw M5 - Figure 8.

Another important issue is unification and modularity, exemplified, for example, by the concept shown in Figure 14, which presents the possibility of using different bodies on a lightweight PAWO-type platform proposed by LUKASIEWICZ-PIMOT.

Figure 14. The concept of modularity of the PAWO platform providing the possibility of replacing accessories as well as adapting the chassis to changing terrain conditions

Source: Łukasiewicz-PIMOT

DIRECTIONS AND DESIRABLE ORDER OF IMPLEMENTATION OF SOLUTIONS IN THE POLISH ARMED FORCES

The introduction of successive solutions should be done according to the principle - simplest first, that is, we start with solutions that can be introduced in a short period of time and build experience on them. Such areas, according to the author, include the systems used in the engineering forces, including demining and landmining systems.

As part of the analysis, the author assumes an assessment of the possibility of integrating a previously selected manned platform of the FUNTER figure 15 type, with several weapons systems, and assessing the suitability of such military equipment under mission conditions. Due to the difficulty of accessing the Operational Requirements of the Polish Armed Forces, the author leaves the evaluation in this regard to the gestors of military equipment in the Polish Armed Forces and the Armament Agency.

The base-chassis could be the FUNTER multifunctional vehicle for special applications. The vehicle was developed at the Industrial Automotive Institute in Warsaw, after several years of research and development work. It is a vehicle with very high off-road capabilities, a significant reserve of strength of chassis structural elements, unprecedented ground clearance and dynamic suspension travel in vehicles of this size. The large excess torque (970 Nm) and torsion 4WS axles make it a unique design. Although the FUNTRER's interior comfort is not up to modern standards, its off-road capabilities are already comparable to off-road sports vehicles. The vehicle has the potential to change design solutions towards remote control, autonomization and drive modernization.

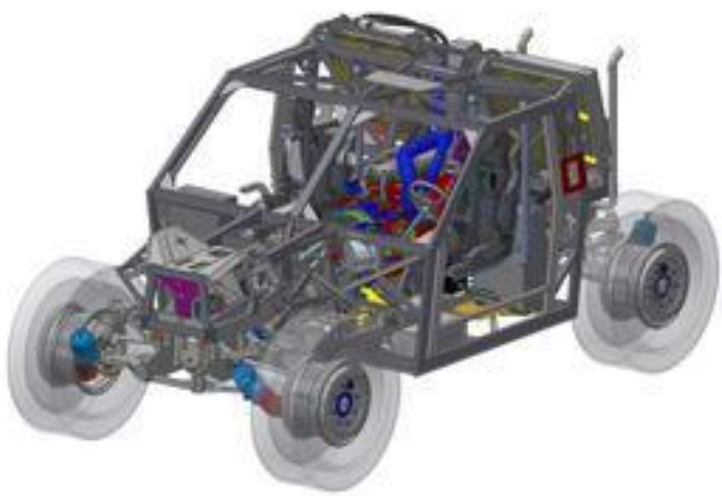

Figure 14. FUNTER multipurpose vehicle for special operations

Source: Łukasiewicz-PIMOT

Remote-controlled elongated charges launcher

The WŁDW elongated charges are used in the Polish Army to make minefield crossings. They are generally launched from the ground, a trailer pulled by a TI, a tank or the deck of a landing ship when making a minefield passage on the beach. The use of an ROV in contact with the enemy carries a high risk for the operator due to the fact that the system's carrier - a tank, transporter or the soldiers operating it - become an easy target. The use of a remotely controlled or, in the future, autonomous vehicle in such conditions is possible without endangering soldiers.

Figure 15. The WŁDW system on a P2P trailer towed by MTLB TI, the WŁDW storage tank.

Source: https://docplayer.pl/71083307-Pismo-stowarzyszenia-saperow-polskich.html
https://www.swinoujskie.info/2015/09/17/saperzy-uczyli-sie-taktyki-oraz-wysadzania-ladunkow-wybuchowych/ (access 10.08.2022)

Potential integration would consist of placing an autonomized WŁWD launcher on a chassis such as FUNTER or HANTER. Such a platform could be developed in the form of an interchangeable body similar to the KROTON/BAOBAB system.

Purpose:

- To perform minefield crossings in the planned direction of attack of own troops in direct contact with the enemy, without the presence of soldiers in the line of contact of troops. The operator operates from stealth or the vehicle performs the mission based on the entered coordinates. Mission execution control using a rotorcraft-type BSP.

Remote-controlled erratic mining system

Systems of the KROTON, BAOBAB family are designed for the execution of minefields, but their use is limited when such a field is executed in contact with the enemy due to the fact that the vehicle becomes an easy target. Using a remotely operated/autonomous vehicle in such conditions is possible without endangering soldiers. The more adventurous use of a remotely piloted/unmanned vehicle in a "last minute" mode on the expected direction of attack provides a surprise effect and causes forced changes in the enemy's intent, leading to a tactical advantage. Mission execution control with the support of a rotorcraft-type BSP.

a)

b)

Figure 16. Erratic mine system on MTLB (a) and JELCZ chassis (b).

Source: https://defence24.pl/przemysl/baobab-ewolucja (access 10.08.2022)

Potential integration would consist of placing from 2 to 4 autonomous launchers of the KROTON system on a FUNTER (4 launchers) or HUNTER (2 launchers) chassis. Such a platform could be developed in the form of an interchangeable body with the possibility of use with other applications, e.g., extended charges, tank destroyer or logistics vehicles, e.g., for evacuation of wounded and/or delivery of combat assets.

Purpose:

- Conducting erratic minefields in the expected direction of the enemy's advance in direct contact without using soldiers in the line of contact of troops.
- Conducting combat minefields erratic minesweeping missions in front of the enemy's grouping after landing without using soldiers in contact with the enemy.

Remote-controlled tank destroyer system

The Polish Armed Forces are planning to acquire tank destroyers equipped with PPKs with a long range of up to 12 km in the near future. Such military equipment is characterized by high effectiveness and combat value. The use of this SpW assumes operation at medium distance from the enemy, and only in certain situations in contact with the enemy. It is expensive due to the use of long-range (10-12 km) anti-tank rockets of SPIKE ER or TOW systems. An unmanned vehicle equipped with cheaper shorter-range missiles, e.g. PPK SPIKE LR or PPK PIRAT, could complement the OTOKAR-BRZOZA system by successfully operating at shorter distances without fear for the lives of the crew, while having similar effectiveness with lower product life-cycle costs.

Figure 17: Demonstrator of the OTOKAR-BRZOZA tank destroyer on the ANDERS combat platform.

Source: https://www.konflikty.pl/technika-wojskowa/na-ladzie/ottokar-brzoza-niszczyciele-czolgow-mspo/ (access 10.08.2022)

Potential integration would involve placing an autonomous launcher of 6-12 pcs. PPK medium- or short-range PPK on FUNTER unmanned chassis, or 2-4 pcs. PPK short-range PPK PIRAT on HUNTER or PAVO unmanned chassis.

Purpose:

- Combating tanks and armored vehicles on the enemy's directions of march or expected directions of attack in direct contact without using soldiers in high-risk missions.
- Conducting combat missions in the enemy grouping after landing, without using soldiers in direct contact with the enemy.

Remote-controlled vehicle with tower system ZSSW-30

The remote-controlled ZSSW-30 turret (Figure 18) was created as a result of development work funded by the Armament Inspectorate of the Ministry of Defense (currently the Armament Agency) in two variants, intended for the Rosomak Wheeled Armored Vehicle (KTO) and the Borsuk BWP. The unmanned nature of the USSW-30 is that its operation can be located outside the turret, which significantly increases the safety of the crew. The turret is the element most often flared by enemy effectors.

Figure 18. ZSSW-30 on the KTO ROSOMAK chassis.

Source: https://www.hsw.pl/aktualnosci/hsw-prezentuje-nowe-materialy-z-badan-zssw-30-strzelania-z-ppk-spike/ (access 10.08.2022)

The ZSSW-30 is armed with a 30 mm Northrop Grumman Mk 44S automatic cannon, a 7.62mm cannon-coupled UMK 2000 rifle, a PPK SPIKE LR launcher and a set of smoke grenades.

Important at this stage of consideration is to assess the possibility of integrating the USSW-30 with the FUNTER or other chassis and switching to fully remote control of the turret from a panel outside the vehicle and/or the possibility of achieving semi-autonomous operation of the turret system. The dimensional fit of the turret to the FUNTER chassis is shown in Figure 19.

Purpose:

- To combat live force and armored objects in direct contact with the enemy without using soldiers in the line of contact of troops.
- Conducting reconnaissance and combat missions in the enemy grouping without using soldiers in direct contact with the enemy.
- Conduct combat missions in the enemy grouping after landing without using soldiers in direct contact with the enemy.

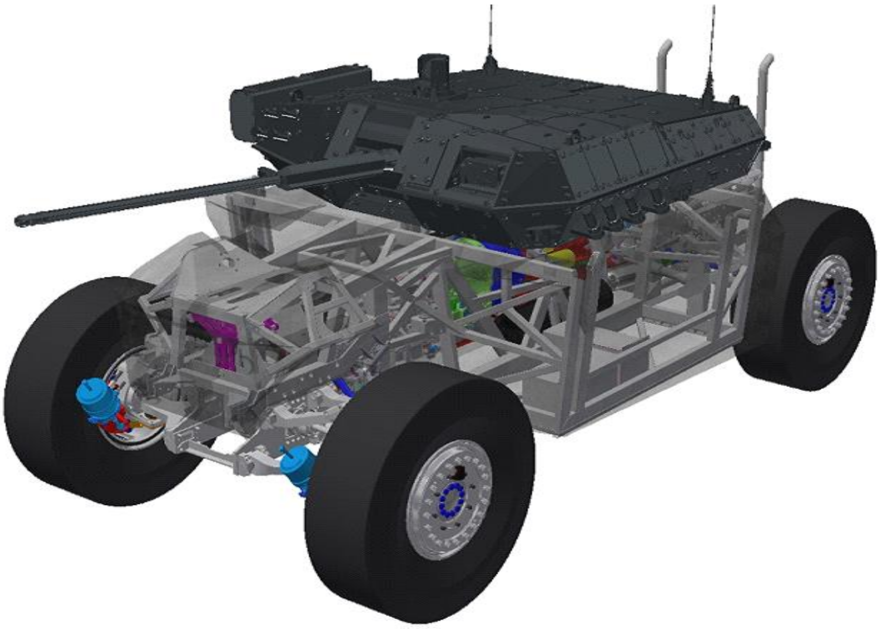

Figure 19. visualization of the integration of the ZSSW-30 turret with the FUNTER remote/autonomous chassis

Source: Łukasiewicz-PIMOT

Remote-controlled vehicle with turret system HITWIS

The HITVIS turret systems are armed with a 30mm Northrop Grumman Mk44 automatic cannon, a 7.62mm cannon-coupled rifle and a set of smoke grenades. In the event that they are subject to replacement with the ZSSW-30 in subsequent years as part of the modernization of the ROSOMAK KTO, they could be reassembled, for example, on autonomous/remotely controlled chassis, e.g. FUNTER or HUNTER type, following the example of the US Ripsaw M5 solution. In this situation, the HITWIS tower system should be subject to adaptation to remote control/autonomization. Considering the Polish experience with the automation of KDA cannons and the ZSSW-30 turret system, this should not pose a significant problem.

Figure 20. HITWIS turret system on KTO ROSOMAK chassis

Source: https://bumar.gliwice.pl/strefa-militarna/o/wieza-bojowa-hitfist-do-kto-rosomak (access 15.06.2022)

The study will be tasked with evaluating the possibility of automating and integrating the HITWIS tower system with the FUNTER/HUNTER chassis.

Purpose:

- To combat live force and lightly armored objects in direct contact with the enemy without using soldiers in the line of contact of troops,
- Conducting reconnaissance and combat missions in the enemy's formation without using soldiers in the direct contact line of troops,
- Conduct combat missions in the enemy grouping after landing without using soldiers in the area of direct contact with the enemy.

OTHER PROSPECTIVE WEAPON SYSTEMS ON REMOTELY OPERATED/AUTONOMOUS VEHICLES

Other weapons, support and logistics systems where the use of remotely controlled and, in the longer term, autonomous unmanned chassis is becoming possible are:

- unmanned vehicle for engineering reconnaissance and track;
- unmanned minesweeper;

– unmanned autonomous engineering and counter-chemical reconnaissance vehicle;
– unmanned medical evacuation vehicle;
– unmanned supply delivery vehicle with hook self-loading system;
– an unmanned vehicle carrying a radiolocation station in POPRAD and SOŁA systems;
– unmanned vehicle carrier of a set of very short-range missiles in the POPRAD system;
– unmanned vehicle carrier of PILICA anti-aircraft and anti-drone sets;
– unmanned vehicle carrier of 120 mm RAK ZS mortar;
– unmanned technical evacuation vehicle for KTO Rosomak and LOTR.

Proposal for State Fire Service and Military Fire Service - autonomous fire vehicle for extinguishing high-risk structures

Extinguishing industrial facilities, fuel depots, munitions depots or forests carries a high risk for firefighters, especially during times of heavy smoke or proximity to chemical, fuel or munitions tanks. In such situations, entrusting the extinguishing of an object to a remotely operated/autonomous vehicle becomes invaluable.

Figure 21: Firefighting device based on the use of the SO-03 jet engine of the TS 11 ISKRA aircraft

Source: https://www.trucks.com.pl/2017/09/19/odrzutowy-strazak/ (access 15.06.2022)

The essence of the work in this area is to explore the possibility of integrating a FUNTER or other unmanned chassis with a firefighting device with a water/extinguishing agent tank, allowing it to operate in close proximity to fire outbreaks.

Purpose:

- to carry out rescue and firefighting operations in a fit mode when extinguishing fires of technological installations in high-risk and increased-risk facilities, combat depots, airports,
- securing industrial facilities at risk of fire by cooling them down,
- extinguishing fires of large-volume facilities,
- extinguishing forest fires,
- conducting mass decontamination.

CONCLUSIONS

1. The Polish Armed Forces will soon need unmanned remotely piloted and, further down the line, autonomous vehicles that provide a platform for armaments with an impact force that allows them to flare tanks and armoured vehicles, as well as military equipment whose use in direct contact with the enemy poses a threat to soldiers.
2. Currently, off-road unmanned vehicles with a DMC of 12,000 kg capable of carrying medium-sized weapon systems are not available in the Polish Armed Forces.
3. Priority should be given to developing unmanned systems where it is technologically simple to introduce them and in areas of greatest exposure of vehicle crews to direct enemy action.
4. Unmanned vehicles should be introduced by observing and "copying" implementations from the US Army. At the same time, available domestic solutions should be used, as well as opportunities to conduct joint projects with European market leaders within the framework of the European Defense Agency and the European Defense Fund.
5. It is advisable to develop unmanned systems on the basis of vehicles in operation in the SZ (unmanned vehicles) and to build unmanned vehicles in parallel, based on the achievements of scientific and industrial units to date.
6. The main technological problems to be solved in the near future are the integration of chassis with weapons systems, the construction of good human-machine interfaces, and autonomization in the future.

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