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A "near miss" or too close to the mark? Balancing drone risk and regulation

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- On Sunday 17 April, British Airways flight 727 on approach to Heathrow was struck by what was reported to be a drone at about 1,700 feet. There has since been some doubt as to whether this was a drone, but its impact on the debate about drone regulation has been no less pronounced for five reasons.
- First, the number of drones has increased: over a million new drones sold around the world every year, and tens of thousands in the sky over the UK right now. Second, so has the number of near-misses with other airspace users: 31 confirmed in 2015, of which 19 involved commercial air traffic; compared to just four the year before.
- Third, the fact that the crew of BA727 could not actually confirm what had hit them should come as no surprise, and the number of near-misses might actually be much higher. Many drones are too small to detect on radar, and are very difficult to spot from an airliner cockpit. Fourth: many modern recreational drones have capabilities that are often beyond the capacity of the actual users.
- Finally, nobody is really certain what would happen if a drone hit an aircraft, including the risk to flight-critical elements such as its engines, control surfaces, windscreen, and vital flight sensors; not to mention the danger to smaller aircraft or helicopters. There needs to be empirical testing.
- These five facts illustrate the risks drones can potentially pose to other airspace users. These risks could also manifest themselves in different ways: experts also know that air crashes often (not always) occur from a combination of failures that, in themselves may have been benign, happen to combine to create an awful outcome.

CII Introduction: although my name is in the byline for this Thinkpiece, it is really the result of discussions with a range of subject matter experts on this topic, as well as a period of desk research and analysis. I would especially like to thank Captain Andy Brown of BALPA who actually wrote for me a Thinkpiece entitled "One Near-Miss Too Many?" which provided an overview of the key issues and I published in October 2015.[1] I would also like to mention the following people who helped me understand the issues from different perspectives: Liz Holton, CII aviation insurance subject matter expert who guided me on the international regulatory positions; Gerry Corbett of the Civil Aviation Authority who took the time to discuss and explain issues around aviation national regulation, and David Sales FCII, Chartered Insurance Broker, aerospace director at CGNMB insurance. That said, the views expressed in this article – and any errors or omissions – are entirely my own and should not reflect the official views of any of these contributors.

On Sunday 17 April, a British Airways flight on approach to Heathrow was struck by something at about 1,700 feet, and the pilot reported that it may have been a drone. Fortunately there was no injury or damage, and the jet was cleared to make its next flight. Amid the media coverage over following week, Transport Minister Robert Goodwill told a House of Lords Committee that the object was "not confirmed as a drone" and "there's indeed speculation that it may have been a plastic bag or something". Does this resolve the debate?

What if it was a drone? What we know...

Whatever hit BA flight 727 on its descent into one of the world's busiest airports that Sunday morning, there are still a few things we can say with certainty on how this incident relates to drones.

The rise of the drones

First, we know that the number of drones has recently risen massively. There are believed to over a million new drones sold around the world every year, and tens of thousands in the sky over the UK right now. What was previously the preserve of the military has blossomed into new and exciting commercial and public interest applications, from affordable farmland inspection to traffic management to parcel delivery in remote areas to surveillance to search & rescue (see Table 1).

Table 1: Breakdown of current and potential drones in the UK

CAA class	Category	Current/foreseen applications	Price/Quantity (now or proj'd)
Small (0–20kg)	<1kg	Leisure use Some commercial surveillance or inspection use in hard to reach areas Military *Black Hornet* nano reconnaissance drone: 16g	Retail availability: £100 Est. tens of thousands Military: 350 *Black Hornets*
	1–2kg	Advanced leisure and commercial use (photography)	£100–£900 Est. thousands
	2–20kg	Mainly commercial (photography/inspection) but a few leisure entering the market Military *Desert Hawk*: reconnaissance drone: 3kg	£500–£20,000 About 500 commercially Military: 30 *Desert Hawks* Est <1000 leisure
Light	20–50kg	Inspection, crop spraying, search & rescue Potential local parcel delivery (total mass).	£40–100,000 <10 commercial Proj'd increase to hundreds if parcel delivery
	50–150kg	Local surveillance (border, forest fires)	£300,000 <10 commercial
Large	>150kg	Military: armed and/or long-range reconnaissance • *Watchkeeper*: 450kg • *Predator* (US): 1,100kg • *Reaper*: 4,700kg Commercial potential heavy lift, cargo transport, or long-range surveillance	>£500,000 Military: total 60 Commercially none in UK at present, proj'd incr to <100

Adapted from House of Lords, EU Committee, *Civilian Use of Drones in the UK*, 24 Feb 2015, Chapter 2, Table 1; with information added from other sources including House of Commons Library, *Overview of Military Drones in the UK Armed Forces*, Oct 2015.

A mass market has also developed at the recreational end. This latter group is most important from a safety perspective: many can be flown with minimum to no operator skill, as many can self-execute difficult aspects of flight such as landing or compensating for wind. The vast majority of these are tiny at less than a kilogram, and at the extreme, the military *Black Hornet* can fit in the palm of a hand. However larger ones of 10–20kg are now entering the

[1] Captain Andy Brown, "One near-miss too many? Drone safety issues and possible solutions: an airspace user persective, *CII Thinkpiece* no.119 (October 2015). www.cii.co.uk/38351

leisure market for purchase by more than just seasoned hobbyists.

An explosion in near-misses

Second, we know that with that drone mass-market increase, the number of near-misses with other airspace users has exploded. The UK Airprox Board receives and analyses reports of near-misses between aircraft over the UK, and there were 31 confirmed cases involving unmanned aircraft, drones or model aircraft in 2015, compared to just four the year before.[2] Of these 31, 25 were above 1,000 feet (too high to be seen by the operator), 20 were in restricted (controlled) airspace and 19 involved scheduled civil air transport (another 3 involved other types of passenger-carrying aircraft such as charter or helicopters).

Whether or not BA 727 actually hit a drone and it all ended well, the trends suggested by the airprox reports combined with the laws of probability suggest that soon an aircraft sometime, somewhere might not be so lucky.

Aside from the numbers themselves, the reports themselves make frightening reading: reports of drones flying within a wingspan's distance of an aeroplane (which is generally regarded as close enough to present a viable impact risk) at critical flight phases such as take-off or landing are not uncommon. Whether or not BA727 actually hit a drone and it all ended well, the airprox trends combined with the laws of probably suggest that soon an aircraft sometime, somewhere might not be so lucky.

See and avoid

Third, the fact that the crew of BA727 could not actually confirm what had hit them should come as no surprise. Many drones are too small to detect on radar, and are very difficult to spot from an airliner cockpit. Former airline pilot Andy Brown explained in his Thinkpiece that while the human eye is very good at spotting relative movement, objects on collision course will appear stationary until the last second when it expands in size.

Although pilots of all aircraft categories are trained to spot external objects early enough to react safely, catching sight of a tiny drone on a collision course is very difficult. That is assuming that the collision geometry allows it to be actually seen from an airliner cockpit windows' very limited aspect: for example during take-off, you cannot see much directly ahead of the aircraft's raised nose; and you will never see anything behind or below you. Additionally, flight crew workload at take-off and especially the approach and landing simply cannot offer time to be searching the sky for drones. It also means that the number of near-misses with drones is probably much higher, given that airprox reports all stem from actual visual sightings or detected radar returns.

Device versus operator capabilities

Fourth, many modern recreational drones have capabilities that are often beyond the capacity of the actual users. The repeated issue about the Civil Aviation Authority (CAA)'s "Visual Line of Sight" safe operation rules clearly illustrates this. Although recreational drones *should* be flown so that they could be clearly seen by the operator (see Figure 1: no more than 400 feet above ground level and in visual sight at all times), they *appear capable* of flying much higher and further.

Figure 1: CAA *Drone Aware* leaflet, November 2015

The rules also state that users of drones intending to fly outside those limitations must seek advance permission from the CAA which then publishes a warning notice to flight crews.[3] However drone users are clearly regularly flouting this rule: of the 31 reported airprox cases in 2015, 25 were

[2] UK Airprox Board 2015 reports: www.airproxboard.org.uk/Reports-and-analysis/Airprox-reports-2015/

[3] Civil Aviation Authority, CAP722: Unmanned Aircraft System Operations in UK Airspace – Guidance, updated March 2015, p.90, para.3.14.

above 1,000 feet and 15 were at or above 2,000 feet. There even was one confirmed sighting at 8,000 feet![4]

The need for testing

Finally, nobody is really certain what would happen if a drone hit an aircraft. Would it impact the windscreen, potentially endangering the flight deck crew? What could it do to an engine? Or sensors that give vital flight information such as airspeed and altitude? The limited damage from the few drone impacts that have occurred over the years could hardly represent the actual probability risk. There has been no empirical testing of drones or drone parts impacting airliners. The only understanding we do have is computer testing in Australia that used data from bird strikes. As regards smaller aircraft like helicopters such as air ambulances or light aeroplanes, absolutely nothing is known.

So if BA727 did strike a drone and it caused no damage, this should hardly indicate the outcome of the next drone strike.

Understanding the risks presented by drones

These five facts illustrate the risks drones can potentially pose to other airspace users. These risks could also manifest themselves in different ways: experts also know that air crashes often (not always) occur from a combination of failures that, in themselves may have been benign, happen to combine to create an awful outcome. So examining the risk drones pose is not just about assessing the probability of immediate and direct damage to various sizes of aircraft.

Damage to a 150–350 seat jetliner might be one thing, but what about its different phases and situations of flight? What if one of those serious near-misses in 2015 had involved an airliner whose crew were already struggling to deal with an life-threatening in-flight emergency? The impact research mentioned above might help to clarify longer-term implications of impacts. For example, what if a drone impact on take-off inflicted damage that was not immediately observable when a safe forced landing would have been relatively easy, but it became catastrophic later in the flight over the middle of the ocean?

The role of aviation regulation

Aviation regulation attempts to mitigate known risks, but the problem is that this has not kept up with the changing drone market. The challenge is that much of the framework for aviation regulation in force today was developed during a time when drones could be easily be treated as a form of aircraft: "unmanned aerial systems" (UAS) as they are known officially were mainly small aeroplane- or helicopter-sized vehicles, with limited applications, and were flown remotely by qualified pilots.

Experts know that air crashes often (not always) occur from a combination of failures that, in themselves may have been benign, happen to combine to create an awful outcome.So it's not just about the risks posed by direct and immediate damage.

A mere decade later, we have a plethora of different sizes, weights, capabilities and operators, a growing and potentially lucrative market ranging from sophisticated commercial and public interest applications to mass retail users operating what could arguably be described as recreational toys. So the same form of regulation cannot apply. On one hand, the regulation cannot in a stroke stifle the development of what could be a lucrative, helpful and in some cases fun set of markets. On the other, the regulation must identify and counter aspects of the market could pose a direct risk to public safety.

Just one aspect of this regulation are the operators. Flight crew licensing for aircraft of all types takes into account the risks posed by aircraft operation not just on passengers and other airspace users but also people and property. But one could probably identify four categories of drone operators:

- "licenced experts" operating the relatively small fleet of larger commercial drones;
- "well-intentioned users" who may observe the CAA's Drone Code and operate with some regard to safety, or make up a commercial mass market;
- "idiotic users" who operate without any consideration of safety or consequences; and finally
- "the ill-intentioned" will be deliberately out to cause damage and/or harm.

Only the first category would be registered and (if the drone is large enough) might be traceable. Only the first two categories would be aware of the risks of flying close to commercial air traffic, though mistakes could always be made. The fact that all but one of the airprox cases last year saw the drone performing an illegal activity such as entering controlled airspace or flying out of visual line of site suggests the latter two categories are becoming a higher risk. And as regards that fourth group, we have yet to see the first instance of "drone terrorism".

A possible new approach?

Fortunately, the regulators and UK and especially EU levels has just begun considering these implications. The

[4] Airprox Report 2015-163, 25 Sep 2015: a drone flew within 50m of an Airbus A319 over Barnet at Flight Level 80 (about 8,000ft). The board confirmed the sighting was of a drone. There was incident report in August (Airprox 2015-139) involving another A319 at about 11,000ft, near Haslemere but it was too far away (just under a kilometre separation) to be confirmed as a drone or a balloon.

European Aviation Safety Agency (EASA) in 2015 began work on drawing up a new blueprint for regulation.[5]

Current EASA thinking

After a concept of operations early that year, followed by a consultation, it culminated in a document setting out a formal view and series of proposals for the future of unmanned aircraft regulation.[6] This was based on a framework identified as follows:

- **Open Category:** low-risk drone operations, identified as under 25kg, limited to operations below 500 feet and less than 500m from the user. They would be subject to geofencing standards to "limit the the airspace they can enter" and other features depending on the sub-category:
    - **Toys & mini-drones (less than 1kg):** shall have limited performance to assure flight below 100ft, or "the means to automatically limit the altitude they can enter";
    - **Very small drones (1–4kg):** would be able to fly above 100ft albeit by someone with "basic aviation awareness" and have "the means to allow automatic identification"
    - **Small drones (4–25kg):** would have additional features.
- **Specific category:** EASA explains that "as soon as an operation starts posing more significant aviation risks to persons overflown or involves sharing the airspace, the operation would be placed in a specific category. For these activities, each specific aviation risk would be analysed and mitigation would be agreed by the authorities before the operation can start, based on a safety risk assessment. This would be materialised by the issuance of an authorisation."
- **Certified category:** these are drones described as operating or with characteristics "akin to normal manned aviation" and therefore would be treated as with classic aviation regulation.

More needs to be done

While this this EASA thinking might be an appropriate step at this stage, we think more is necessary. Many of the problems identified above could be resolved through a combination of measures.

First we join other stakeholders including the British Air Line Pilot's Association in calling for that empirical research described above.

Second, we concur with EASA's thinking of geo-fencing all retail drones to below about 1,500 feet above ground level, and outside certain specified reserved areas such as airports and secure facilities.

Finally, we think that all drones above a certain weight and speed (based on the empirical research) should be equipped with *or have installed* an on-board transponder and then registered to the user. The transponder (similar to that used on most aircraft) emits a unique signal code for that user, and would ease detection and identification by ground radar and, more importantly, aircraft collision warning equipment. On their own, transponders might at least reduce the near-misses; but registration would also allow tracing action which could influence the "idiotic users" described above. Finally, these measures need to be enacted at the earliest convenience, rather that the years that such changes usually take.

These measures may require a bit of decisiveness on the part of politicians and decision makers. BA727 may have ended well for all concerned, but next time that plane descending over West London or elsewhere might run into something a little bit harder than a plastic bag...

Laurence Baxter helped establish the policy research and thought leadership function at the Chartered Insurance Institute in 2007. He has since led projects in these areas in support of the general insurance, London Market and life/pensions/long-term savings parts of the organisation, including setting up and running this *Thinkpiece* series in 2009. This followed periods as a senior policy adviser at the Council of Mortgage Lenders, a financial services campaign policy lead at the consumer group Which?, and as a policy researcher at HM Treasury.

[5] www.easa.europa.eu/drones

[6] EASA, Technical Opinion: Introduction of a regulatory framework for the operation of unmanned aircraft, Dec 2015.

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