5th International Scientific and Business Conference—Future Engineering 2019
ISBN: 978-1-60595-632-9

Subsonic Unmanned Anti-Tank System SKORPION II—Launches and Recovers

Paweł Dobrzyński[1], Andrzej Frydrychewicz[2], Bogdan Machowski[1] and Aleksander Olejnik[1]

ABSTRACT

The article presents the concept of the SKORPION II anti-tank and anti-submarine system, which could be used as a universal system of destruction of ground and surface facilities or as a support system for air reconnaissance. The unique character of the Subsonic Anti-tank Scoring System SKORPION II and the lack of analogous solutions on the defense market make it difficult to determine the relationship of costs to other analogous projects. A certain approximation of the cost scale may be the comparison of SUAS with approximate prices of modern weaponry, e.g., Predator (single-engine, unmanned reconnaissance aircraft with control and data reading system)—USD 25 million, this price many times exceeds the estimated value of the system (estimated at PLN 1 million) SKORPION II. The cost of purchasing similar products usually does not take into account the fact that, after their purchase, the Polish user has no possibility of its development, because he has neither the knowledge nor the documentation enabling production of his own products of this class. The SKORPPION II system, which is the Subsonic unmanned anti-tank system, allows the levelling of the potential enemy's armour and should only be produced by Polish companies, which could provide a Polish presence outside the US and Israel.

Keywords: aerial anti-tank systems, a universal system of destroying objects, eliminating the armoured advantage, mass use aircraft.

[1]Military University of Technology, 2 Sylwestra Kaliskiego Street, 00 – 908 Warsaw 46, Poland
[2]Warsaw University of Technology, Pl. Politechniki 1, 00-661 Warsaw, Poland

PRELIMINARY

The use of aircraft as an effective weapon against armoured troops has been known since the times of WWII. The most well-known anti-tank planes were: JU-87 Stukas, He-129 and IL-1 and IL-2. These aircraft were characterized by strong weapons, and, in the case of He-129 and IL-2, armour protecting the engine and crew. In the 70s of the last century, there was a return to this idea, which resulted in assault aircraft: A-10 and Su-25.

In both cases, the ability to survive on the battlefield provided them with powerful armour. Both of these planes are used today, where there is a need to destroy tanks, vehicles, or ground reinforcements. Due to its geographical location and the shape of the area and neighbourhood of the Russian Federation, Poland is particularly vulnerable to the attack of large armoured forces. Therefore, he needs an effective anti-tank plane in his arsenal. Considering the number of tanks of the aggressor, it must be a "mass use" aircraft.

Striving to implement this idea in 1990-1995, the design of the PZL-230 SKORPION battlefield plane was developed. This project in relation to A-10 and Su-25 was characterized by possessing light armour. In exchange, it had to have previously unknown manoeuvrability as a means of defense. Despite the fact that the project had the support of the army and enjoyed the interest of foreign co-operators who actively supported the project (engine, avionics), PZL-230 SKORPION fell victim to the political games of the Third Republic.

Today, the need for such a means of struggle is far greater, it also seems that a formation (the Territorial Defense Forces) was formed, in which such a system would have the greatest justification. Moreover, the development of aviation electronics and unmanned aircraft based on it allows the construction of a battlefield plane in a different way. A serious limitation of PZL-230 SKORPION's manoeuvrability was the maximum overload that a human can withstand, while the pilot's cabin and the catapult seat imposed large dimensions of the self-flight. An unmanned aircraft can be much smaller and therefore more manoeuvrable, which increases its survival capabilities, but also reduces production costs.

As a result of the analyses carried out at Warsaw University of Technology and Military University of Technology, the price of a free attack aircraft equipped with several unguided missiles may be lower than one manoeuvring missile and the effect, in the form of destroyed vehicles, may be greater than in the case of a bomb attack or missile attack rocket. For the Polish assault aircraft to be used in conditions of complete aggression in the air, it must be small, difficult to detect from the air, and start from hidden launchers (airports will be destroyed in the first phase of the conflict). Its high manoeuvrability allows it to operate at a minimum altitude where classical airplanes will be helpless.

Based on the above assumptions, Warsaw University of Technology (WUT) and Military University of Technology (MUT) have signed a consortium agreement aimed at obtaining financial resources for the construction and testing of the prototype of the autonomous subsonic anti-armour system (code name SKORPION II) that could be used as a universal system for destroying ground and surface facilities or as a system support of air reconnaissance.

It should be emphasized that MUT together with Military Institute of Armament Technology (MIAT) and EUROTECH, in the years 2009-2012, took part in the scientific-industrial consortium and the development of the demonstrator of the Unmanned Impact Vehicle designed to destroy targets in the zone of the responsibility of the Land Forces Brigade (PBR R 00 0044 09). The research and development project was completed successfully but has not been implemented, and critics claimed that Poland does not need such a strike measure. The same specialists were delighted with the effectiveness of the Israeli "drone kamikaze" used in the fights in the Caucasus [6].

The only product implemented in this category in Poland is the WARMATE [7] Circulating Ammunition System. It is an innovative product in the family of unmanned systems of the WB GROUP, characterized by lightweight construction and the possibility of carrying out various types of missions. WARMATE is successfully used by Polish and foreign armed forces and may play a key role on the future battlefield.

TACTICAL AND TECHNICAL ASSUMPTIONS OF THE PROJECT

According to the authors, the project of SUAS SKORPION II (Fig. 1) (**Subsonic Unmanned Antitank System**) “shoot and recover" is an innovative breakthrough in the area of armed struggle strategy. The breakthrough consists in equipping the subunits of the Polish Armed Forces with a new type of weapons, allowing for its quick use from a safe distance, using the element of surprise and on building and introducing a new generation of armed robots for ground, air, and surface fight, with considerable autonomy of operation.

Dimensions

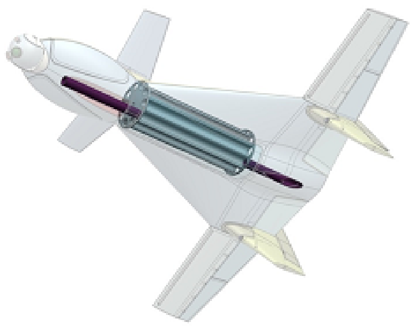
wingspan	4.5 m
length	4.5 m
support surface	5.1 m2
lengthening the drone	3.9

Performance

stall speed	115 km/h
combat speed	800 km/h
pitch	6000 m
time of return by 180 degrees	4 s
long-term combat flight	30 min
permissible overload	15
loading the surface	69-108 kg/m2

Skorpion II

WYMIARY	
Rozpiętość	4.5 m
Długość	4.5 m
Powierzchnia nośna	5.1 m^2
Wydłużenie	3.9



OSIĄGI	
Prędkość przeciągnięcia	115 km/h
Prędkość bojowa (h = 0m)	800 km/h
Pułap	6000 m
Czas zawrotu o 180 deg	4s
Długotrwałość lotu bojowego	30 min
Dopuszczalne przeciążenie n_z	15
Obciążenie powierzchni	69 – 108 kg/m^2

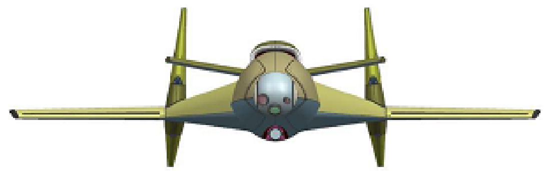


Figure 1. Basic dimensions and performance of the SUAS SKORPION II [8].

The SUAS project combines the advantages of a small jet plane that does not require airport infrastructure (it can take off from anywhere: land, farm building roofs, deck/ship, floating platform, railway platform, forest clearing, etc.) with modular rocket and innovative equipment control system. The whole gives an effective method of attacking vehicles and objects of the enemy while having the advantage in the amount of expensive and complicated mechanized and armoured equipment. The integrated system is distinguished by the following:

- Simplicity and reliability of the structure,
- Simplicity of use and service,
- Total immunity to E-M interference,
- Low price,
- Low indicators of mass-dimensional characteristics,
- High universality and modularity of the structure, and
- High reliability of system operation in unpredictable situations.

An important characteristic of SUAS is its ability to operate autonomously, resulting from the fact that AUV does not have to use any active systems to communicate with other control or navigation systems (e.g., GPS, teletransmission, telemetry, etc.).

SUAS operation is based on pre-programmed systems and in-line navigation (IMU) allowing for the following:

- Flying to the area selected by the operator before the start, after the trajectory determined by him (at an extremely low altitude—the use of terrain and permanent objects to mask the starting point and his own route);
- Finding, using sensors (mainly OE's warhead), the targets of the attack, in the area covered by the Wap control status (Weapon Free), while ensuring the blocking of the attack in the areas covered by ground handling weapons control status WH (called Weapon Hold);
- Attack with 10 guided missiles (or a 250-ft bomb) of detected objects;
- Return to the designated landing area; and,
- Finding a landing site (flexible network).

During the mission, the SUAS does not communicate with the ground operator or generate any active radio signals. The following situations are an exception to this rule:

1) During the arrival, the SUAS may occasionally use a radio altimeter or laser rangefinder (during the attack itself, the frequency of use of the radio altimeter may be relatively high).
2) During the "in swarm" flight, after reaching the place of attack, the first machine from the formation informs the other (encrypted by radio) about the coordinates of the detected attack targets.
3) During a mission using laser guided missiles, SUAS can radio the terrestrial operator about the time it has left to reach the attack site.
4) At the moment of receiving from the ground the encrypted radio signal CE (Cease Engagement), it confirms with the encoded radio signal "abort of combat" (and departure to the backup place of attack).
5) Just before reaching the landing area, the SUAS turns on the position lighting LEDs and informs the ground staff about its position, using a short radio signal (waiting for the radio signal of permission to land and exact coordinates of the catching grid).
6) Shortly before the SUAS on-board computer generates a self-winding signal (e.g., due to defects resulting from damage obtained during the fight), the SUAS sends, with full power, an encrypted radio signal with location information and the reason for starting the self destroy procedure.

The estimated duration of the SUAS mission is 15-30 minutes. During this period, the SUAS should reach the area of attack at a speed of about 800 km/h, launch 10 missiles from the rocket launcher-magazine of missiles, and return to the landing site (where a flexible net maintained by pneumatic pillars awaits it).

The method of SUAS's operation is best defined by the phrase "fire and recover."

INNOVATION OF THE "SKORPION II" PROJECT

The SUAS project meets all of the following criteria that are generally accepted for innovative projects:

1) MINIATURIZATION.

The SUAS fulfills the miniaturization criterion, which can be proved by the fact that its predicted span is < 4.8m, the its own drone weight is < 250 kg and the engine mass is < 42 kg (Fig. 2), which is a fraction of the weight of even the lightest pilot systems capable of carrying launchers with anti-tank missiles with a calibre of 70 mm.

Skorpion II

Engine	**MicroTurbo classes TRI 40**
engine starting string	340 daN
pitch	6000 m
fuel consumption	< 1.2 kg/daN
price	~ 50 000 $
Weight	
fuselage	200 kg
drive	50 kg
armament	100 kg
fuel	180 kg
navigation and pilot system	20 kg
starting weight	550 kg

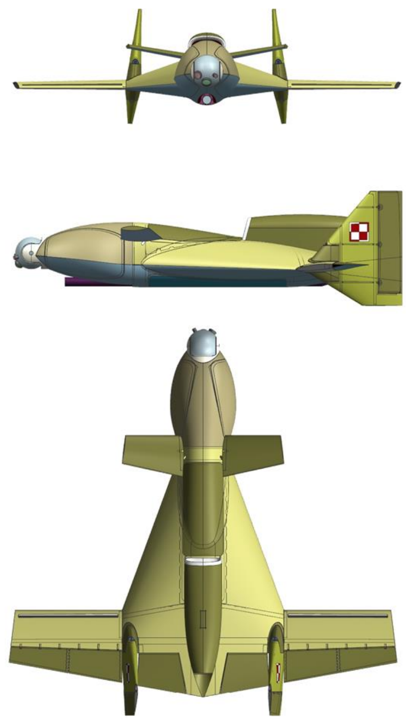


Figure 2. The assumed engine and mass parameters of SKORPION II [8].

During the development of the SUAS concept, it was assumed that it will be supported by only two operators who will be able to assemble the entire structure on the launch pad in just 5 minutes! Thanks to this, SUAS will be difficult to detect not only at the starting position, but also during the flight to the attack site or during transport to the starting position.

2) DYNAMICS OF ACTION/SPEED.

The simulations carried out at the Warsaw University of Technology and the Faculty of Mechatronics and Aviation WAT indicate that SUAS will be characterized by high dynamics and high manoeuvrability. This construction has been calculated and designed for a maximum permissible overload of n = 15 (with an assumed ceiling of max. 6 km). The use of "Canard" type rudders and the care of aerodynamic details by the main airframe builder Ing. Andrzej FRYDRYCHEWICZ [1, 2] allows us to assume that SUAS will be a highly manoeuvrable object, whose flight parameters will significantly hinder the enemy's anti-aircraft defense, other UAV, or tactical aviation.

3) LOW DETECTION

The poor radar and optical detection of the SUAS results from the miniature airframe dimensions and from the composite materials that are expected to be produced. Extremely low flight altitude, significant speed, and manoeuvres using terrain, a small reflecting surface, and no radio emission make the SUAS (like its protoplasts—manoeuvring missiles) one of the most difficult to detect air objects. Another argument that supports the inclusion of SUAS in weakly detectable systems is the passive system of the detection of attack targets by the O-E head.

4) SURPRISE EFFECT

SUAS gives the opportunity to get a surprise effect, and thus, the opponent's inability to counteract. The possibility of starting the UAV from any place causes that the potential opponent of the RP will be forced to take into account the combat potential of the SUAS in its operations (Fig. 3). The SUAS project has the features of an innovative solution that currently does not find its equivalent, either on the domestic or foreign market.

5) INCREASING THE PERFORMANCE

The scope of SUAS's operation will be achieved by the use of modern knowledge regarding the production technology of miniature aircraft structures and turbo-jet engines. The maximum reach of SUASs can be compared with much more complex (and several orders of magnitude more expensive) systems currently available to the Polish Armed Forces:

- Cannon -howitzer KRAB (range: 40 km, mass of a projectile 40 kg);
- SKORPION II (range: 2x100 km, mass of rocket weapon/bomb: 100 kg/250 pounds) (Fig. 4);
- Missile manoeuvres Naval Strike Missile (range: 200 km, mass of the warhead: 125 kg); and,
- Stand-off JASSM (range: 370 km/ take off from the aircraft/, mass of the warhead 454 kg).

As you can see, the SUAS ranging parameters and firepower put this system in the group of colloquially known systems as "Polish fangs."

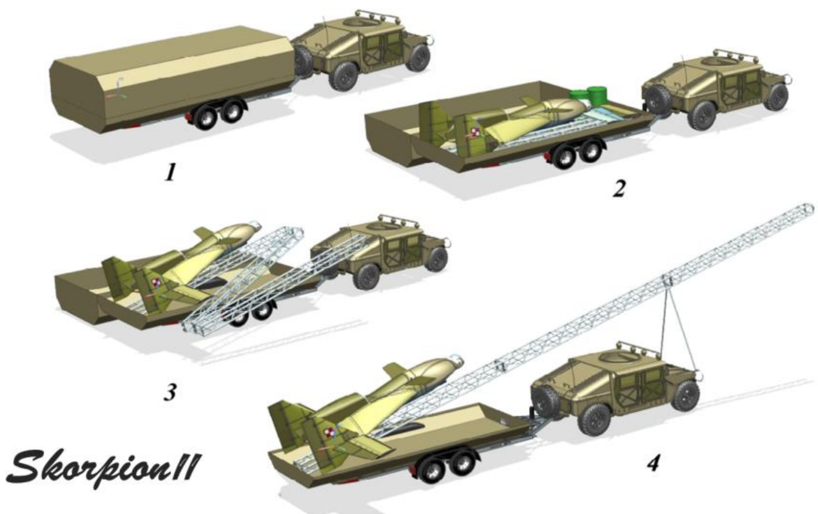


Figure 3. One of SUAS SKORPION II transport and start variants [8].

6) POSSIBILITY OF AUTONOMOUS ACTION/IN A SWARM

The project of SUAS includes building a distributed multi-agent technology system for controlling a group (swarm) of autonomous unmanned aerial vehicles (ABAL) for performing tasks distributed over the space within one mission on a predetermined territory. For this purpose, an innovative methodological apparatus was used for the development of distributed intelligent control systems for a team of robotic mobile sub-systems that are objects of a new generation. This method allows solving important tasks of synergic operation of a group (swarm, Fig. 5) of ABAL robots and providing important competitive advantages, such as flexibility and efficiency, effectiveness and scalability of operations, and the reliability and vitality of the entire system.

7) MODULARITY AND VERSATILITY AT LOW COST

All elements of the SUAS project have a modular structure. This applies to both the physical airframe layer and the structure of control, navigation, and weapon systems (Fig. 8). The most important program blocks can be distinguished among autonomous, mutually communicating, pro- gram modules for the following:

- Artificial swarm intelligence software;
- Support for a miniature radio receiver;
- The operation of sensors and on-board equipment;
- Attack and defense algorithms;
- Image processing module and O-E head control;
- A module for airframe, drive, lighting and radio altimeter;
- Handling the missile-launcher or bomb hole;
- The inertial counting navigation system (IMU); and,
- Support for the jet engine and fuel tank.

The versatility of the SUAS results from the adoption of the fuel standard for the turbojet engine (JP8, JP10) and the adoption of NATO standards STANAG 4110, 4425, 4367 for the launcher—as a dimension of 2.75 "(70 mm). All electronic modules will communicate with each other using a redundant LAN network, and each of the modules will be connected by means of standard connections used in the aviation/automotive industry. The project also includes the essential components of NATO standard STANAG 4586, regarding the interoperability of unmanned aircraft and Unmanned Control Systems. This defines architecture, interfaces, communication protocols, data elements, and message formats. Thanks to this treatment, each of the SUAS modules can be developed and improved independently of the others. It guarantees easy development of the entire SUAS as it acquires further technologies useful for this construction.

8) STABILITY OF WORK UNDER ANY CONDITIONS

Stability of SUAS operation, regardless of conditions, will be ensured, among others, thanks to the turbojet engine. Modern engines of this type, regardless of temperature, environmental conditions, or the length of storage time of the UAV, retain constant invariable parameters of work without the need to perform any service. The same advantage is characteristic of 70 mm missiles, whose main source of propulsion is a solid rocket engine.

Figure. 4. Predicted ranges SUAS SKORPION II [8].

9) USE OF KNOWLEDGE/TECHNOLOGY IN A NON-STANDARD METHOD

According to the concept authors, SUAS will use the knowledge of Polish defense companies and technical universities. Without the commencement of development works, it is very difficult to identify technologies that would be difficult or impossible to develop in this country, and failure to achieve these goals would mean a failure of SUAS implementation. The project provides for the partial use of technologies already acquired as part of projects already implemented. An example of a non-standard approach to the knowledge base is the assumption of the feasibility of a project that combines the advantages of two seemingly mutually exclusive flying objects, i.e. a manoeuvring missile and an attack aircraft.

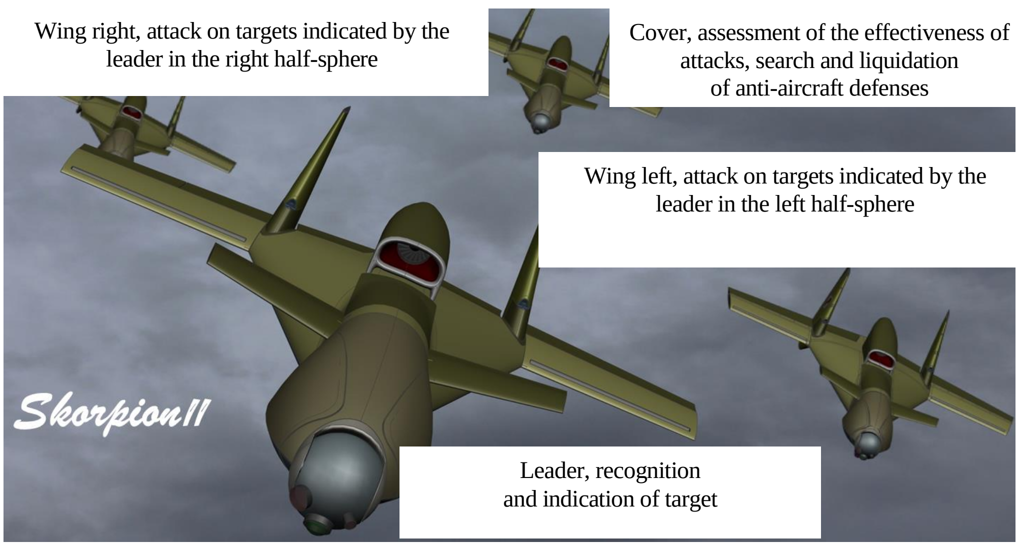


Figure 5. A typical formation and role of individual UAVs [8].

10) INTELLECTUALIZATION OF TECHNICAL SYSTEMS

The SUAS system, acting as an autonomous one, also in the swarm, is distinguished by the ability to use elements of artificial intelligence. On-board software with information provided from the machine's sensors can generate a signal to attack and select the place of impact. The flow of information between objects, due to restrictions created by the air environment, forces the intellectualization of the technical solution, the core of which is program modules. The project documentation describes them as follows:

- Hazard analyser and action counter generator (manoeuvres, flares);
- Analysis of the type of the target and its surroundings—selection of the optimal method of attack;
- A marker of objects already destroyed, excluding them as targets of re-attack;
- Manoeuvre controller with the task of reducing the probability of being detected during the arrival time;

- A self-liquidation trigger (e.g., when defects in control systems are detected);
- Advanced system diagnostics;
- Machine positioner based on a digital map and image analysis of the ambient TV;
- A communication module with the environment including: laser range finder, altimeter and radio communicator; and,
- A meteorological module (automation of engine operation parameters, flight and launch of rocket missiles).

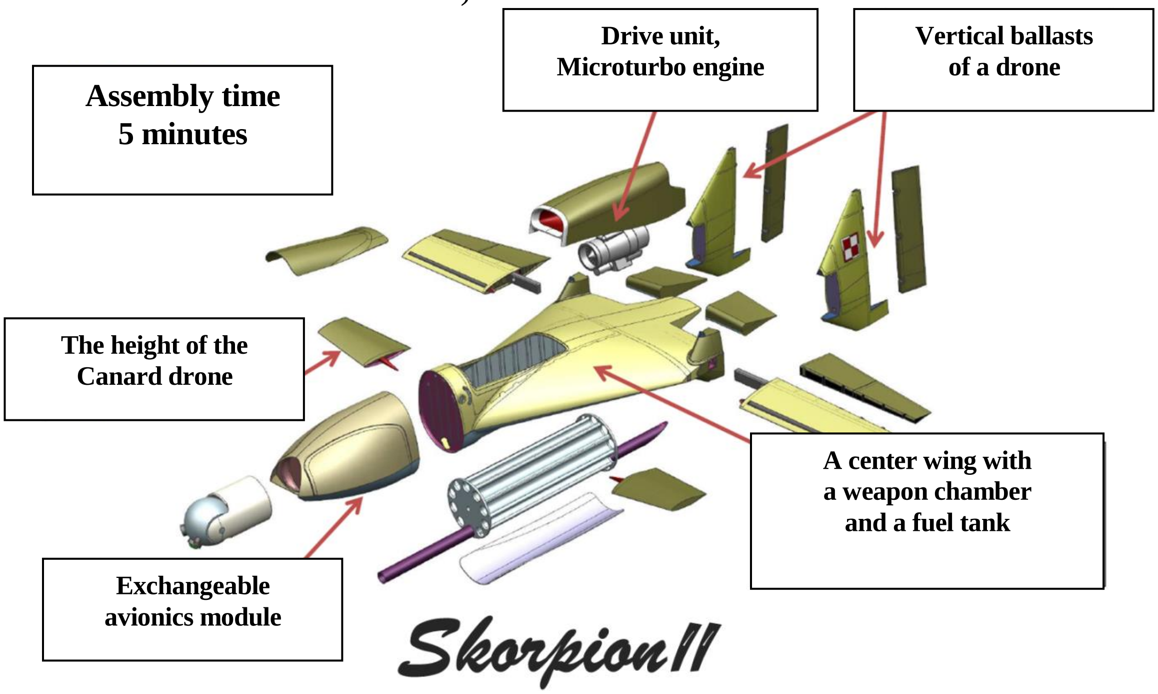


Figure 6. Illustration of the modular SUAS SKORPION II construction [8].

INTENDED USE AND ARMAMENT OF SUAS SKORPION II

Subsonic Unmanned Antitank System SKORPION II is a system designed for all types of Polish Armed Forces. In particular, SUAS will be assigned to activities based on the surprise principle of the opponent, including the following:

- Offensive operations leading and supporting operations of land, air and sea formations;
- Territorial defense, especially during retaliatory operations;
- Use during special operations and irregular activities, including the rear of the opponent;
- SUAS machines can be easily used for destroying armoured and other equipment in marching columns or for destroying buildings, airfields, and other military objects;

- Machines of the SUAS system due to small dimensions can be especially useful in sea and amphibious operations, as they are ready to attack within a few minutes, together with the launcher on ships, ships, barges, surface boats, and submarines!

Impact on capabilities (revised/built) by developing and implementing SUASs:

1) The use of relatively cheap subsonic unmanned autonomous flying platforms can carry anti-tank missiles as part of the system allows building mobile, low-cost effective combat means at these ranges.
2) Completely passive operation of the system in the detection, tracking, and an impact mode allowing the system to be hidden, plus the detection of armoured vehicles as well as airplanes and helicopters, independent of their technology with a system has self-defense capabilities and limits the effectiveness of the attack by objects of air attack or effective interaction of the enemy.
3) Effective impact on point and surface targets using the same projectile calibre in a wide range of ranges from the universal platform is the dream of every military commander.
4) Ground forces or Special Forces performing tasks to fight enemy groups across the country could effectively affect an enemy equipped with armoured vehicles within a range of up to 100 km. In missions justified by the tactical situation, there is the possibility of using SUAS is foreseen as a "kamikaze mission" (mission without return). In this situation, the purpose of the SKORPION II attack may be distant from the place of its start by approx. 250 km.
5) Effective direct impact can be made on the following:

- Elements of drive systems (wheels, tracks, engines) of moving ground, surface and underwater objects;
- Light tactical fortifications and the opponent's live strength;
- Mobile ground or surface facilities marked with a laser illuminator;
- Fixed terrestrial or surface objects marked with a laser illuminator or known geographic coordinates;
- Road, rail and sea infrastructure with known geographical coordinates;
- Enemy helicopters located in the ground zone; and,
- Airplanes on the runway or in hangars.

6) Implementation of tasks is related to:

- Reconnaissance and diversion missions;
- Support for one's own troops in situations characterized by high dynamics; and,
- Tying down short-range enemy's anti-aircraft defenses in operations using one's own aviation.

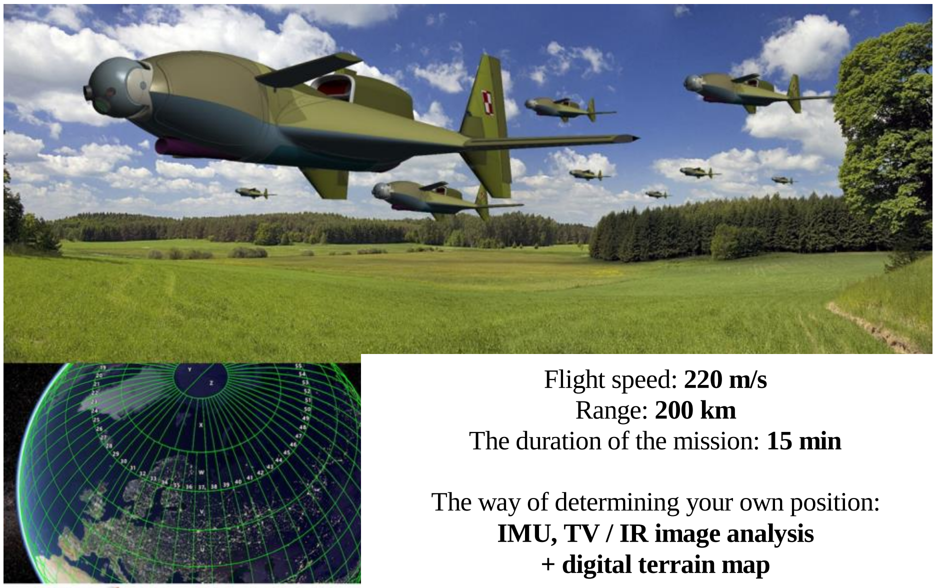


Figure 7. The assumed way of SUAS SKORPION II navigation [8].

7) The ability to remotely destroy armoured weapons, helicopters, and fortifications using the following (Fig. 8):

- Unguided 70 mm rocket missiles with a cumulative and fragmentation warhead (HEDP);
- Unguided missiles with a calibre of 70 mm with a special head (HE Submunition, WDU Flechette, illuminating, etc.);
- Self-guided 70 mm rocket missiles with a HEDP head;
- Self-guided for laser illuminator 70 mm rocket missiles; and,
- Self-guided miniature torpedoes with a calibre of 70 mm with a HE head.

In 2012 at the Faculty of Mechatronics and Aviation of the Military University of Technology, at the Institute of Mechatronic Systems (formerly the Rocket Technology Institute), the problem of the urgent need to modernize the Polish Armed for Missile Self-Defense Systems V-SHORAD was noticed. A team was formed among the scientific staff of the institute, which set itself the goal of finding a solution to the problem by implementing new types of homing heads and infrastructures with increased ranges and power of the warhead at the expense of their manoeuvrability.

The design of such a projectile was codenamed "LANCA."

Figure 8. Predicted armament SUAS SKORPION II [8].

The simplicity of the proposed solution results from the features of the fire system proposed by the WAT specialists, which, missing from the MANPADS sets, is owned by Ministry of Defense. This is based on the following:

- There is no need to have a complicated mechanism to launch the rocket, which simplifies the system's operation, its reliability, and also speeds up the speed of operator training.
- Lack of on-board gas-cooled detectors, since all required signals for the autopilot is obtained from the mosaic detector and the appropriate application software.
- There is no spin of the projectile, making it possible to use analogue controls and novel missile control algorithms developed in MUT.
- There is the possibility of firing "straight ahead" or shooting at "catch in flight."
- It can be used in sets of marching motors purchased in NATO countries (e.g., adapted from the Hydra-70 system, compatibility of weapon systems).
- The efficiency of the warhead is increased by increasing the amount of explosives by eliminating the gyroscopic optical tracking head (typical for MANPADS missiles).
- Simplification of logistics and transport safety are achieved by the modular construction of missiles that enables separate transport of each of its elements (e.g., marching engine, fuse, warhead, etc.) in dedicated collective packaging.

Based on the data of the 2.75 "Hydra system with the MK 66 MOD 6 engine, a series of simulation tests were carried out, examples of which are shown in Figs. 9 and 10 [3]. The simulation results confirm the assumed tactical and technical design requirements for the LANCA system. The strong argument for the urgent need to implement missile systems proposed by the team is that their operation is cheap and practically maintenance-free (use would only require emergency training of soldiers loading rocket missiles on the launcher).

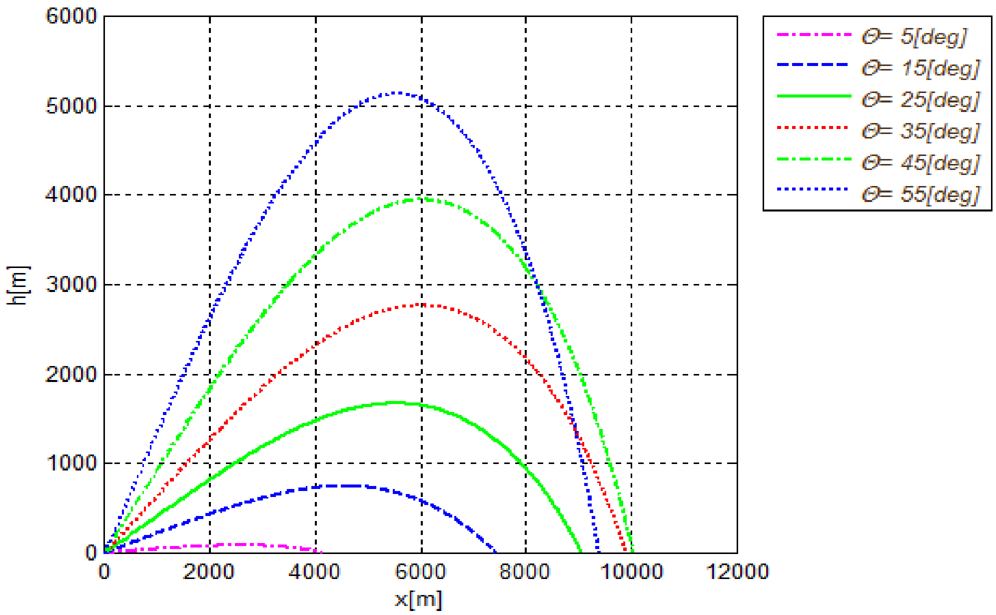


Figure 9. Rocket flight path 70 mm (2.75 ") for a parametrically variable starting angle.

In order to better illustrate the possibilities of such a system, the author's team proposed a comparison of different types of missiles using a graph (Fig. 11), including two indicators—E_T transport efficiency defined as

$$E_T = \frac{m_{GB}}{m_{PR}}, \quad (1)$$

where

- m_{GB} [kg]—mass of warhead;
- m_{PR} [kg]—the mass of the entire missile,

and E_{PZ} speed and range efficiency defined by the formula:

$$E_{PZ} = V_{PR} * R_{PR} \, , \qquad (2)$$

where

- V_{PR} [m / s]—maximum speed of a missile;
- R_{PR} [m]—the range of a missile.

The modern missile system is not only a rocket missile and its control, but also the technology of chemical production and precision mechanics. It also includes advanced systems of communication and fire control, flight control and tracking, proximity sensors and igniters, and navigation systems. It is also a necessity to appoint and obtain competences necessary for, for example, servicing them, which is often overlooked when deciding to purchase a rocketing technique.

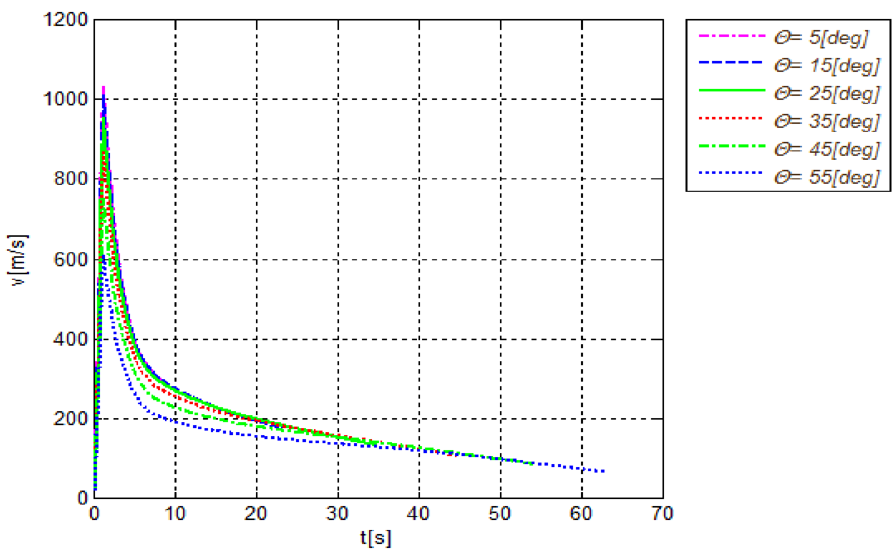


Figure 10. Changing the flight speed of the 70mm rocket (2.75 ") as a function of time for a parametrically variable starting angle.

The project can be of great importance to entities that are expected to be the leading in the process of further development and implementation of the SUAS idea - among them you can include the following:

- Institute of Technical Air Forces (main research and certification centre, armament 70 mm);
- MESKO S.A. (supplier of rocket components and missiles 70 mm);
- PCO S.A. (producer of optoelectronic systems);
- Military Aviation Works No. 1 (manufacturer of composite airframe elements);

- Military Aircraft Works No. 2;
- Polska Grupa Zbrojeniowa S.A. (initiation of financing sources, commercialization and co-ordination of the project);
- Zakład Produkcji Specjalnej "GAMRAT" Sp. z o.o. (supplier of components of the star platform);
- Stomil Poznań S.A. (supplier of rubber components and seals);
- Military Automotive Works (supplier of UAV equipment components);
- Wytwórnia Sprzętu Komunikacyjnego "PZL-Kalisz" S.A. (supplier of mini turbojet engines);
- Wojskowe Zakłady Elektroniczne S.A. (supplier of the electronic component).

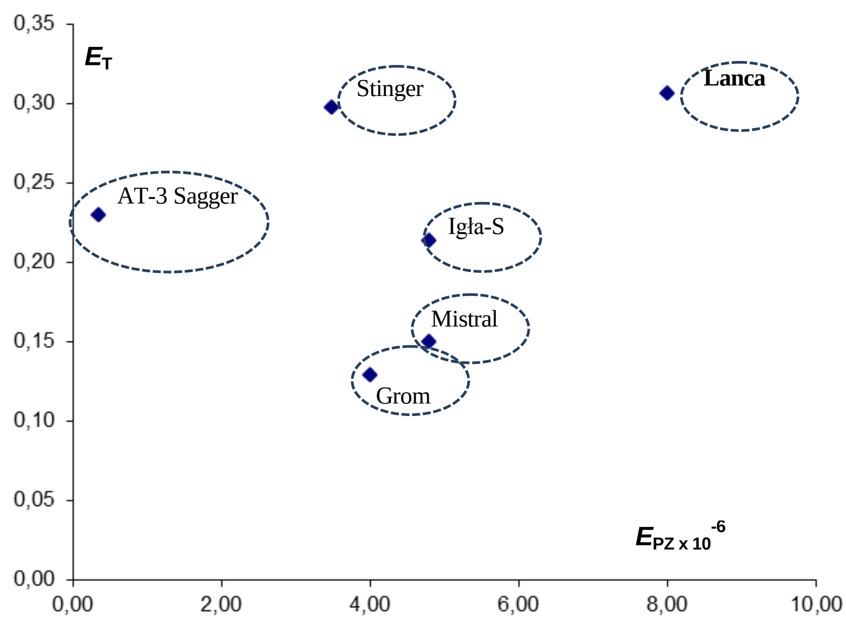


Figure 11. Comparison of parameters of selected rocket systems in the space of transport efficiency (E_T) and speed-range (E_{PZ}).

CONCLUSIONS

In 2018, in the Concepts category, the Chapter of the 4th EDITION of the "INNOVATIONS FOR POLISH Armoured Forces" Competition appreciated the project and awarded a distinction to the scientific consortium of PW and WAT for "Sound unmanned anti-tank system without pilot—"Shoot and Recover." Authors of the application were Paweł Dobrzyński, Andrzej Frydrychiewicz, Stanisław Lipski, Bogdan Machowski.

The project of anti-tank UAV may be of great importance for the entities that are expected to be the leaders in the process of further development and implementation of the SUAS concept. They include the following:

- Air Force Institute of Technology (main testing and certification centre, weaponry 70 mm);
- MESKO S.A. (supplier of rocket component and weaponry 70 mm);
- PCO S.A. (manufacturer of optoelectronic systems);
- Military Aviation Works No. 1 (manufacturer of composite airframe components);
- Military Aircraft Works No. 2 (continued);
- Polska Grupa Zbrojeniowa S.A. (initiating sources of financing, commercialization and coordination of the project);
- Special Production Plant "GAMRAT" Sp. z o.o. (supplier of starter platform elements);
- Stomil Poznań S.A. (supplier of rubber components and seals);
- Military Automotive Works (supplier of equipment components for BSL);
- Wytwórnia Sprzętu Komunikacyjnego "PZL-Kalisz" S.A. (supplier of miniature turbojet engines);
- Wojskowe Zakłady Elektroniczne S.A. (supplier of electronic component).

The implementation of the SUAS project may bring about a significant increase in the area of the competence of all the above mentioned participants in the process of implementation of the SKORPION II system, not only in Poland, but also internationally. It will also make it possible to achieve competence in designing various types of manoeuvring missiles, which could only have been the subject of costly purchase by Polish society and its Armed Forces in the past.

The unique character of the SKORPION II Sub-Pilot Non-Pilot Anti-Tank System and the lack of similar solutions on the armaments market make it difficult to determine cost ratios to other similar projects. Some approximation of the scale of costs may be a comparison of SUAS with approximate prices of modern armament, e.g., Predator (single-engine, unmanned reconnaissance aircraft with data reading and control system)—$25 million, F-16A Fighting Falcon (single-seat, multi-purpose, lightweight fighter aircraft)—$25 million, Tomahawk (cruise missile) - $1.3 million. Their price many times exceeds (estimated at about PLN 1 million) the value of the SUAS SKORPION II system set. The costs of purchasing products similar to PBSP usually do not take into account the fact that the Polish user, after purchasing them, one does not have the possibility to develop them, because one does not have the knowledge or documentation to produce one's own products of this class.

An example of a missed opportunity is the SKORPION project, Figure 12.

The fate of this project was briefly presented in the history of "PZL-230 Scorpion."

On the other hand, the history of another work by Eng. Andrzej Frydrychiewicz, the plane "FLARIS: a private jet"[4], made its first flight, has recently had a positive ending.

Meanwhile, in the real world, we are dealing with a return to the concept of a light aircraft of the battlefield [5].

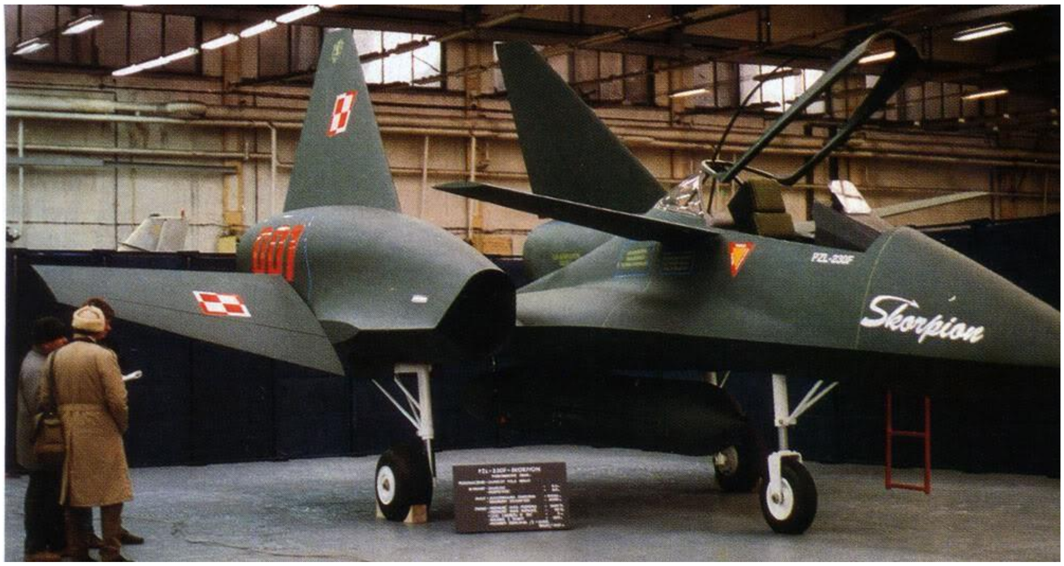


Figure 12. SKORPION aircraft model [9].

REFERENCES

1. Mroczek, A. 2016. *Konstruktor. 26 rozmów z Andrzejem Frydrycheweiczem*. Wydawnictwo Galaktyka.
2. Polityka: *Pan samolocik opowiada*. Available from: https://www.polityka.pl/tygodnikpolityka/nauka/1514942, 1, pan-samolocik-opowiada.read [Accessed 30 April 2019].
3. Dobrzyński, P., S. Lipski, B. Machowski, and T. Olszewski. 2018. "Koncepcja polonizacji pocisków rakietowych kalibru 2,75", *Problemy mechatroniki. Uzbrojenie, lotnictwo, inżynieria bezpieczeństwa*, 9(2):157-178; DOI: 10.5604/01.3001.0012.1109.
4. Polski Przemysł: *FLARIS: prywatny odrzutowiec? Wystarczy 1,5 mln euro*. Available from: https://polskiprzemysl.com.pl/przemysl-lotniczy/flaris-lar-1-jednosilnikowy-samolot-odrzutowy [Accessed 30 April 2019].
5. Defence24: *Scorpion - wielki powrót lekkiego samolotu pola walki*. Available from: https://www.defence24.pl/scorpion-wielki-powrot-lekkiego-samolotu-pola-walki [Accessed 30 April 2019].
6. Wprost: *Izraelski "dron-kamikadze" użyty w walkach na Kaukazie*. Available from: https://www.wprost.pl/swiat/535506/izraelski-dron-kamikadze-uzyty-w-walkach-na-kaukazie.html [Accessed 30 April 2019].

7. Grupa WB: *System Amunicji Krążącej WARMATE*. Available from: https://www.wbgroup.pl/produkt/bojowy-bezzalogowy-system-powietrzny-warmate [Accessed 30 April 2019].
8. *SKORPION II subsonic anti-tank system—"Shoot and Recover"*. Presentation for the Competition of the Ministry of Defense "Innovations for the Polish Armed Forces".
9. Pokazywarka: *Polski przemysł zbrojeniowy—projekty, koncepcje, prototypy. PZL-230 Skorpion*. Available from: https://pokazywarka.pl/3fk1l0/#zdjecie4055191 [Accessed 30 April 2019].