

# The CREOGN Research Notes

French Gendarmerie Officers Academy Research Centre

Issue 53 – September 2020

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## TOWARDS A REFORMATTING OF THE CIVIL AVIATION SECTOR: AUTONOMOUS FLYING VEHICLES

Environmental awareness had already targeted the airline industry with the "plane bashing" (being ashamed of taking the plane because of its carbon footprint). Airlines around the world have now been lastingly weakened by the coronavirus epidemic, both from a financial and, more generally, operational point of view. This situation has often required state support to avoid bankruptcy, with no guarantee of recovery in the short term. For example, the Italian company Alitalia received three billion euros in the form of a bank loan guaranteed by the state<sup>1</sup>, which de facto became the owner of the company. In Germany, the state intends to acquire 25 per cent of the capital of Lufthansa, while Air France-KLM is conditionally supported by France and the Netherlands. On the other hand, the spread of electric flying vehicles<sup>2</sup> seems to be the starting point of a new mobility revolution to relieve traffic congestion in big cities in the years to come.

Indeed, by 2030, urban traffic congestion in Europe and the United States could cost nearly 300 billion dollars. Under these conditions, the air route could also improve the response time of first responders. Concurrently with these projections, there is a strong trend towards changing mobility consumption patterns (V-lib, carpooling, carsharing, etc.). The automotive and aeronautics industries are interested in these developments, as evidenced by the growing number of projects aimed at rethinking tomorrow's mobility, notably through the development of autonomous flying shuttles. More than 120 models are currently at a more or less advanced stage of study around the world. While the technical challenges are almost overcome and society seems ready to accept these modes of mobility, the issue of air safety remains particularly complex to address under the pressure of this new growing market.

1 L'impact de l'épidémie de Covid-19 sur le secteur aérien, [veilleinfotourisme.fr](https://www.veilleinfotourisme.fr), 3 September 2020. <https://www.veilleinfotourisme.fr/entreprises-et-clienteles/transports/l-impact-de-l-epidemie-de-covid-19-sur-le-secteur-aerien>

2 The electric motorization of these small aircraft seems to be a sine qua non condition for their acceptability in urban areas, where they are mostly used, because of the constraints in terms of noise and air pollution.

## I) Airspace as a way out of terrestrial congestion, provided it is regulated

A June 2019 ANSYS survey<sup>3</sup> measured how potential users felt about the future of autonomous aircraft. While 70% contemplate taking an autonomous aircraft in their lifetime, that number drops to just over 50% when looking ahead to the next decade. Young people are the most supportive of flying machines; more than 80% of 18-24 year olds are willing to fly in an autonomous aircraft, compared to just under 50% of those over 65. When asked to select their biggest concerns about autonomous flight, respondents said their worries centered on technology failures and the autopilot's ability to react to atmospheric conditions. When respondents were told that only takeoffs and the last 10 minutes of current flights were likely to be controlled by a pilot and that the rest was autonomous, 36% said they would feel much safer in a fully autonomous aircraft.

Actually air travel modes are increasingly diverse. The invention of Franky Zapata from Marseilles is a perfect example. When he flew over the English Channel in the summer of 2019, he left a deep impression<sup>4</sup>. To anticipate these changes, regulatory and infrastructure developments are necessary. These are complex issues that will probably not be fully resolved as quickly as desired by the industry. However, it seems to be only a matter of a few years before taking a flying cab or having goods delivered by drone becomes a reality. Last year, Safran group announced that it was starting to produce electric motors for drones and flying taxis<sup>5</sup>.

In order to fly, these drones and other autonomous flying machines will need precise airspace mapping, so that they can be warned of potential obstacles and respect air traffic lanes. To this end, it is technically vital to make the databases speak the same "language" for efficient exchanges. Since flying vehicles may have to cross borders, the authorities of the overflowed country will have to be able to verify their flight permits.

Finally, reorganizing airspace use is necessary to avoid the risk of collisions between these aircraft, as some accidents have already occurred, notably in Canada<sup>6</sup> and in Mozambique<sup>7</sup> in 2017. Unfortunately, these accidents will likely occur on a more regular basis if regulation is not improved as traffic becomes heavier.

Keeping these issues in mind, regulators in many countries are working on reforming their aviation safety, and are planning to redesign air traffic lanes in order to take into account the new forthcoming mobilities. There will always be incidents likely to trigger accidents, whose causes and circumstances will have to be investigated. Unfortunately, the lack of universal standardization for drones' organic components and the lack of reliability requirements regarding performance and safety are to be expected for the beginning of this new era. An analogy can be made with the recent arrival of electric scooters on our streets. That's why extensive investigations of data will be necessary to identify the causes and circumstances of accidents<sup>8</sup>. Accurately determining the origins of accidents will be the first key step in preventing them from happening again by improving materials and procedures. Today, the use of drones is subject to significant restrictions. In France, flying over urban areas, airdromes and sensitive sites (state buildings, military sites, nuclear power plants, etc.) is prohibited. Yet, these aerial

3 « Ansys Reveals 70 % of Consumers Expect to Travel in an Autonomous Aircraft in Their Lifetime », *ansys.com*, 17 June 2019.

<https://www.ansys.com/about-ansys/news-center/06-17-19-ansys-reveals-70-percent-consumers-expect-travel-autonomous-aircraft>

4 LE MONDE AVEC AFP, Franky Zapata parvient à traverser la Manche debout sur sa planche volante, *lemonde.fr*, 4 August 2019. [https://www.lemonde.fr/economie/article/2019/08/04/le-francais-franky-zapata-reussit-a-traverser-la-manche-sur-sa-planche-volante\\_5496431\\_3234.html](https://www.lemonde.fr/economie/article/2019/08/04/le-francais-franky-zapata-reussit-a-traverser-la-manche-sur-sa-planche-volante_5496431_3234.html)

5 JAMES, Olivier, Safran débute la production de moteurs électriques pour drones et taxis volants, *usinenouvelle.com*, 27 May 2019. <https://www.usinenouvelle.com/article/safran-debute-la-production-de-moteurs-electriques-pour-drones-et-taxis-volants.N847545>

6 LE PARISIEN AVEC AFP, Première collision entre un drone et un avion commercial au Canada, *leparisien.fr*, 15 October 2017. <https://www.leparisien.fr/faits-divers/premiere-collision-entre-un-drone-et-un-avion-commercial-au-canada-15-10-2017-7333776.php>

7 MOUSSET, Anne-Katel, Quand un drone entre en collision avec un avion, ça fait des dégâts, *usinenouvelle.com*, 9 January 2017. <https://www.usinenouvelle.com/article/photo-quand-un-drone-entre-en-collision-avec-un-avion-ca-fait-des-degats.N485314>

8 Véhicules autonomes et taxis volants : l'importance des données dans la gestion des risques de demain, *gmconsultant.com*. <http://www.gmconsultant.com/vehicules-autonomes-taxis-volants-gestion-risques/>

drones are mostly used in urban zones. The authorities are careful to validate flight plans in those areas in order to protect restricted places. The use of *geofencing*<sup>9</sup>(virtual geographical barriers equivalent to electronic bracelets for delinquents) should facilitate the respect of these restrictions, without putting a strain on the authorities. In case of transgression, the fleet manager and the authorities would be alerted.

Then there is the question of how to "deal with the unexpected" once in circulation, based on systems for anticipating and detecting collision or transit risks in a disturbed weather zone. A British startup has thus developed an approach to in-flight conflicts for drones<sup>10</sup>. This new system allows companies in the air sector to record their flight plans in advance and to modify routes in real time in the event of a potential conflict. Such systems are key to boosting the use of drones and will have to demonstrate their reliability.

## II) The infrastructures are to be designed and the risks to be optimised

The concept of a vertiport for small vertical takeoff and landing vehicles such as flying cabs is gaining ground. It could be adapted to the roofs of buildings, parking lots or train stations<sup>11</sup>. This being said, special attention should be paid to the concentration of aircraft taking off and landing in a restricted space, with regulation by a "control tower" that can prohibit the movement of these aircraft when traffic density becomes too high and dangerous. Generally speaking, the occasional and localized saturation of airspace is an issue that will require these "control towers" to be networked.

As with airports, vertiports will have to be controlled areas to guard against the risk of attacks on passengers, damage to equipment, and the transport of illicit materials, due to the lack of on-board personnel. This will require access control, detection of prohibited objects and reinforced video protection. Similarly, the environment of the vertiports will have to be secured to prevent drones from being targeted by shots during the delicate landing and takeoff phases. Appropriate means of intervention will have to be invented to enable law enforcement to force a flying vehicle to land or to prevent it from taking off. We can imagine using electric flying motorcycles to carry out an intervention, as is the case in Dubai where the police are testing this solution to record traffic violations<sup>12</sup>. At the same time, the security of the on-board computer system will have to be protected against hacking attempts at taking control or, more simply, against mere failures. In order to help protect data, a reference table could be used to control its integrity (like Tripwire or a similar software). This table would contain the digital signature or *hash* of the flight plan data downloaded in the aircraft.

If the first security risk that comes to mind is on the airport side, as mentioned above, the second risk is technical and has to do with the reliability of the electric supply and motorization of these vehicles. The operational implementation of aerial drones by the Gendarmerie has shown that the occurrence of engine failures was a thousand times higher than that of helicopters, a level of reliability that could not be tolerated by civil aviation certification bodies<sup>13</sup>. While electric propulsion limits the risks associated with fuel for combustion engines, other risks can be anticipated based on feedback from the various players involved with electric vehicles. There is already a preliminary analysis of the risks pertaining to

9 DECOURT, Rémy, Taxis volants: la Nasa et Uber plangent sur la régulation du trafic, 27 May 2018.

<https://www.futura-sciences.com/tech/actualites/drone-taxis-volants-nasa-uber-plangent-regulation-traffic-64520/>

10 PELLEGRIN, Hugo, Un système pour éviter les collisions entre taxi volant et drone de livraison, *tom.travel*, 22 July 2019.

<https://www.tom.travel/2019/07/22/un-systeme-pour-eviter-les-collisions-entre-taxi-volant-et-drone-de-livraison/>

11 ZAFFAGNI, Marc, Volocopter présente un terminal pour ses taxis volants Volocity, *futura-sciences.com*, 21 October 2019.

<https://www.futura-sciences.com/tech/actualites/drone-ns-volocopter-presente-terminal-taxis-volants-volocity-68718/>

12 20 MINUTES AVEC AGENCE, Vidéo. Dubaï : Les policiers testent l'Overbike S3, une moto volante futuriste, *20minutes.fr*, 17 November 2018.

<https://www.20minutes.fr/high-tech/2373647-20181117-video-dubai-policiers-testent-hoverbike-s3-moto-volante-futuriste>

13 MOREL, Jean-François, ABELLARD, Mathieu, L'emploi des drones de la gendarmerie au maintien de l'ordre, in *Revue de la gendarmerie nationale*, n° 267, June 2020, p. 126.

the different stages in the life cycle of the battery supply chain. Similarly, the study by the French National Institute for the Industrial Environment and Risks (INERIS), *Approche de la maîtrise des risques spécifiques de la filière véhicules électriques* (Approach to controlling the specific risks of the electric vehicle sector)<sup>14</sup>, can be used to address the subject of electrical and electronic components, that are especially essential to autonomous navigation controls.

Their coupling with geolocation systems to ensure the safe guidance of aircraft is another point of vulnerability in case their signal is intentionally or accidentally jammed. GPS jammers, which are forbidden in France, broadcast a signal that interferes with the frequencies of geolocation service satellites, rendering them ineffective. A jammer disrupts all GPSs within its transmission range, from a few meters to several hundred meters away depending on its power. The Agence nationale des fréquences (ANFR / National Frequency Agency) intervened following a complaint from the civil aviation authority concerning GPS interference at Lyon Saint-Exupéry airport<sup>15</sup>. The ANFR agents investigating the complaint found out that a GPS jammer was being used. It had been installed by the driver of a heavy goods vehicle who did not want to be "tracked" by his employer and who was regularly driving past the airport.

Palliative solutions are now possible, such as :

- programmed trajectory anticipation to compensate for any occasional geo-localization issue;
- real-time trajectory control by fleet managers with the possibility of resuming drone mode for remote piloting on a frequency range far from GPS.

Autonomous flying vehicles are no longer a utopia, but their environment must still be adapted, on the basis of international regulation, to avoid a state of anarchy that would lead to accidents likely to delay the deployment of these new forms of mobility.

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14 <https://www.ineris.fr/sites/ineris.fr/files/contribution/Documents/ve-analyse-apr-couv-ineris-1386077293.pdf>

15 AGENCE NATIONALE DES FRÉQUENCES, Les brouilleurs GPS, *anfr.fr* [read on 1 September 2020].  
<https://www.anfr.fr/controle-des-frequences/brouillages/les-brouilleurs-dondes/les-brouilleurs-gps/>