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TECHNICAL NOTE

UNMANNED AERIAL VEHICLES (UAVS) - THE FUTURE OF AERIAL BATTLEFIELD?

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Background: The authors describe the use of unmanned aerial vehicles in contemporary battlefield as well as certain non-military applications of the UAVs. Legal issues regarding protection of human rights and health hazards for operators resulting in obligatory entry-level and periodic health examinations are also discussed.

Keywords: medical examination, military and civil applications, unmanned aerial vehicles

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INTRODUCTION

Unmanned aerial vehicle (UAV), unmanned aerial system (UAS), or drone is an aerial vehicle requiring no on-board crew and incapable of transporting passengers. UAVs are classified into two types including remotely piloted or autonomous aircraft. Unmanned aerial vehicles are used for both military and non-military purposes.

The possible scope of non-military applications is very broad and may include:

- internal security and crisis management systems;
- monitoring of forest resources;
- geometric measurements and geology;
- environmental protection;
- meteorology;
- delivery services;
- agriculture;
- exploratory and rescue missions;

In the armed forces, UAVs are currently used mostly as observation and reconnaissance devices, and therefore are usually equipped with optoelectronic heads. When armed and intended for combat operations, the vehicles are referred to as unmanned combat air vehicles (UCAVs).

FUTURE APPLICATIONS

Recent advances in aviation technique, including manufacture of continuously improved unmanned platform systems, were aimed, among others, at increased safety of airborne crews, opening the way to reducing their use in military operations (reconnaissance flights, delivery of equipment and supplies, mine sweeping, target identification and strikes, etc.) and certain particularly dangerous situations related to these operations. UAVs would also be particularly useful in areas affected by mass destruction weapons and in areas where the risk of the loss of life by the airborne personnel and the likelihood of aircraft destruction is too high to justify the mission. As already mentioned, UAVs protect the health and lives of airborne personnel while bringing multimillion savings resulting from reduction in losses of combat airplanes as a result of shot-downs. It is obvious that due to the technological economic, and military potential, the most advanced designs of unmanned aerial vehicles are developed in the United States. As part of the global strategic procedure of the USA, drones have been used for quite a long time in military conflict zones such as Afghanistan, Iraq, Yemen, or Syria. In recent years, UAVs were also used in the fight against the Islamic State. As the results of the use of UAVs in contemporary battlefields are very promising, the designers compete in the variety of forms and uses of these devices while conducting new experiments regarding the use of UAVs in the battlefield [1,3,6].

The dominant direction in the development of new weaponry consists in introduction of unmanned systems that may perform tasks without the involvement of manned forces that might pose risk to the soldiers. In near future, the use of unmanned aerial vehicles will bring about significant changes in the use of airspace, bringing new quality as well as causing new problems in air traffic management. Small, unregistered drones used in the airport areas may pose risks to passenger planes upon take-off or landing. One must not rule out the possibility that a failure of even a small unmanned aircraft may pose risk to an outsider.

UAV REGULATION

Considering the possible risks associated with unmanned aerial systems, all countries, including Poland as the member of the EU and NATO, must adjust their airspace use regulations so as to fulfill their obligations with regard to the European law and ensure the safety of flights, including the safety of civilian aircraft. Legal regulation of the safe use of unmanned aerial vehicles should be forced ahead, separating the UAV traffic from the traffic of other aircraft, determining rules for airport use and establishing the criteria for granting UAV use permits.

All civil aircraft (both manned and unmanned) are subject to the Chicago Convention on International Civil Aviation [4]. The International Civil Aviation Organization (ICAO), a UN agency for the supervision of the development and safety of air transport, defined the deadlines for implementation of regulations regarding individual categories of unmanned platforms:

- by 2018 - preliminary integration with airspace traffic, excluding no-drone zones;
- by 2028 - full integration ensuring airspace operation transparency, with unmanned systems being visible for air traffic control services and capable of communicating with these services.

In Poland, the report regarding the use of unmanned aerial vehicles developed in 2013 by the Civil Aviation Office (ULC) highlights the potential variety of applications while stating that the lack of regulation to date was not an obstacle for the progress in unmanned aviation [9]. Following the 2011's amendment of the Aviation Law, UAV flights are subject to certain conditions. Besides the US regulations (Federal Aviation Administration (FAA)

"Unmanned Aircraft Operations in the National Airspace System" 72 FR 6689, 13 February 2007) [5], the Polish regulations are among the least restrictive worldwide as flights of civil UAVs with takeoff weight not exceeding 25 kg are generally allowed for recreational or sporting purposes without any permit requirements; the aircraft does not have to be registered and the user has no obligation to hold an additional civil liability insurance or any certificates. Flight permits and compliance with environmental requirements or noise standards is not required either.

HUMAN RIGHTS ASPECT

A very important problem that remains to be solved following the introduction of unmanned aerial vehicles, particularly when used for military purposes, is the broadly understood protection of human rights. This is due to the fact that the use of UAVs in military or anti-terrorist operations is associated with the death of numerous civilians as was the case during military operations in Afghanistan, Iraq, Yemen, Pakistan, Gaza Strip, Israel, and Somalia. These problems should be considered by the UN Human Rights Council that had been formed to promote human rights and fundamental freedoms and that serves to respond to all cases of human rights encroachment worldwide. The Human Rights Council focuses on providing support to the Member States by participating in dialog, establishing institutional structures and delivering technical aid to ensure compliance with human rights-related requirements. These goals are achieved in collaboration with national governments, regional organizations, state institutions and non-governmental organizations involved in protection of human rights. By its authority, the Council proposes recommendations to the UN General Assembly with regard to the further development of international law within the scope of human rights.

UAVS IN POLISH ARMY

The United States, being the leader in construction of unmanned aircraft platforms, had suggested the need for a global vision of use and modernization of these combat assets as early as in the late 1980s. The first plan including different types of armed forces was developed in 1988 (Master Plan for UAV Development). Polish armed forces are currently at the stage of introducing the vision for implementation, use and development of UAVs as combat assets meeting the army's operational requirements. In terms of UAV potential, our air forces are rather modest as compared to other NATO forces; steps are being taken by the Ministry of Defense to change this situation. Thanks to the Afghanistan mission where Polish soldiers cooperated with American soldiers using MQ and Predator devices in different combat operations, our experience in the use of UAVs increased significantly. Currently, the UAVs are used mainly as auxiliary weapons, particularly useful for reconnaissance purposes. However, in recent years, UAVs have also been successfully used at the strategic level. They are also very important at the operational and tactical levels.

Reconnaissance imaging concept was introduced into the Polish Armed Forces' technical modernization plan for years 2009-2018, including the purchase of 86 UAVs of mini-to-medium altitude long endurance (MALE) class (operational level), tactical medium-range unmanned aerial systems (division level), tactical short-range unmanned aerial systems (brigade level) and mini unmanned aerial systems (subunits), including vertical take-off and landing systems. Some difficulties were encountered with regard to execution of orders, but the situation is about to change within a short time and large unmanned systems, including systems armed with guided missiles, will be purchased [7].

Widespread use of UAVs is imminent since manned planes such as, for example F-16, albeit being well equipped with observation modules, are not completely safe for observation of theater zones. For this purpose, manned aircraft should be supported by UAVs equipped with highest-class reconnaissance equipment. Sending UAVs into combat zones is much easier since it protects pilots' lives as well as costly military assets. Losses incurred as the result of an UAV being shot down are less bothersome from the standpoint of safety and costs.

UAVS OPERATORS' SELECTION

The order of the Commander General of the Armed Forces regarding the organization of aviation training as regards selection, training, and granting instructor licenses to UAV pilot operators, was issued for implementation and detailed arrangements within individual types of armed forces. The entity responsible for implementation of all undertakings pursuant to the order is the Polish Air Force Inspector while the training base is provided by the Polish Air Force Academy in Dęblin.

The detailed scope of the order includes the rules for selection of candidates for instructor training and identifies personality traits required for proper implementation of tasks as well as motivation required from an UAV operation instructor. The order also includes an assessment of aviation expertise required to start the instructor training, the scope of theoretical knowledge required from UAV pilot-operators to become UAV system instructors, the scope of practical training required from UAV pilot-operators to become UAV system instructors, the principles for granting instructor flight licenses and definition of the UAV instructor duties.

At the first stage of recruitment and selection, candidates for instructor training will be selected from experienced military aviation staff members as the instructor cadre must provide the training core for future candidates for UAV pilots and operators recruited from the civilian population.

UAV pilot operator instructor training must include, among others, the assessment of interpersonal capabilities as well as the principles of psychology, didactics and education with particular focus on:

- aviation psychology;
- crew cooperation;
- techniques for assessment and selection of candidates for pilot operators and trainees;
- human abilities and limitations;
- briefing techniques, including practical training;
- completion of detailed documentation (task fulfillment evaluation cards);
- ethical aspects of the instructor-trainee relationship;
- principles of education and didactic methods.

UAVS OPERATORS' HEALTH CHECK

Following the selection of candidates for instructor training, the candidates are referred for entry-level or periodic health examinations at appropriate Regional Military Aviation Medical Examination Commissions to undergo appropriate medical and psychological examinations. The scopes of these examinations, developed by specialists from the Military Institute of Aviation Medicine and members of the Regional Military Aviation Medical Examination Commissions and presented in Tab. 1. and Tab. 2., guarantee appropriate selection of candidates for instructor trainings as well as appropriate monitoring of psychophysical status of instructors in the future [1,2,3,4].

Upon the development of the scope of examinations, it had to be kept in mind that humans, albeit not being on board of the UAV, remain an important element of its operation by providing an essential link in the platform control process as well as observing the theater and launching the missiles [2,8]. Therefore, a problem arises regarding appropriate selection of candidates meeting appropriate criteria in terms of both physical and mental health. Psychological examinations are of particular importance. Performance of UAV operator tasks is comparable, in terms of focus requirements, to that of air traffic controllers which is considered stressful and exhausting, requiring special mechanisms for the control of work regimens with appropriate breaks and working time limits. UAV pilots, often being secluded for many hours, must make difficult decisions while observing the theater and potentially directing bomb strikes, sometimes aimed at populated targets, while observing the situation on the monitor screen. Witnessing the aftermath of bomb strikes is very stressful and has negative effect on mental state of operators. The sight of casualties leaves a mark in operator's mind, oftentimes leading to the development of post-traumatic stress disorder (PTSD), as realistically described by an American drone pilot, Brandon Bryant, diagnosed with PTSD after several years of service. Data available in American literature contain numerous examples of significant mental decompensation that has a tendency to escalate, be difficult to treat, and sometimes leads to acts of violence or suicide attempts. The incidence of PTSD in UAV operators is higher than that in combat plane pilots, posing a significant problems e.g. for the US Army. As mentioned before, traumatic events may lead to the development of post-traumatic stress disorder.

The American Psychiatric Association defines not only the possible causes of PTSD, but also its possible implications such as life threat and the accompanying helplessness. This includes the permanent reconstruction of the traumatic event, trauma-related nightmares, rumination, obstinate avoidance of memories and situations that brings the trauma to the mind, and overall reduction of reactivity - avoidance of feelings and thoughts associated with trauma, avoidance of being reminded of important aspects of trauma, and demonstration of emotional chill in interpersonal relationships.

Troublesome symptoms of psychophysical agitation include:

- difficulties with falling asleep or sleeping;
- concentration problems;

– irritability;
– aggression;
– outbursts of anger.

One of the commonly repetitive symptoms of PTSD is the strong tension caused by any reminiscence of the traumatic event or any object bringing the event to the mind, as well as an intrusive feeling that the event is taking place again.

CONCLUSIONS

Considering the above, problems associated with appropriate selection of UAV pilot operators are of utmost importance. A question should be asked regarding the personality traits of future UAV operators. One must be aware that UAV operators must consider the possibility of being forced to remotely kill humans while observing the area under attack. This would have a tremendous impact on their mental state. In addition, situations requiring the operator to remain in seclusion, often within a shelter, for many hours, must cause adverse stress-related effects directly affecting the operator's mental health. Therefore, periodic examinations and, particularly, entry-level examinations, should include special psychological examinations consisting not only of tests used in plane pilot examinations, but also of individual approach to every candidate, with attention being paid to their life to date, all possible circumstances and sometimes concealed existential, family, or intellectual problems. Private and family lifestyle may provide additional information useful when formulating the opinion regarding candidate's suitability for the position of an UAV operator. Clinical experience shows that many psychological dysfunctions are manifested during teamwork in psychophysical burden conditions. What are, therefore, the optimum traits of a UAV pilot operator? According to the opinion of the Head of the Military institute of Medicine's Department of Psychiatry and Combat Stress, col.

Tab. 1. The scope of entry-level examinations for unmanned aerial vehicle (UAV) pilot operator candidates.

•	Analysis of medical documentation.	
•	Specialist medical examination (internal diseases specialist, surgeon, laryngologist, neurologist, dentist, gynecologist in case of female candidates).	
•	Psychological examination.	
•	Anthropometric measurements.	
•	Laboratory investigations:	Blood type and Rh factor (by indication), hematology with blood differential test, ESR, VDRL;
		Urinalysis;
		Serum levels of glucose, bilirubin, creatinin, urea, uric acid, sodium and potassium;
		Serum activity of transaminases (AST, ALT);
		Lipid profile (total cholesterol, LDL and HDL cholesterol , triglycerides),
		Hepatitis B, hepatitis C (HbS-Ag, anti-HCV antibodies) and HIV (anti-HIV antibodies) screening tests;
		Qualitative screening for illicit drugs and certain medication in urine (marijuana, cocaine, amphetamine, extacy, morphine, methadone, benzodiazepines, others),
		Genomic tests (DNA tests) - if not performed before.
•	Radiological examination (X-ray) of chest organs.	
•	Resting electrocardiographic (ECG) examination.	
•	Echocardiographic examination (ECHO).	
•	Treadmill exertion test (according to "Simulator" software/Bruce protocol).	
•	Ultrasonographic (USG) examination of abdominal organs.	
•	Radiological examination (X-ray) of the entire spine.	
•	Magnetic resonance imaging (MRI) of the entire spine - by indication.	
•	Corneal topography.	
•	Contrastometric examination.	
•	Eye refraction test.	
•	Radiological examination (X-ray) of paranasal sinuses.	
•	Computed tomography (CT) examination of paranasal sinuses - by indication.	
•	Tone threshold audiometry.	
•	Electroencephalography (EEG).	
•	Pantomographic examination of dentition.	
•	Cytological examination - in female candidates.	
•	Other additional and specialist examinations by indication.	

Radosław Tworus MD, PhD, "the UAV pilot operator candidate is a physically and mentally mature individual with life, military and war experience. They have the experience of commanding and being commanded, saw suffering an death, saved lives and killed to save other lives; they should be aware that being UAV operators they would have to kill in a much more efficient manner and have to do it only for a just cause in line with their own conscience. Thus, the profession of an UAV pilot is a profession for a very experienced soldier rather than a position for a freshly uniformed rookie".

The aforementioned scopes of entry-level and periodical health examinations are included in the draft of the Manual for Medical Examinations of Military Aviation Personnel currently under the final stage of evaluation by the National Consultant in Aviation Medicine and National Consultants in individual medical specialties pointed out by the Military Health Care Inspectorate.

Tab. 2. The scope of periodical health level examinations for unmanned aerial vehicle (UAV) operators (performed biannually).

•	Analysis of medical documentation.	
•	Specialist medical examination (internal diseases specialist, surgeon, laryngologist, neurologist, dentist, gynecologist in case of female staff members).	
•	Psychological examination.	
•	Anthropometric measurements.	
•	Laboratory investigations:	Hematology with blood differential test, ESR, VDRL;
		Urinalysis;
		Serum levels of glucose, bilirubin, creatinin, urea, uric acid, sodium and potassium;
		Serum activity of transaminases (AST, ALT);
		Lipid profile (total cholesterol, LDL and HDL cholesterol , triglycerides),
		Qualitative screening for illicit drugs and certain medication in urine (marijuana, cocaine, amphetamine, extacy, morphine, methadone, benzodiazepines, others),
		Genomic tests (DNA tests) - if not performed before.
		Genomic tests (DNA tests) - if not performed before.
•	Radiological examination (X-ray) of chest organs.	
•	Resting electrocardiographic (ECG) examination.	
•	Treadmill exertion test (according to "Simulator" software/Bruce protocol) - by indication.	
•	Radiological examination (X-ray) of the entire spine - every 4 years.	
•	Magnetic resonance imaging (MRI) of the entire spine - by indication.	
•	Contrastometric examination - every 4 years.	
•	Amsler Grid Eye Test - after the age of 50.	
•	Eye refraction test.	
•	Glare test - every 4 years.	
•	Mesotest - every 4 years.	
•	Radiological examination (X-ray) of paranasal sinuses - by indication.	
•	Computed tomography (CT) examination of paranasal sinuses - by indication.	
•	Tone threshold audiometry.	
•	Cytological examination - in female staff members.	
•	Ultrasonographic (USG) examination of genital organs in female staff members - by indication.	
•	Other additional and specialist examinations by indication.	
•	Other additional and specialist examinations by indication.	

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