ANALYSIS OF THE ACTUAL CONDITIONS OF THE UNMANNED AERIAL VEHICLES OPERATION IN SR AND IMPLEMENTATION OF THE STANDARDIZED KNOWLEDGE BASIS INTO THE EDUCATION PROCESS

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Summary. The article deals with the analysis of conditions of the unmanned aerial vehicles operation in the area of Slovak republic by the legal and also juridical persons with regard to the actually valid legislation. Based on the studies, rules and regulations the article summarizes requirements on the knowledge basis of the applicants for the license for the unmanned aerial vehicles operation. An important attribute of the utilization possibilities of the unmanned aerial vehicles is their safe and secure operation in the mission area. Within this context also the issue of the implementation of the standardized knowledge basis into the education process is discussed.

Keywords: unmanned aerial vehicle; aviation legislation; Transport Authority; education; license

1. INTRODUCTION

It is common knowledge that aviation belongs to the most quickly developing sectors of the human activities. The desire for flying has been known since the ancient times. During the last several tenths of years we can observe a very fast technological development from a short one-minute flight to the space flights. Supersonic flight speeds have been achieved and the civil aviation is worldwide spread. The aviation transport has become relatively financially available and above all in comparison with other types of transport it is very safe. Nowadays it is possible to state that in today's globalized world the safe and quick aviation transportation have become inevitable.

Recently unmanned aerial vehicles (UAVs) have had more and more application possibilities. A UAV is a vehicle without a pilot directly on a board of this vehicle; a pilot (or operator) controls a vehicle from the ground. As the overwhelming majority of new technical inventions also UAVs had been developed and used at first in the army. The development of the modern technologies and their common availability caused that these vehicles have been available also for the wide public. On the present a remotely controlled aerial vehicle is affordably priced practically almost for everyone regardless of the theoretical knowledge and practical experience with flying.

The differences in the UAVs operation in comparison with the manned aircrafts requires creation of several specific regulations which takes into account this differences from the legislation point of view. The condition of the UAVs operation in the SR airspace is a permission that is issued by the Transport Authority based on the successful accomplishment of the specified theoretical and practical examination.

2. UAVs OPERATION

Till lately the UAVs neither in the area of SR nor in the aviation transportation and other application areas have been practically not used. It was caused by several factors. Primarily there had been no appropriate legislation for their operation, which would clearly specify conditions of the UAVs operation in the airspace together with other transport aircrafts.

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Other reason was no domestic production of the UAVs. In addition the UAVs which can transport freight or people would have to fulfil the same requirements as other transportation aircraft, including multiple backup of all systems against the malfunction and failures. Current UAVs are valuable especially because of their performance, price and safety.

In regard to the fact that UAVs production and utilization have not been in Slovakia developed, no intense attention has been paid to the area of the legislation.

In the Slovak republic the UAVs operation is in the competence of the Transport Authority that issued the Decision No. 1/2015 from the 19.08.2015 [1] and the Decision, which together with the § 7, section 2 low No. 143/1998 from the Collection of Laws and subsequently amended specifies conditions to perform flights by the aircraft capable to fly without a pilot in the Slovak republic airspace. This Decision involves UAVs with the maximum take-off weight up to the 150 kg. These vehicles can perform flights in the airspace only according to the conditions specified by the Transport Authority after the agreement with the Ministry of Defence of the Slovak republic.

Toys, even if capable of flying but not equipped with internal combustion engine, are subject to the Directive 2009/48/EC.

Unmanned Aircraft Systems (UAS) and in particular Remotely Piloted Aircraft Systems (RPAS), when used for civil applications and with an operating mass of 150 kg or more are regulated by the European Aviation Safety Agency (EASA) according to the Regulation (EC) No. 216/2008.

EASA is supporting the European Commission to progress a regulatory framework for unmanned aircrafts. In December 2015, the EASA published a technical opinion which contains, in its section 4, an update of the roadmap published by the European RPAS Steering Group (ESRG) in 2013.

EASA also supports the work of the ICAO UAS Study Group. So far ICAO has published Circular 328 (2011) on UAS and amended Annexes 2, 7 and 13 to the Chicago Convention to accommodate RPAS intended to be used by international civil aviation. EASA has already published:

- Guidance material to support approved Design Organisations (DOA or AP-DOA) to select the appropriate certification specifications (among the ones applicable to manned aviation) from where to build the certification basis for RPAS design (E.Y013-01));
- NPA 2012-10 to transpose amendment 43 to ICAO Annex 2 into Standard European Rules of the Air (SERA).

On the 31.07.2015 EASA launched a consultation process on a new regulatory framework for drones. This document (A-NPA) [2] presented the new regulatory approach for safely operating remotely piloted aircraft. This flexible approach, (based on the 'Concept of Operations for Drones' [3]), provides a set of rules which are proportionate and risk based. In other words, safety requirements are in relation to the risk an activity poses to the operator and to third parties (e.g. general public). The greater the risk is, the higher the requirements are. This is done in order to ensure that there is no compromise in safety, but there is a flexible environment for this promising industry to grow. In order to assist in better understanding the A-NPA and to encourage participation in the consultative process a Summary of the A-NPA, was developed. The consultation process ended in September 2015. The outcome of the consultation process is the Technical Opinion on the operation of drones published on 18.12.2015. This opinion lays down the foundation for all future work for the development of rules, guidance material, as wells as, safety promotion to ensure unmanned aircraft are operated safely and their impact on the safety of the aviation system is minimized. The opinion includes 27 concrete proposals for a regulatory framework for low risk operations of all unmanned aircraft irrespective of their mass. The proposals are operations centric, focusing on how the drones will be used rather than their physical characteristics. It establishes 3 categories of operation: 'Open', 'Specific' and 'Certified' with different safety requirements for each, proportionate to the risk. EASA's Technical Opinion mentions the use of new rules in combination with safety promotion material to achieve a proportionate, safe environment.

2.1. Rules and conditions for the UAV operation under the SR framework

As it was mentioned the UAVs with the take-off weight above 150 kg come under the European regulation framework. In this chapter we will deal with the aircraft capable to fly without a pilot on the

board with the take-off weight up to the 150 kg, which means that they are under the national competence.

As it was listed above from August 2015 all UAVs besides the models up to the 20 kg used for the recreational purposes are a subject to the Decision No. 1/2015. For the mentioned model is this Decision only a recommendation and their operation is performed without the control of the Transport Authority and they do not have to perform any administration acts. On the other side if these vehicles are operated in order to complete aerial works they are under the competition of the Transport Authority likewise the UAVs with the take-off weight above 20 kg. The permission of the Transport Authority to fly with the UAV, its evidence in the aircraft register and the requirement to own the UAV pilot's license depends on the planned applications and also on the UAV weight.

Before the UAV implementation into the operation it is necessary to be familiar with many important facts and rules that have to be adhered by the operator to operate the vehicle in accordance with the national rules and requirements.

Table 1 briefly summarizes responsibilities and conditions of the UAVs use in the area of the SR for the private or business purposes.

Table 1 Overview of conditions and responsibilities of the UAVs operation in Slovakia

Aircraft type/utilization	Private purposes	Business purposes
UAV up to the 20 kg (including UAV with the take-off weight up to the 0.5 kg – "aircraft toy")	• To respect general conditions of its utilization	• To register the UAV into the aircraft register • To respect general conditions of its utilization • To obtain the UAV pilot's license • To obtain the aerial works permission
UAV with the take-off weight above the 20 kg	• To respect general conditions of its utilization • To register the UAV into the aircraft register • To obtain the UAV pilot's license • To obtain the aerial works permission • To make an agreement about the liability for damage insurance • To own the evidence certification • To keep the flight log	• To respect general conditions of its utilization • To register the UAV into the aircraft register • To obtain the UAV pilot's license • To obtain the aerial works permission • To obtain a flight permission • To make an agreement about the liability for damage insurance • To own the evidence certification • To keep the flight log

According to the article 2 section 2 of the Decision – about the conditions of the UAVs utilization the holder of a valid permission of the Transport Authority for flying with the UAV can be:

- a person that operates a UAV by the aerial works completion,
- a person that operates a UAV with the maximum take-off weight above 20 kg.

In case that the UAV is intended to be used for business purposes the weight is not determining. Before the obtained permission for aerial works completion it is necessary to fulfil following obligations:

- To register a UAV into the aircraft register at the Transport Authority.

- To obtain a UAV pilot's license after the successful accomplishment of the theoretical and practical examination at the Transport Authority.

2.2. General rules for the UAV operations

To the most important rules for the UAV operation belongs:

1. The UAV operator is responsible for the UAV operating condition and its airworthiness, for the flight preparation and performance and he has to be apprised of the actual utilization of the airspace.
2. It is not possible to fly with the UAV
   - besides the UAV operator line of sight or in the distance greater than 1 000 m (without the visual contact),
   - in the distance up to the 50 m from any person, building, ship or vehicle with the exception of the equipment or person operating the UAV during its take-off or landing,
   - in the controlled airspace and in the segregated airspaces including the areas sensitive to noise from the air transportation (for example protected areas),
   - in the proximity of public or private airports for the general aviation, including heliports in the distance up to the 5 500 m from the ATZ zone without the permission and co-ordination with the airport operator.
3. UAV altitude is given in feets or meters.
4. Time is given in the UTC.
5. The UAV flight has to be performed so that safety of other planes, persons and property on the ground cannot be endangered and the environment protection against the noise and emissions from polluting materials from the UAVs has to be secured. The UAV flight should be performed in the distance greater than 1 500 from the populous areas or mass actions organizes in the open space, if the UAV is powered by the gas engine or its take-off weight is above 7 kg.
6. UAV cannot be used for the passenger, luggage, freight or postal transport.
7. It is prohibited to drop objects from the board during the flight.
8. UAV night flights are prohibited.
9. If the UAV is equipped with the flashing lights, they have to be turn on during the flight.
10. UAV flights can be performed in the visual meteorological conditions in the uncontrolled airspace of the G class from the ground up to the 330 ft/100 m AGL in the visual contact with the UAV.
11. Flights with the UAVs have to take into consideration populated areas, meeting places of persons, protected areas and zones (for example water resources, roads).

3. REQUIRED KNOWLEDGE BASE AND PRACTICAL SKILLS

If the UAV is used for aerial works, its operation is allowed only for a person, who is a holder of a certificate issued for this purpose by the Transport Authority. For this certificate acquirement it is necessary to pass theoretical and practical exams at the Transport Authority.

3.1. Theoretical exams

If a person who will operate the UAV is a holder of a pilot's license of any category issued by a competent authority, then there is no need to pass the theoretical exam, else it is necessary to fill in an application form F081-B of the Transport authority, Department of Aviation Personnel Licensing for the theoretical exam and to deliver filled and signed obligatory application for the exam from theoretical knowledge F182-B to the Transport Authority at least 14 days before the planned exam term.

The theoretical exam takes 90 minutes, is written on PCs in the Slovak language and consists of 100 questions with three possible answers, one of which is correct. The exam from the theoretical knowledge consists of the following subjects:

- aviation law and air traffic control procedures,
- aircraft general knowledge
- aircraft flight performance and planning,
- meteorology,
- operation procedures,
- principles of flight,
- communications.

3.2. Practical exams

The practical exam can be carried out after the successful completion of the theoretical exam. The applicant has to for this purpose fill in the application and to send it to the Transport Authority, Division of Civil Aviation, Department of Aircraft Operations. An inspector of the Transport Authority of the SR will determine place and time of the practical exam. The applicant will perform the practical exam according to the instruction with his own UAV, which will operate. By the practical exam the applicant's skills and abilities to control the UAV and the solution of possible collision situations are verified.

4. IMPLEMENTATION OF THE KNOWLEDGE BASE INTO THE EDUCATION PROCESS

Aircraft and also UAV operation requires a high margin of the safety and responsibility. The determining influence on the safe operations has in addition to the technical construction of the vehicle also the acquirement of the specific base of the theoretical knowledge and practical skills, which pilots and operators will obtain during their study and training courses.

After the study of the actually valid legislation and materials issued by the Transport Authority of the SR the research team from the Faculty of Aeronautics of the Technical University of Košice has created conditions for the education in regard to the standardized knowledge base and for the acquisition of the practical skills in the UAV control within the frame of the KEGA 028TUKE-4_2013 project.

The core solutionists from the Department of Aviation Technical Studies of The Faculty of Aeronautics at the Technical University of Košice have practically created conditions for the education and training in the form of courses or by the implementation of a study program at the first degree of the university study. For the construction testing and pilots' training of small multi-rotor platforms, technical and also spatial conditions have been created.

Furthermore the employees and PhD. students from the Department have been successfully performing on a long-term basis:

- research in the area of the design and construction of small multi-rotor vehicles with the focus on the increase of their operational safety [4],
- research in the area of sensorics and electronic control systems of autonomous unmanned aerial vehicles with the focus on their communication and collision avoidance systems,
- applied research focused on the utilization of various physical fields sensing [5], for example by the magnetic mapping of areas with archaeological research using magnetometers of a new generation developed at the Department of Aviation Technical Studies [6].

For the education in the required theoretical areas an electronic course on the basis of the Learning Management System (LMS) within the solution of a diploma thesis [7] has been created. The course is prepared for 13 weeks and corresponds to one academic term (Figure 1). The course materials have been processed in the form of presentations and pdf files. The course contains also continuous tests and one final test. The course can be updated and also modules can be complemented at need.

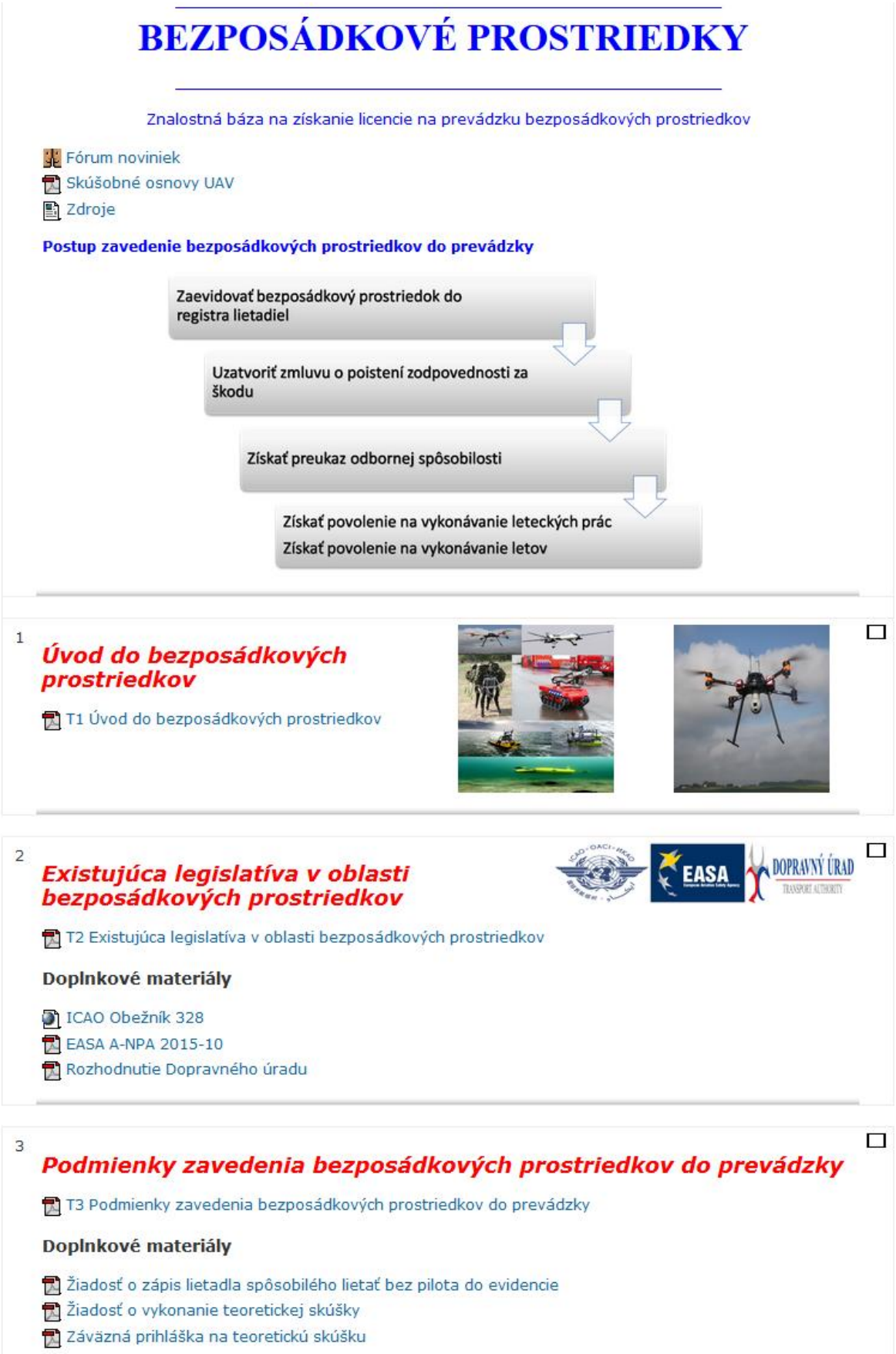

Figure 1 Course view in the Moodle learning platform

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5. CONCLUSION

Recently there is an increasing trend in the unmanned aerial vehicles utilization in private, but also in the business area. This fact has been influenced above all by the cost availability and by the technological research of the electronic components with better functionalities, reliability, precision, utilization possibilities and lower power consumption.

The theoretical and practical handling of these interesting new technologies and also the acquirement of required knowledge specified by the Transportation Authority of the SR in their Decision No. 1/2015 from the 19.08.2015 is relatively demanding and complex task. The Faculty of Aeronautics of the Technical University of Košice has personnel, material, technical and special potential for the preparation and training for the UAV operator's applicants. It also has a scientific potential to solve current tasks in regard to the UAV construction, control, communication and development of the on-board electronics and sensors.

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