Getting Ready for the Challenges for the Air Traffic Management for Unmanned Aerial Systems (UAS)

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The next 20 years will see enormous changes in air traffic. One aspect of this change is the probable introduction of UAVs into controlled air space. Within the US military alone funding for UAS development has increased from $3 billion in the early 1990s to over $12 billion for 2004-2009. It has been estimated that the civil UAS market would reach €100 million (US $129.6 million) annually by 2010. UAVs support long duration missions that would be difficult, if not impossible, to resource using conventional aircraft. Examples include the monitoring work being undertaken by the Customs and Border Patrol on the US Mexico border. They also include more speculative proposals to incorporate UAVs into the security systems for the 2012 London Olympics.

There are, however, some safety concerns. UAVs have a significantly higher accident rate than manned aircraft partly because the standards that are used in the engineering of UAS platforms often fall below those required in conventional aircraft. Documents such as FAA's 08-01: Unmanned Aircraft Systems Operations in the U. S. National Airspace System, as well as EUROCONTROL's Spec-0102 on the Use of Military Unmanned Aerial Vehicles as Operational Air Traffic Outside Segregated Airspace and the UK Civil Aviation Authority's CAP 722, therefore, place strict limits on the operation of UAS. The commercial opportunities created by UAS mean that it may be difficult to defend these restrictions in the long run. ANSPs and regulators will face growing political pressure to allow the integration of UAS operations. It has, therefore, been argued that we need to ensure UAV operations do not increase the risk to other airspace users; that ATM procedures should mirror those applicable to manned aircraft; and that the provision of air traffic services to UAVs should be transparent to ATC controllers.

In order to meet these objectives, we must learn as much as we can from previous incidents that illustrate safety concerns for future UAV operations in controlled air space. For example, the NTSB investigation into the US Customs and Border Patrol's Predator crash at Nogales, Arizona found that "Five of the training events listed on the ... Pilot Conversion form were not accomplished during the pilot's training. Those events were: Mission Planning/Briefing/Debriefing, Handover Procedures - Ground, Mission Monitor/MFW Procedures, Operational Mission Procedures, and Handover Procedures – Airborne". In cases where the training of ground crews for UAS falls short of even the reduced requirements for UAV operations, it should hardly be surprising that there are often considerable failures in communication with Air Traffic operations.

The role of 'lost link profiles' in the Nogales crash offers further insights into critical areas of future interaction between ATCOs and UAS platforms. These are the flight patterns that are executed autonomously when UAVs lose contact with ground based control. Typically, the vehicle will fly to a fixed location where it will circle in the hope that contact can be resumed before the fuel is exhausted. This creates problems for ATCOs because mission demands may lead the UAV some distance from the waypoints that are filed for a lost link profile. If communications are lost, the vehicle will autonomously cross the airspace between their present location and the initial waypoint for the lost link profile. Following the Nogales accident, NTSB investigators found that there were three lost link profiles stored on the ground control system. Only one of these could be active at any one time. However, the pilot could change their selection during an operation in response to changes in the area in which the UAV was being flown. There is considerable potential for confusion for ATM staff with three potential lost link profiles stored on these systems as the UAV autonomously may cross controlled air space even if it was originally operating in a segregated area. The NTSB investigation following this accident argued that there "was no standardized safety-based method for determining the routes for the lost-link flightpath and that inadequate consideration was given to ensuring the flight path did not include flight over population centers, property, or other installations of value". The lost-link profile followed by the Predator on the day of the accident was unnecessarily complicated. It was also argued that the pilots were uncertain about the actual flightpath of the UAV following the loss of communications with the vehicle.

Section 8 of FAA Guidance 08-01, cited above, establishes the communications requirements for the operation of UAS inside the US National Airspace System. Pilots must have immediate radio contact with relevant ATC facilities at all times if the UAV is being operated in class A or D airspace or under IFR. The FAA guidance also required that operators should have notified the FAA and ATC of any changes to their lost link profiles. These updates would have helped to coordinate any response to an emergency. However, changes to the 'lost link profiles' had not been communicated to these other agencies. The NTSB, therefore, argued that there was a real potential for an in-flight collision as the UAV created a significant hazard for other users of the National Airspace System. During the incident itself, the agreement under which the Nogales Predator was operating has a requirement that following the loss of communications link, the pilot in command was to immediately inform ATC of:

1. The UAS call sign.
2. UAS IFF [Identification, Friend or Foe] squawk.
3. Lost link profile.
4. Last known position.
5. Pre-programmed airspeed.
6. Usable fuel remaining (expressed in hours and minutes).
7. Heading/routing from the last known position to the lost link emergency mission loiter.

However, there was no communication between Albuquerque Air Route Traffic Control Center and the UAV pilot about the lost link profile. This lack of communication was compounded by a loss of power to the UAV during the accident. The aircraft shut down its satellite communication system and the transponder. If the transponder had continued to work with mode C altitude data then ATC might have been able to track the course of the UAV and warn other airspace users.

Prior to the Nogales accident, the Predator's restricted operating air space extended along the US southern border from 14,000 to 16,000 feet MSL. However, the loss of power prevented the UAV from maintaining its altitude. The Predator breached the lower limit of the restricted zone. The investigators, therefore, argued that the UAV was operating autonomously in unprotected airspace until it crashed. ATC contacted the Predator's pilot after they lost contact with the vehicle and the transponder had stopped working. However, the pilot did not inform Albuquerque Air Route Traffic Control Center that the UAV had descended below the 14,000 feet MSL. At this point, the pilot or the ATCO should have declared an emergency and taken measures to alert traffic in the area. They should have alerted neighbouring centres to monitor the missing vehicle. The ATC could also have started efforts to increase the level of surveillance on the UAV, for instance by contacting the Western Area Defense Sector to gather information using their height finding radar.

These observations from the Nogales accident reiterate the need for additional requirements on UAV operators to increase the level of cooperation with ATC. Prior to the accident ATCOs were only provided with mandatory training on the UAS operations in the form of a 30-minute briefing and a Powerpoint presentation. As a result, it has been recommended that UAS operators conduct extensive reviews between ATM personnel and the ground crews. The purpose of these meetings is to clarify their response and required actions both during standard and degraded modes of operation. The NTSB have argued that "These operational reviews should include, but not be limited to, discussion on lost-link profiles and procedures, the potential for unique emergency situations and methods to mitigate them, platform-specific aircraft characteristics, and airspace management procedures".

We have only begun to consider the range of new hazards created by the integration of UAS into controlled air space – other problems include the difficulty of using conventional radar to monitor some of these vehicles. They also include the difficulty of managing ground movements if UAVs are allowed to operate alongside conventional vehicles even though their crews may be hundreds of miles away from the aerodrome. However, the political and commercial pressures will only grow and so it is critical that we begin to act now for a more complex and possibly dangerous future.

References

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