



THE USE OF DRONES IN TRANSPORT

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Abstract: *The use of Unmanned Aerial Vehicles (drones) is primarily associated with military applications, from reconnaissance to bombing of targeted objects and liquidation of concrete persons. However, in recent times, with drones becoming more affordable, new uses of drones have emerged. One of the most important areas in new applications is the transport area. The Directive 2010/40/EU of July 7th, 2010 on the framework for the deployment of Intelligent Transport Systems points out that the increase in the volume of road transport is the primary cause of increased congestion of road infrastructure and rising energy consumption and also of some environmental and social problems. A prerequisite for introduction of an intelligent system is the availability of precise data about the traffic and road conditions. Drones, known for their easy maneuvering, great flexibility and relatively low costs of operation, can be used as a great aerial sensor for traffic data collection. They can provide bird’s eye view over routes of a large areas, and provide observation of traffic flow formation and dissipation. Also, many companies have recently begun to develop new ways of delivery of parcels that involve their delivery to the customer's backyard using the drones. This paper discusses the civilian use of drones in the transport analyzing the benefits and potential risks of their application.*

1 INTRODUCTION

International Civil Aviation Organization Cir 328 AN/190 defines [1]:

- Unmanned aircraft as an aircraft which is intended to operate with no pilot on board, and
- Unmanned aircraft system as an aircraft and its associated elements which are operated with no pilot on board

The Global Air Traffic Management Operational Concept [2] states: “An unmanned aerial vehicle is a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous.

Unmanned aerial vehicles (UAVs, known in the mainstream as drones) can be realized as:

- Autonomous aircrafts or as
- Remotely piloted aircrafts (RPA).

By autonomous aircrafts, orbit, altitude, speed and other flight characteristics are entered into the computer, which is an integral part of the drone, before they hit the road, and then UAVs execute their orders independently. The second type, RPA, is governed by remote controller. UAVs for commercial use can be realized in different ways, in different forms (such as airplanes, quadcopter, hexacopter, octocopter...) and sizes (1.27 - 3450 kg).

Drones were mostly connected with the military purposes. On that remind us almost daily newspapers' drone warfare headlines, and texts such as "British aircraft and unmanned drones used in military operations targeting Isis in Iraq ..." [3] or "Al-Qaida in Yemen says U.S. drone killed man who claimed Charlie Hebdo attack" [4], or "There are regular strikes in Pakistan, Yemen and Afghanistan. Recently it was reported that a U.S. drone strike killed an American and an Italian citizen held captive by al-Qaida..." [5], etc.

The application of drones in disruption of sports events has also been demonstrated in practice. They were used to promote "Greater Albania" during a Euro 2016 qualifying match between Serbia and Albania, as a provocation of the players and the audience. The violence began when a drone carrying an Albanian flag and a map showing Kosovo as part of "Greater Albania" was flown over Belgrade's Partizan Stadium.[6] Similar application of drone was in May 2015 when Boca's supporters had flown a drone over the pitch, which mocked River's relegation to the second tier of Argentine football in 2011. [7]

However, there also exists the other side of drone application. In the past few years, the drones were becoming increasingly common in various spheres of life.

Because of some of their advantages over other aircrafts, multicopters, which for takeoff don't require airstrips, are suitable for use in agriculture, in combating mosquito broods, research and monitoring of activities of oil transportation, including control of oil and gas pipelines, for control of forests and forest fires, flooded areas... Very often they are used for monitoring of sports events and competitions in cycling or marathon, recording of various celebrations, and in the film industry in general. In some countries, drones are used by estate agents. The range of application of drones will be spread in a number of other areas at a speed that will depend on the technical capabilities of the new generation of drones and the human imagination. This paper will predominantly deal with the possibility of applying of drones in logistics, to transfer shipments. However, in order to allow drones to be massively used, it is necessary to previously provide a legal basis for their implementation.

2 LEGAL ASPECTS OF USING OF DRONES TO TRANSPORT PACKAGES

According to the FAA, different types of UAS operations are recognized:

- Public Operations (Governmental); they are limited by federal statute to certain government operations within USA airspace. Title 49 U.S.C. § 40102(a)(41) provides the definition of "Public Aircraft" and § 40125 provides the qualifications for public aircraft status. Whether an operation qualifies as a public aircraft operation is determined on a flight-by-flight basis, under the terms of the statute. The considerations when making this determination are aircraft ownership, the operator, the purpose of the flight, and the persons on board the aircraft.[8]
- Civil Operations (Non-Governmental); Any operation that does not meet the statutory criteria for a public aircraft operation is considered a civil aircraft operation and must be conducted in accordance with all FAA regulations applicable to the operation. There are two methods of gaining FAA authorization to fly civil (non-governmental) UAS[9]:

- Section 333 Exemption¹; and
- Special Airworthiness Certificate (SAC)² .
- Model Aircraft (Hobby or Recreation only); These UASs are for hobby or recreational purposes only. Individuals flying for hobby or recreation are strongly encouraged to follow safety guidelines, which include[10]:
 - Fly below 400 feet and remain clear of surrounding obstacles;
 - Keep the aircraft within visual line of sight at all times;
 - Remain well clear of and do not interfere with manned aircraft operations;
 - Don't fly within 5 miles of an airport unless you contact the airport and control tower before flying;
 - Don't fly near people or stadiums;
 - Don't fly an aircraft that weighs more than 25 kg;
 - Don't be careless or reckless with your unmanned aircraft – you could be fined for endangering people or other aircraft.

Individuals who fly within the scope of these parameters do not require permission to operate their UAS; any flight outside these parameters (including any non-hobby, non-recreational operation) requires FAA authorization.

As a novelty application of drones is poorly regulated by law. It is possible that under existing regulations identical UAV user's activity, with the same results, in one case be a punishable act, and in another not. For an example capturing news with drones can be used. Capturing news with drones can have consequences. A new FAA memorandum provides new guidance[11]:

- News media require FAA authorization for news gathering with a drone.
- Hobby drone pilots require FAA authorization if they intent to capture news and sell them to the news media.
- Hobby drone pilots do not require FAA authorization if they have no intent of news gathering but happen to come across news and then give the resulting video or images to the media.

But, as usual, essential are details, so it is recommended to study carefully this document.

At the beginning of 2015 it a wave of new laws governing the use of drones began to spread. One of the first countries that will regulate UAV, including leisure drones, will be UAE. Addressing the Future Air Transportation Systems conference in Dubai, Mohammad Faisal Al Dossari, Director, Aviation Safety Affairs, Air Navigation & Aerodrome, UAE GCAA, said[12]: “Our challenge is to regulate the commercial side first and then the leisure side whether people operate as clubs or are private users who view them a toys – we even want to regulate these activities. We anticipate a length consultative phase to think about the processes needed to obtain necessary approvals and the guidelines that need to apply. At some point we also have to develop the implementation plan. We are even going to regulate unmanned systems that are less than one kilogram.”

By law, in the USA any aircraft operation requires a certificated and registered aircraft, a licensed pilot, and operational approval. Section 333 of the FAA Modernization and Reform Act of 2012 (FMRA) grants the Secretary of Transportation the authority to

¹ A grant of exemption in accordance with Section 333 and a civil Certificate of Waiver or Authorization (COA); this process may be used to perform commercial operations in low-risk, controlled environments. Instructions for filing a petition for exemption are available here.

² Applicants must be able to describe how their system is designed, constructed, and manufactured, including engineering processes, software development and control, configuration management, and quality assurance procedures used, along with how and where they intend to fly.

determine whether an airworthiness certificate is required for a UAS to operate safely in the National Airspace System (NAS).[13]

On February 15th, 2015, the FAA released its Notice of Proposed Rulemaking (NPRM³) for small, unmanned aircraft in which it is proposed to amend its regulations to adopt specific rules to allow the operation of small unmanned aircraft systems in the National Airspace System. These changes would address the operation of unmanned aircraft systems, certification of their operators, registration, and display of registration markings.[14]

Legal regulation does not develop at the same speed in the United States and Europe.

France was one of the first countries to adopt, through two judgments in April 2012, regulations on civilian drone use and one of the first to authorize, under strict conditions, flights ‘outside the pilot’s view’. As a direct consequence, France is a country with a very large number of drone operators, the vast majority of whom use them for photography. French law stipulates that drones must fly at altitudes of less than 150 m, so that they do not pose a risk to air traffic. The regulatory framework also sets out four ‘scenarios’ and authorizations potentially required, specifically depending on the weight of the drone, the flight length, the altitude, whether the flight is in or out of the pilot’s sight and the area being overflown. [15]The European Aviation Safety Agency (EASA) has recently promoted its “Concept of Operations for Drones” - A risk based approach to regulation of unmanned aircraft. Considering the broad range of operations and types of drones, it is proposed to establish three categories of operations and their associated regulatory regime[16]:

- *Open*; The Open operation category of drones, should not require an authorization by an Aviation Authority for the flight but stay within defined boundaries for the operation (e.g. distance from aerodromes, from people, etc.).
- *Specific*; The “specific” operation category will require a risk assessment that will lead to an Operations Authorization with specific limitations adapted to the operation.
- *Certified*; The “certified” operations will be required for operations with a higher associated risk or might be requested on a voluntary basis by organizations providing services such as remote piloting or equipment such as “detect and avoid”.

The open category is for the very low risk drone operations, therefore without involvement of Aviation Authorities, even for commercial operations. No airworthiness approval is foreseen and there are also no approvals or licenses for operators and pilots. It is designed to allow simple operations and for the small and medium-sized enterprises to gain experience. The risk for other airspace users is mitigated through separation with manned aviation. The drone must be flown[16]:

- Under direct visual line of sight (VLOS): 500m;
- At an altitude not exceeding 150 m above the ground or water; and
- Outside of specified reserved areas (airport, environmental, security).

According to the Riga Declaration on Remotely Piloted Aircraft (drones) “Framing the Future of Aviation” [17] the aviation community established the following principles to guide the regulatory framework in Europe:

- Drones need to be treated as new types of aircraft with proportionate rules based on the risk of each operation;
- EU rules for the safe provision of drone services need to be developed now;
- Technologies and standards need to be developed for the full integration of drones in the European airspace;

³An NPRM is a public notice issued by law when an independent agency, such as the FAA, wishes to add, remove or change a rule or regulation as part of the rulemaking process.

- Public acceptance is key to the growth of drone services; and
- The operator of drone is responsible for its use.

If European regulators continue with their current approach, drone operations in the European Union (EU) are going to become very permissive, far outpacing American regulations. The European Aviation Safety Agency (EASA) has released a regulatory framework that calls for new regulations to be proposed by December 2015. In the proposed framework, the EASA has specifically focused on innovation, saying that regulations must “not simply [transpose] the system put in place for manned aviation” but rather must create “one that is proportionate, progressive, risk based and...[expresses] objectives that will be complemented by industry standards.”[18] In the EU there are 2,495 operators of drones weighing less than 150kg. The EASA believes that number to be the largest amongst worldwide operations where just 2,342 operators are flying in the rest of the world combined (with 2,000 of those sanctioned operations taking place in Japan).[18]

3 THE USE OF DRONES TO DELIVER SHIPMENTS

A delivery drones can be utilized to transport packages, food and other goods. As of 2014, delivering of packages with drones in the United States was not permitted under regulations.

Amazon, which on December 1st, 2013 announced its own futuristic delivery system for small packages (up to 2.26 kg), has pushed the U.S. government for permission to test unmanned aircraft as it seeks to develop drones to speed shipping products. The Federal Aviation Administration gave the Seattle-based online retailer a waiver allowing flights as fast as 161 kilometers an hour and as high as 122 m off the ground.[19] This allows Amazon to test drones and the whole system of delivery. According to performed analysis, Amazon’s proposed use of drones is promising reducing costs of crosstown delivery of small packages to about \$1 what is only a fraction of existing same-day delivery options. Small drones can cover more than 80% of the packages Amazon sells. However, Amazon hopes that in the second phase drones will be able to transmit shipments weighing up to 25 kg at distances up to 16 km.



Fig. 1 One of Amazon's flying 'octocopter' mini-drones Source: [20]



Fig. 2 Aircraft by e Google[x]'s Project Wing Source: [21]

Amazon’s idea was originally patented in September 2014, but checking the patent one can see that it is not as simple as “take off from the warehouse and drop off the package.” The drones will talk to each other, receiving information about weather, traffic, obstacles, etc. to update their routes in real time, determining if their flight paths and proposed landing areas are safe and free of obstacles. It will be possible to update package delivery locations as customers move around, so a package can come to the customers at work or home, depending on where they are when their shipment is ready—including pulling location data from a smartphone. Amazon order screen has four options for delivery: “Bring It to Me,” “Home,” “Work,” and “My Boat.” There will also be relay locations, allowing drones to drop off

packages for further transport, or to recharge or swap batteries. Amazon also wants its drones to be able to drop packages at a “secure delivery location,” perhaps an Amazon Locker or even the trunk of a car.[22]



Fig. 3 Alibaba drone Source: [23]



Fig. 4 DHL drone Source: [24]

China's biggest internet retailer Alibaba also has begun testing drone-based deliveries to its customers. During the three days trial in limited areas around Alibaba's Taobao division distribution centers in Beijing, Shanghai and Guangzhou they used small quadcopter drones to make deliveries to its customers. These urban areas were limited in distance by a one-hour flight of distribution centers. The maximum weight of the packages was limited to 340g. "Even though it's very limited in scope, Taobao is delivering real goods to real people, which is a step further than its Western counterpart Amazon has gone," Tech in Asia's Paul Bischoff told the BBC.[25]

In Europe, DHL Company has started in December 2013 a week-long pilot of the drone, which was remotely controlled and could be used for delivery of urgent items such as medicine. DHL's first trial saw a medical package fly across the river Rhine in Bonn, from a pharmacy to the company's headquarters. The drone, known as the “Paketkopter” (fig. 4), travelled 2.5 km and was able to dispatch parcels weighing around 3 kg.[24]. At the end of 2014, DHL started to use drones to carry parcels to a tricky-to-access island of Juist in the North Sea. The 'parcelcopter' can take packages of up to 1.2kg across the 12km stretch from the city of Norden at a speed of up to 64 km per hour (depending on the wind).[26]

4 CONCLUSIONS

As can be seen from the above examples, the most important companies in the world expect a lot from the use of drones in the transfer of shipments. Planned investments are large and it is realistic to expect that in the coming years the number of drones and transferred shipments will increase exponentially. It can be expected that in the near future swarms of drones will be flying over our heads and deliver their cargo on the benefit of both, cargo companies and end users. But, there is always at least one “but”. What will happen when the first drone crashed on someone's head in some of the economically developed countries, or even worse, when several drones in a series land on heads of several passersby? Or what will happen when wind suddenly would change its intensity? Or, when an error occurs in the navigation system? Who will be responsible for the damage? There are a lot of similar questions, but, the whole idea seems promising.

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ПРИЛОЖЕНИЕ НА ДРОНОВЕТЕ ПРИ ОСЪЩЕСТВЯВАНЕ НА ТРАНСПОРТНИ ПРЕВОЗИ

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Ключови думи: безпилотни въздухоплавателни средства, безпилотна въздухоплавателна система, дрон, интелигентни транспортни системи, транспортни превози.

Резюме: Приложението на безпилотни въздухоплавателни средства (дронове) в миналото се е свързвало с военни действия, като разузнаване, бомбардиране на целеви обекти, както и убийство на определени лица. В наши дни, обаче, те намират по-широко приложение, като едно от тях е използването им при осъществяване на транспортни превози. Съгласно Директива 2010/40/EU от 2010 г.

относно условията за въвеждане на интелигентни транспортни системи в областта на транспорта, повишеният обем на превозите с автомобилен транспорт води до увеличаване на задръстванията по пътищата, нараства на консумацията на енергия, както и замърсяването на околната среда. Ето защо, като предпоставка за въвеждането на интелигентни транспортни системи в транспорта, може да се счита необходимостта от събирането на точни и конкретни данни за движението на автомобилите и характеристиките на пътно-шосейната инфраструктура. В тази връзка дроновете могат да се използват като въздухоплавателни средства, които да събират данни за автомобилното движение, тъй като те са лесно маневрени, гъвкави и разходите за тяхната експлоатация са минимални. Те също така предоставят възможност за наблюдение на големи площи от птичи поглед, както и установяване на местата, където възникват задръстванията. Освен това, голяма част от крупни транспортни компании започват да използват дроновете с цел доставка на съответния товар до задния двор на техните клиенти.

Настоящият доклад има за цел да разгледа възможностите за приложение на дроновете за граждански цели в транспортния сектор, като са анализирани също така ползите и рисковете от тяхната употреба.