UNMANNED AERIAL VEHICLES – A SOURCE OF NEW THREATS IN CIVIL AVIATION

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ABSTRACT
The presence of unmanned aerial vehicles in the airspace is affected by stimulating the development of aviation but also led to the creation of a new kind of threat. The variety of design and versatility of their applications made unmanned aerial vehicles widely available to all people. The number of flight incidents involving UAV was largely caused by failure to follow the rules of safe operation and the lack of experience of the operator. Due to the effects which may entail collision with an unmanned aircraft, aviation authorities and the users themselves take a series of measures aimed at their elimination.

KEY WORDS
UAV, safety, aviation, operation, events.

DOI: 10.26410/SF_1/17/6

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Introduction

The development of unmanned aerial vehicles recorded in recent years made that they are considered as a new type of aviation. The lack of legal regulation, the popularity of the drones, the possibility of their use in many areas make the drones are commonly operated. Therefore, the presence of unmanned aircraft commonly called drones generates a new kind of threat to traditional users, or manned aircraft and airport infrastructure. In the future UAV[1] will be making the same number of air operations as traditional planes. In the United States, on the basis of the analysis of Federal Aviation Administration it was concluded that the number of registered UAV significantly exceeds the number of aircraft and helicopters. In Poland the UAVs number of operators constantly is also increasing.

In the past, unmanned aerial vehicles were used only for military purposes, now modern UAV with the power they possess are used in many areas. Transport, logistics, rescue, forestry, agriculture, science, entertainment are not the only numerous areas in which applying unmanned aerial vehicles is universal. Unmanned aerial vehicles can perform air operations with the diverse degree of the progress, in extreme weather conditions, places hard to reach and thanks to new technologies, in addition to flights, they can also serve other purposes, which considerably influences and determined the development of their applications. Persist-

[1] Unumanned Aerial Vehicles.

ent presence of unmanned aerial vehicles in the airspace, the lack of qualifications, the knowledge of laws, rules, security, air traffic, and the number of air events involving UAVs is growing steadily. Therefore unmanned aircraft are considered to be a threat not only by the public but mainly by staff. This shows that drones are not only regarded as a new era in aviation, but mainly as a potential source of threats.

The development of the UAV

Unmanned aerial vehicles are permanently present in the sky, therefore it is necessary not only to pass appropriate legal regulations but also define their role and future that has been specifically included in an Aviation Strategy for Europe of 7 December 2015. In part "Progress in the innovation, digital technologies and investment" an attention was devoted to the UAVs development. The strategy proposes a legal framework in order to ensure the safety of the industry and includes privacy concerns, data protection, security and the environment[2]. By 2020, the European Union plans to invest 430 million euros per year in the research project called Air Traffic Management in the single European sky, the SESAR[3]. Appropriate investments in innovative technologies can give Europe a leading role in the field of international air transport. The most important elements of the Aviation Strategy for Europe include the proposal for a new regulation, which is intended to replace Regulation (EC) No 216/2008[4]. Adapting the European air safety system to future challenges is aimed at a designed regulation, among others by creating appropriate, separate regulations for functioning of the dynamically growing market of unmanned aerial vehicles. National aviation authorities are also implementing new provisions on performing air operations on unmanned aerial vehicles. To a large extent, the future of aviation depends on the opening of the European market for unmanned aerial vehicles, which is an important new area of investment for European entrepreneurs. The UAV market is primarily a source of technological innovations that have a significant impact on economic growth in the coming years. The lobby of the service industry and the air industry insistently also appeal to European authorities to introduce drones to the single market. The UAV development leads to increased possibilities of their applications and thus to an increase in air operations, which in turn stimulates the integration process with manned aviation, but also increases the possibility of adverse events.

Incidents with uavs

The statistics provided by the ASRS Database Report show that the most frequent cases of endangering the safety of aviation are too close and uncontrolled movement of unmanned aircraft. Such situations frequently arise from the loss of control of the ship, the lack of experience in flying UAVs, knowledge of the safe operation and often recklessness and an amateur approach of users to operating it[5]. Easy availability of UAVs and low cost make that the holders of unmanned aircraft are often children, and the operation is treated in a superficial way, combined with a lack of knowledge of the provisions of air law and of principles of performing flights, are causing air ac-

[2] Accessedon: http://ec.europa.eu/transport/modes/air/news/2015-12-07-aviation-strategy_en (access 4.03.2017).

[3] Single European Sky ATM Research – the program which is the technological pillar of the single European sky. Its purpose is to develop and implement a modern system of air traffic management.

[4] Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC.

[5] Unmanned Aerial Vehicle (UAV) Reports, National Aeronautics and Space Administration, 2016.

cidents. Additionally, one should consider the factors that man has no influence on such as the change in the direction of the wind, disadvantageous meteorological conditions which can also be the cause of the accident. The events of different type are systematically recorded and there are assessed risks and threats of joint usage of the airspace based on their diversity. In the media it is more and more often possible to listen about unmanned aerial vehicles which violate the rules of using the airspace, collide with planes of airlines. Events take place in many airports worldwide. Compact UAVs can cause the damage which in the end can result not only in the breakdown but also a plane crash of the largest passenger aeroplane. An airline pilot does not have a possibility of observing the earth, he isn't gifted to provide for possibilities of the collision with small drone. Event in the air the plane with a drone can lead to an explosion of fire and many other complications that are a threat to passengers. Nowadays a lot of incidents occur in which unmanned aerial vehicles unlawfully violate the airspace, damaging the passenger aeroplanes. Many cases include incidents at London's Heathrow Airport. While Airbus A320 belonging to British Airways with 137 people on board was landing, it collided with the drone also the same type of aeroplane when flying to London has encountered in its path the drone performing a flight. Both airplanes passed each other scarcely in the distance of 20 meters. Its pilot spotted the unmanned flying engine on the tip of the right wing of the aircraft, and then over his ballast. He managed to avoid a collision, as the pilot managed to pass by unmanned aircraft[6]. In the United Kingdom more than two million UAVs are used. In just half a year, 23 cases were reported when UAVs approached flying aircraft, 12 of which were considered as the highest-risk incidents. British Airline Pilots' Association reported that in just one month, 7 incidents of networks were reported, four of which were classified as category A (serious risk of collision). BALPA suggested conducting research concerning effects of the collision of passenger aeroplanes with UAVs. According to experts, the more unfortunate collision can damage engines and windscreens of cabins of planes. UAV falling into the engine could cause the uncontrolled scattering of many metal parts. A plane can fly without one engine, but metal pieces flying with the quite big speed can damage containers of fuel and hydraulic lines. They can also hit pilots in the cockpit.

One of the many events took place at the Warsaw airport. The plane of German airline Lufthansa passed the drone. The pilots immediately notified the tower. The incident took place when the Embraer 195 flying from Munich to Warsaw with 122 passengers on board approached to a landing. Pilots suddenly noticed that there is a drone only 100 m from the aircraft. Immediately air traffic control service decided to change the direction of landing of another aircraft. It launched a procedure to notify the police about the threat to air traffic. Embraer 195 landed safely at Okęcie Airport. Prosecutor's Office in Cracow in cooperation with the Internal Security Agency is investigating a similar incident that occurred in 2014 in the military part of the International Airport Cracow-Balice, where an offense was committed with the use of UAVs, which consisted in the breach of the rules of air traffic and caused the risk of air crash. For such incident a drone operator can be sentenced to eight years in prison.

In Los Angeles, Airbus A380 Lufthansa in the flight LH 456 from Frankfurt to Los

[6] Accessed on: https://www.theguardian.com/technology/2016/apr/28/heathrow-ba-plane-strike-not-a-drone-incident (access 06.03.2017).

Angeles nearly collided with an unmanned aerial vehicle just 22 km from the airport at an altitude of almost 1500 m. The crew noticed the drone from the cockpit because it was about 60 m above the plane. The German security service of air transport now warns that drones are the danger to air transport. They are calling for registering the equipment to the purpose of the simpler identification. German specialists think that for that purpose one should–install transponders UAVs registering the height, direction and the airspeed[7]. A similar incident occurred near Charles de Gaulle Airport in Paris. The drone flew only a few meters next to the Airbus A320 of the airline Air France. A plane flying from Barcelona was approaching the airport, when the second pilot on the left side of the plane saw the drone. The pilot decided to exclude the autopilot and to pass helms. Boeing 737-700 belonging to the airline, Linhas Aereas de Moçambique (LAM) was a domestic flight, when at the time of the landing it was struck by an unidentified object. Crew heard a loud bang, but in spite if this they decided to continue the approach. Initial examination showed significant losses; the collision with an UAV resulted in serious cracks on the front of the hull.

Unmanned aircraft are present also in the airspace where flights performing military aircrafts. One of the Polish F-16 fighters stationed in the 31st Tactical Air Base in Krzesiny near Poznań suffered in an incident involving an "unidentified" flying object. According to official information provided by the command of the base, the plane it was damaged but managed to land. After landing, which went smoothly according to the filed flight plan, a technician noticed scratches on the hull of the machine during routine aircraft maintenance. During the flight, the pilot did not receive any signals of irregularities of the flight, and all on-board equipment worked correctly and the flight itself went smoothly without interference. After landing the plane was found to have damaged protective coating and under the fuel tank, as a result of which the machine was moved away from the flights, and appoint the Commission is examining the circumstances in which it came to the event. Where part of the UAVs would get to drive may favour completely damage and stop the engine during the flight, which led to a serious situation, not only for aircraft but also for the crew. Aerial events involving unmanned aerial vehicles are already common, which is why it is extremely important to introduce prevention in order to reduce adverse events.

Prevention

Experts from The Colorado Agricultural Aviation Association decided to check if the pilot is able to notice the middle class quadcopter. As part of experiment pilots had the task performing the flight to a few places and advising whether while performing the flight they noticed current in UAVs air. Pilots before performing the flight were informed of the UAVs presence. The outcomes of the experiment allow to state that even pilots informed of the UAVs presence in the airspace weren't able to notice them. The pilot of the helicopter having a greater visibility from the cockpit wasn't also able to notice UAVs[8]. The presence of drones in the sky is often compared to the presence of birds, for which the air space is a natural habitat. Collision of aircraft with birds, "bird strikes" usually ends in "scratching the body" – it is dirty, dented or detachment less significant portion of the aeroplane, but still allows continued flight.–Thus, in "favorable"

[7] Accessed on: http://www.latimes.com/local/lanow/la-me-ln-drone-near-miss-lax-20160318-story.html (access 06.03.2017).

[8] Accessed on: https://www.aopa.org/news-and-media/all-news/2015/october/08/unseen-drone (access 10.03.2017).

conditions, RPAS[9] is able to pull apart the covering wing and get stuck in it, possibly can bounce from the wing or fuselage and crack, if there is a collision in the leading edge or in the bow of the aircraft.

Mercatus Center, an American non-profit scientific organization operating at George Mason University, published a report which shows that small civilian drones are just as little dangerous to other aircraft as flying birds without any control of the airspace. Mercatus Center analyzed data from the past 25 years, coming directly from the FAA and concerning the cases of threats caused in American airspace by wild birds. In U.S. airspace lives 10 billion birds. It is definitely more than the number of UAVs ranging from professional to completely amateur, of which there are many. For many years the FAA has collected data about the collisions of birds with aircraft and has stored them in the National Wildlife Strike Database since 1990. The database contains only voluntarily report events so in fact there may be much more. The data show, that in spite of a huge amount of the fowl, air accidents with the participation of birds very rarely appear. But birds still are the biggest danger in the vicinity of major airports and at the specific height. Procedures to scare away birds from such zones, however, are imroving. Perhaps in the future for the purposes of deterrence of birds off they will be used RPAs. In the rest of the airspace the risk of collision with the birds is now smaller. Therefore, if drone operators abstain from flying near airports, it will significantly reduce the probability of collision. In the CTR strict control zones, and especially within a few hundred meters from the runway drones should not fly unless they officially get permission from TWR[10]. The release of unmanned aerial vehicle in the airspace around airports without the consent of the Polish Air Navigation Services Agency is forbidden and is considered a criminal offence, because it represents a direct threat to the safety of air traffic. Air traffic services do not have appropriate resources and powers to monitor the area around the airport. The illegal presence of drones in the airport area brings many consequences, not only for the drone operator, but above all for commercial aircraft engaged in flight operations at the airport. In many countries, aviation authorities have started social campaigns in order to prevent accidents related to unmanned aerial vehicles and disseminate knowledge about their use. In Poland, the Civil Aviation Authority issued a special leaflet containing basic principles of sport and recreational flying, related to the prohibition of flights over people, close to airports, cities and buildings, as well as on the roads.

[9] Remotely Piloted Aircraft Systems.

[10] Tower

Figure 1. Information leaflet

Source: http://ulc.gov.pl/pl/uav/4002-lataj-z-glowa-kampania-informacyjna-ulc (access 10.03.2017)

The activities of prevention include mobile applications available to all users of unmanned aerial vehicles. DroneRadar is an application dedicated to civil operators. By using the application, one can quickly and easily check whether you can fly drones in a given place and time. DroneRadar informs other airspace users about performed flight. DroneRadar has positive recommendations by the Civil Aviation Authority, Air Rescue and the State Commission on Aircraft Accident Investigation[11]. Another application is the DRONE Safety Checklist. It is addressed to operators engaged in both recreational and commercial UAV operations and to training centres as a learning resource. It was developed at the Department of Aviation Technology at the Silesian University of Technology and is compatible with international ICAO Circular 328 Unmanned Aircraft Systems (UAS) and Manual on Remotely Piloted Aircraft Systems (RPAS) or Doc 10019, and also Annex 19 ICAO Doc 9859. Creating the relevant legal system, mobile applications, social campaigns, stricter requirements in relation to the use of drone is just not many activities aimed at minimizing air events but also supporting the process of integration, which is of great importance to aviation safety.

[11] Accessed on: https://droneradar.eu/info (access 10.03.2017).

Figure 2. Description of the functioning of the DroneRadar application

Source: http://www.swiatdronow.pl/droneradar-polska-aplikacja-mobilna-dla-operatorow-dronow (access 10.03.2017)

Integration of uavs in the airspace

A key element in the development of unmanned aircraft is common to the functioning of the human spaceflight for civil aviation. The presence of unmanned aircraft and their development is beneficial and stimulating to the European aviation market and forces the development of suitable conditions for the operation of air space between the UAV and traditional users. The process of integration also affects the competitiveness on the market. According to the report by the Vision Gain's brand company, in 2014 the market of unmanned aerial vehicles reached the value of 1.3 billion USD, and until 2025, this figure can rise to the level of 10.2 billion USD. The European services sector also records the positive effects of the presence of UAVs. The new area which is the use of unmanned systems, forces not only the creation of new jobs but also the need for the creation of certified training centers and facilities for science and research.

Integration is also a step into the future of civil aviation, the introduction of UAVs to the single sky and the continuous technological development of the structure allows for the implementation of new applications and can use not only service providers but the whole European Community that uses the opportunities offered by the UAV. Another advantage is the fact that the European Commission in the framework of the new budgetary perspective provides funding for companies operating in the unmanned aviation industry under Horizon 2020[12] and COSME[13]. The integration process is primarily depends on the creation of an adequate system of legal acts governing the operation of UAVs. The integration process is associated closely with the development of remotely controlled systems,

[12] A funding programme for research and innovation in the European Union.

[13] COSME is the EU programme for the competitiveness of enterprises and small and medium-sized enterprises for the period 2014-2020.

therefore, it is essential to perform flights in an open air space and participate in air traffic in the full sense of these words. The ability to perform flight operations of unmanned aircraft in VMC visibility conditions or based on appropriate systems on-board equipment in different classes of airspace determines UAVs new requirements for on-board equipment. Therefore, to take full advantage of the air space the UAV will have to be equipped with appropriate devices. Due to the large number of air events, the integration process has become necessary to ensure aviation safety and proper use UAVs in the airspace.

Conclusion

The appearance of unmanned aircraft on the civil market has allowed the emergence of a new kind of aviation sector but also contributed to the creation of new sources of danger for the safe functioning of civil aviation. The European Commission compares the development of the industry of civil UAVs to the development of computers, mobile phones and the Internet. The equipment is becoming more and more perfect, has more and more opportunities, but first of all, it is available for an average citizen. The scale of using unmanned aircraft is still increasing, which makes that they are treated as normal airspace users. According to „Forbes", in 2025 UAVs will constitute 10 percent of the European aviation market, and over the next quarter of the century, only in Europe 150 thousand new jobs related to the operation of UAVs will emerge[14]. A new legal system, prevention efforts, awareness of the society, the education of future users is one of the few activities that impact minimizing the risk of adverse events in aviation involving unmanned aircraft. However, field aviation is which, constantly is involving a certain amount of risk, and in daily operations, it cannot be completely eliminated.

[14] accessed on: http://www.forbes.pl/rynek-dronow-sie-rozrasta-do-czego-sluza-drony-,artykuly,194141,1,1.html (access 13.03.2017).

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