Sharing airspace with Uncrewed Aerial Vehicles (UAVs): Views of the General Aviation (GA) community expressed at the E-Drone GA user group meeting (26th March 2021)

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1 Introduction

The E-Drone project (https://www.e-drone.org/) is a research consortium led by the University of Southampton aimed at assessing the societal and environmental benefits of using drones as part of logistics fleets for public service applications.

Commercial drone operations take place mainly in uncontrolled airspace, which is extensively used by the sports and leisure flying community, including users such as private light aeroplanes/helicopters, gliders, microlights, hang gliders, paragliders/paramotors, hot air balloons, model aircraft flyers and other interest groups loosely referred to as the General Aviation (GA) community. There has been growing concern amongst this community regarding the expansion of drone operations. The E-drone project therefore ran a national workshop on 26/3/21 to which a large number of groups that represent the GA community were invited.

The purpose of the March workshop was to:

- Brief the GA community and others regarding current drone operations and plans within the E-drone, Solent FTZ (Future Transport Zone) and other connected consortia.
- Discuss alternatives to Temporary Danger Areas (TDAs) for allocating airspace.
- Allow the GA community to voice their concerns and make suggestions.
- Record, analyse and respond to all the comments and issues raised.
- Determine next steps.

The workshop outlined an alternative to TDAs that is referred to as 'Class Lima'. Class Lima is: i) an interim step towards UAV Traffic Management (UTM); and ii) a permanent, decentralised, shared airspace solution for low risk areas.

2 Code Topics and Predominant Themes

There were over 500 participants' comments recorded during the two-hour workshop. The relationships between the code topics identified during the thematic analysis of the comments and the predominant themes into which they were grouped are shown in Figure 1. Discussion summaries of participants' concerns and issues for each topic are provided in subsequent sections, grouped according to their associated over-arching themes.

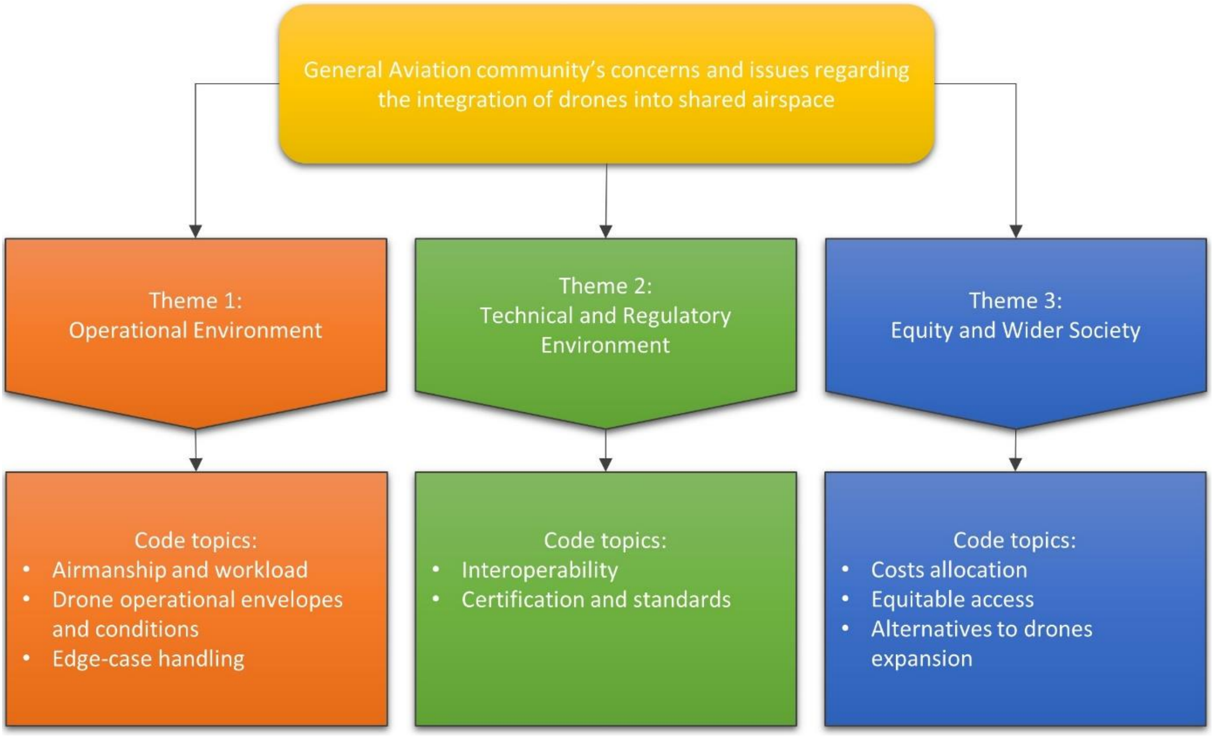

Figure 1: Diagram of code topics and over-arching themes.

3 Theme 1: Operational Environment

3.1 Airmanship and Workload

Concern was expressed over how GA airspace users would be able to ensure de-confliction from drones in shared airspace, which will inevitably rely on some system for identification as it is impossible to de-conflict objects if you do not know their position. The majority of GA traffic operating in low level uncontrolled airspace (i.e. where drone operations typically take place) operates under a cooperative principle of see-and-avoid, which can be viewed as a special case of Detect-And-Avoid (DAA, discussed later in this section), and is sometimes called the 'see-and-be-seen' principle.

This is broadly influenced by the Big Sky Theory, which is the assumption that two randomly flying bodies in unconstrained airspace are very unlikely to collide as the volume of airspace is significantly larger than the volume of the bodies (Knecht 2001). Historically, much of the operational aviation safety and navigation standards were, and still are, based on this concept. However, the increasing proliferation of drones in uncontrolled airspace is viewed as a potential threat to this concept.

See-and-avoid relies on GA pilots being able to see drones with the naked eye, and the difficulty of visually identifying drones, which are often much smaller than the smallest crewed aircraft, was raised as a concern. This led to the suggestion that drones should incorporate high-visibility markings or lighting to aid visual identification. Another concern was that the additional time spent looking-out for drones would be a distraction from other flying tasks, although a continuous and thorough scan of surrounding airspace for potentially conflicting traffic is required anyway for aircraft operating under Visual Flight Rules (VFR).

A complicating factor is the position of drones in the general hierarchy of rights-of-way (i.e. who avoids whom, Figure 2) stipulated in the rules of the air for aircraft on converging paths (EASA 2020; CAA 2021). The hierarchy is organised in order of control over the aircraft flight trajectory, with balloons and gliders being the most beholden to wind and weather conditions having priority over powered aircraft, who are able to avoid such phenomena with their on-board propulsion systems, which also means they are able to maintain desired altitudes and headings. More specifically, the rules state that for two aircraft on converging paths, the aircraft that has the other on its right shall give way, except that: powered heavier-than-air aircraft shall give way to airships, gliders and balloons; airships shall give way to gliders and balloons; gliders shall give way to balloons; and powered aircraft shall give way to aircraft which are towing other aircraft or objects (EASA 2020).

All current drone operations have a safety pilot on the ground who can and will override and take avoiding action in any conflict situation, which effectively puts drone operations at the bottom of the hierarchy shown in Figure 2 giving way to all other aircraft. Drones will not necessarily each have a pilot in the future, thus a decision will be needed regarding where drones will be placed in the hierarchy. The main contention here is the right-of-way between powered aircraft and drones, as it is a reasonably settled matter that aircraft with more control over their flight trajectory give way to those with less control.

Many participants suggested that, for de-confliction to be truly possible in shared airspace, a DAA solution was necessary, whereby aircraft can detect each other via some form of Electronic Conspicuity (EC) technology (an umbrella term for technologies that allow airspace users to be detected electronically) and take avoiding action if required. In particular, if drones were placed at the bottom of the rights-of-way hierarchy and required to avoid all other traffic, a DAA system would be essential because drones cannot rely on visual contact (i.e. see-and-avoid) to avoid crewed aircraft.

Many EC technologies exist, but there have been no comparisons reported in the literature as to which technology is best suited to different situations. Currently, different EC technologies (including avoiding the use of EC technology all together) have been adopted in various aviation communities, leading to an entrenched resistance to change to accommodate others. There is some guidance from the CAA in the UK, in that Automatic Dependent Surveillance-Broadcast (ADS-B), a system where aircraft broadcast data such as position, identification, altitude and velocity, is the preferred standard, but nothing has been enforced.

Concerns regarding EC raised by participants included:

i) being forced to carry such equipment in order to be permitted entry to specific airspace;
ii) the cost of installing EC equipment on their aircraft;
iii) interoperability between the different EC technologies;
iv) the need for avoiding actions taken to resolve conflicts to be coordinated between the aircraft involved (e.g. Traffic Collision Avoidance System, TCAS, routinely fitted to commercial airliners);
v) the use of EC equipment requires more heads-down time inside the cockpit, which distracts from maintaining a good look-out.

Another system to increase situational awareness of potential conflicts with drones is VHF-Out, whereby drones continuously broadcast automated position reports over a VHF audio frequency. However, concerns were raised by participants that this was an unrealistic proposition for reasons such as:

i) pilots would have to monitor yet another frequency, increasing their general workload;
ii) it would be impossible to maintain situational awareness from a barrage of drone position reports;
iii) such a system may not be possible due to frequency congestion on the VHF spectrum.

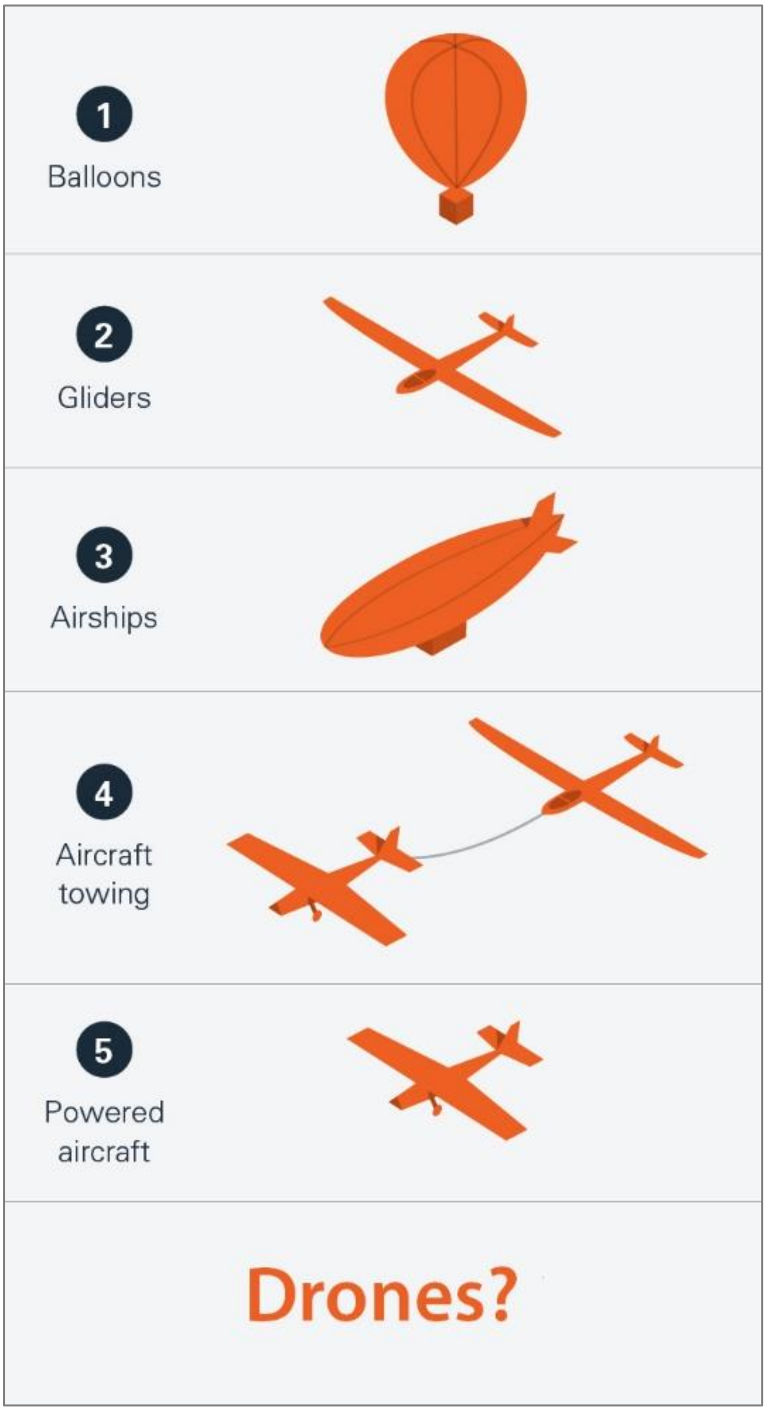

Figure 2: Aircraft rights-of-way.
Aircraft at the top have right-of-way over those below. Source: adapted from CAA (2021).

More general concerns raised by the participants were that blocks of Class Lima airspace represented more regions of uncontrolled airspace for GA users to avoid (e.g. if they do not want to/cannot carry EC equipment on-board), leading to 'pinball' navigation being required rather than more direct routings between origin and destination. However, 'pinball' navigation is already an issue in uncontrolled airspace due to the increasing amount of Airspace Change

Proposals (ACPs) being approved by the CAA, and the concern raised was more that the Class Lima concept could exacerbate the problem rather than initiate it.

The issue of poor airmanship and general lack of respect for other airspace users on the part of drone operators was raised, based on anecdotal evidence from the participants (e.g. operators flying drones with no ADS-B in contravention of the approval for their operation).

3.2 Drone Operational Envelopes and Conditions

Participants suggested that minimum weather conditions for drone operations should be more clearly defined, providing more certainty to pilots that below defined minimum weather conditions, drone operations would not be active. However, GA users often require good weather conditions (e.g. Visual Meteorological Conditions, VMC) to conduct their activities, and therefore the more likely situation was that drones would remain operational in weather conditions that would ground many GA operations (e.g. fog). A related issue was how to deal with rapidly changing weather conditions and the associated promulgation of whether or not drones were operational.

Drones typically operate at low levels and participants suggested that DAA systems on drones should be extended to include detection and avoidance of ground obstacles (e.g. masts, electricity pylons/wires). Such obstacles would represent non-cooperative targets (i.e. no EC technology), unless they were fitted with conspicuity beacons detectable by on-board EC equipment, although installation of beacons on obstacles would obviously entail costs. An alternative solution could be to fit drones with a Ground Proximity Warning System (GPWS) to assist with avoiding controlled flight into terrain or obstacles. This would require drones to be equipped with a database of terrain and obstacles (or receive such data via real-time up-link), and with the necessary sensors (e.g. barometric and radio altimeters) to enable the use of such data in a GPWS.

3.3 Edge-Case Handling

The handling of edge-cases (i.e. circumstances that could conceivably occur at the extremities of operations, but are unlikely to occur very often) was the subject of a number of questions from the participants, alongside a general concern over the difficulties involved in overcoming the technical challenges associated with finding solutions to the edge-cases identified.

The main questions posed by participants in this regard were related to:

i) How drones might handle bird-strikes, and whether this would lead to a catastrophic failure of the drone involved, in contrast to crewed aircraft which are usually still flyable following a bird-strike. This is likely to depend on the size of the drone, with decreasing drone size likely to lead to an increasing likelihood of catastrophic failure.
ii) How model aircraft flyers and hobbyist drone users (as opposed to commercial drone operators who might be expected to be more aware of relevant regulations and subject to more rigorous operational approval procedures) might be accommodated within shared airspace, in particular without prohibitive equipment costs being involved.
iii) The consequences for drone operations of interference with Global Navigation Satellite Systems (GNSS) (e.g. jamming or spoofing attacks) leading to degraded navigational performance of drones.
iv) How the Class Lima concept would interact safely with the military low flying system in the UK.
v) How non-cooperative targets in shared airspace can be handled, involving aircraft (or birds, ground obstacles) that either have no EC technology or a systems failure on-board.

4 Theme 2: Technical and Regulatory Environment

4.1 Interoperability

There are a slew of different EC technologies available and their compatibility with one another was identified as a concern by participants. Some form of standardisation to ensure interoperability of EC equipment was seen as necessary. However, mandating an existing standard would force a switch of equipment for those that do not already use that standard, whilst introducing a new standard would force a switch of equipment for all. In both cases, resistance is likely to be encountered from a substantial body of existing EC users.

A point relating to the standardisation of EC technology was that UK Air Navigation Service Providers (ANSPs) are not allowed to use ADS-B (a promising form of EC technology) as the sole source of surveillance radar, which means aircraft may need to have equipment for two systems on-board. For example, both ADS-B and a traditional Secondary Surveillance Radar (SSR) transponder depending on the requirements of the airspace in which they intend to operate.

4.2 Certification and Standards

Some participants were of the opinion that drone operators were prone to corner-cutting on matters relating to safety and regulations, and that a strong profit incentive was sometimes pursued at the expense of safety. On a related point, some participants thought the CAA was not harsh enough in dealing with drone operators found to be non-compliant with required standards.

A desire for an Equivalent Level of Safety (ELOS) for drones relative to crewed aviation was expressed, whereby an ELOS would be granted for drone operations if compensating factors (e.g. imposed design changes, limitations, equipment) can be shown to provide safety levels equivalent to that of literal compliance with regulations. This is essentially what is achieved on a case-specific basis when a drone operator submits an application to the CAA for operational authorisation who then assesses the safety case and risk assessment produced by the operator. A drone operator could specify a Minimum Equipment List (MEL) in the safety case, without which they would not fly (commercial crewed aviation uses MELs already).

Some participants thought that drones should be subject to a full airworthiness certification scheme similar to that used for crewed aircraft type certification. Currently, there is no regime for drone airworthiness certification, with airworthiness being assessed by the CAA as part of the operator's case-specific application for operational authorisation.

Other concerns relating to certification and standards raised by participants included: the ability of drones to meet Required Navigation Performance (RNP) standards (specified standards of navigation which allow aircraft to be navigated along a precise path with a high level of accuracy and integrity) and the associated reliance of GNSS accuracy; and that high software reliability standards should be followed and verified for drones.

5 Theme 3: Equity and Wider Society

5.1 Costs Allocation

A recurrent concern for participants throughout the workshop was the issue of who should bear the cost of any new aircraft equipment necessary to be able to access shared airspace. Broadly, participants' opinions were divided into one of two positions:

i) The status quo operates very well currently, therefore any new entrants who want to use airspace in new ways (i.e. commercial drone operators in shared airspace) should be the ones ensuring everyone else (i.e. existing users) has the required equipment; or

ii) Continuous improvement in technology is to be expected over time and therefore GA pilots would be willing to install the new equipment required, but effort should still be made to standardise equipment and minimise cost burdens.

Overall, opinion erred on the side of the need for commercial drone operators to meet the burden of costs for any new equipment required (i.e. position one).

As a way to offset some of the costs associated with the purchase of EC equipment, the UK Department for Transport (DfT) launched a funding scheme in October 2020 aimed at encouraging the uptake of EC within the GA and drone communities. The fund is being administered by the CAA and offers a 50% rebate (up to a maximum of £250) on the cost of an EC device. The fund will remain open until 30th September 2021 (or until the funding is used).

One other issue raised by participants was the costs associated with processing proposals to change the design of airspace (i.e. ACPs) submitted to the CAA for approval, as would be the case for the implementation of a shared airspace concept such as Class Lima. Changes to UK airspace are proposed by airspace change sponsors (typically ANSPs or airport operators, but can also be other organisations), and the CAA receives varying numbers of ACPs each year of differing degrees of size and complexity, all of which incur costs to process. A related concern raised by participants was the cost associated with lodging opposition to ACPs by those that disagree with proposed changes.

5.2 Equitable Access

The issue of how to ensure that the ongoing rights to access uncontrolled airspace are managed in a way that is equitable for all users was raised by participants. One likened the designation of airspace for drone use (albeit shared with crewed aircraft) to the Inclosure Act of 1773 that created a law enabling enclosure of land, removing the right of commoners' access (HMG 1773). Fundamental to ensuring equitable access is how initially to define 'equitable access' in terms of rights to airspace, and which airspace utilisation metrics should be developed/utilised as the basis for implementing and monitoring an equitable system of rights. A related concern was that society in general will not care about whether or not the GA community has equitable access to airspace if the expansion of drone operations improves their lives, leading to the GA community losing access due to the weight of public opinion in favour of drones.

Participants suggested there was a general paucity of societal impact studies investigating the effects on people and communities that could occur as a result of increasing drone logistics activities. To provide the GA community (and other stakeholder groups) with the opportunity and necessary knowledge to participate in the co-development of future shared airspace, it is important that clear, realistic scenarios of future drone use (including wider societal impacts) are established and disseminated.

5.3 Alternatives to Drones Expansion

There was some scepticism among participants as to the ability of drones to provide a reliable all-weather service that could compare favourably with other modes (e.g. van-based logistics) in terms of service level and overall cost benefits. Some participants questioned whether there was any demand for drone logistics operations at all, and wanted to see more justification of the needs and economic cases for expansion.

Participants were concerned about function creep, as identified by Boucher (2016), whereby drone logistics operations are initiated for a use case where drones are the most suitable transport mode, but then this proves to be a gateway to the inevitable proliferation of drones to use cases where other modes might represent better alternatives. In other words, the ‘slippery slope’ argument starting with (for example) drones for NHS logistics, and ending with full roll-out to wider parcel deliveries.

References

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