

Science and Technology Committee

Oral evidence: Commercial and recreational drone use in the UK, HC 2021

Wednesday 26 June 2019

Ordered by the House of Commons to be published on 26 June 2019.

Watch the meeting

Members present: Norman Lamb (Chair); Bill Grant; Mr Sam Gyimah; Darren Jones; Stephen Metcalfe; Carol Monaghan; Graham Stringer.

Questions 162 - 329

Witnesses

I: Captain Tim Pottage, Chairman of RPAS (Remotely Piloted Aircraft Systems) Working Group, British Airline Pilots Association; Andy Sage, Head of Unmanned Traffic Management, National Air Traffic Services; and Special Sergeant Kevin Taylor, Chief Pilot, Lincolnshire Police Drone Unit, Lincolnshire Police.

II: Elaine Whyte, Director, PricewaterhouseCoopers; Tris Dyson, Executive Director of the Centre for Challenge Prizes, Nesta; Julia Jiggins, Head of Civil Avionics Strategy, Thales; and Sean Cassidy, Safety and Regulatory Affairs, Amazon Prime Air.

Written evidence from witnesses:

- [National Air Traffic Services](#)
- [Thales](#)
- [British Airline Pilots Association](#)

Examination of witnesses

Witnesses: Captain Pottage, Andy Sage and Special Sergeant Taylor.

Q162 **Chair:** Welcome, all of you. Thank you very much for attending. If any Committee members or witnesses have any interests they feel they should declare, please do so.

Can I ask each of you to introduce yourselves briefly? Then we can get into the questioning. We have quite a tight schedule. If someone has given an answer that you feel is satisfactory, don't feel that you all have to answer that question.

Special Sergeant Taylor: Good morning. I am Special Sergeant Kevin Taylor from Lincolnshire police drone unit. I am the chief pilot there. I am a volunteer, as a special sergeant in the drone unit. My day job is working alongside NQEs doing training for drones. I work in some drone detection as well, in my day job.

Q163 **Chair:** You are a full-time police officer.

Special Sergeant Taylor: No, I am a volunteer. I volunteer my hours, as a special constable.

Q164 **Chair:** Very good. Thank you very much.

Andy Sage: Good morning, everybody. I am Andy Sage, head of unmanned traffic management at NATS. NATS is the largest air traffic service provider in the UK, managing 2.5 million flights per annum across the UK's skies and at most of the UK's largest airports. My role is to provide services and infrastructure that both protect the safety of our existing customers and enable the integration of co-operative drone activities in our airspace.

Captain Pottage: Good morning. I am Tim Pottage. I am a current airline pilot. I have been doing that for 29 years or so. I represent 10,000 UK professional pilots, including airline, helicopter, search and rescue, police, HEMS and drone pilots. BALPA's mission statement is to make every flight a safe flight. That is purely the reason why I am here. I have no commercial interest in drones one way or the other.

Q165 **Chair:** Thank you all very much indeed. Do you think that the current regulations relating to flight restriction zones and aerodromes are adequate?

Andy Sage: We strongly support the action that the Government took at the beginning of this year, with the extension of flight restriction zones.

Q166 **Chair:** To 5 km.

Andy Sage: That is correct. On safety grounds, we thought that was exactly the right thing to do. At the same time, in order for it to be enforced effectively, one needs to provide an efficient, transparent and easy way in which the public and commercial operators can gain access



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to that much larger bit of airspace. In our discussions with police forces, they have expressed some concern about the ability to enforce such a large area. That is why we have taken measures to try to make it easier for responsible users to gain access to that airspace.

Q167 Chair: We have a restriction zone to 5 km, but you talk about users gaining access to that airspace. Can you explain how that works? Can you also expand a bit on your point about whether the regulations are currently enforced effectively or whether it is work in progress that needs strengthening?

Andy Sage: They are flight restriction zones, so one is able to access them.

Q168 Chair: They are not exclusion zones.

Andy Sage: No. They are flight restriction zones, so they are areas of airspace that one can access, but you are now required by law to gain the approval of the relevant ATC authorities wherever that bit of airspace might be. That might include NATS itself, the local airport and the police. One is required to do that. While you operate within that airspace, you are required to adhere to all the other provisions in law around maximum height, maximum weight and so on.

Q169 Chair: Do drone users know about these regulations? Are they well understood? Are applications being actively made constantly under the new, extended restrictions?

Andy Sage: We have done a lot of work with the UK CAA to try to make them visible to the public. We have developed a different way of communicating with the public, recognising that we are communicating with a different type of user. The Dronesafe website is one example. The Drone Assist app that we launched now has almost 130,000 users. I think it has gone even higher since our written submission to the Committee. Those all make it very clear and unambiguous where one can fly and where one requires—

Q170 Chair: Do we know how many applications are made? Is it monitored?

Andy Sage: We are currently evaluating that process. It has been running for a number of months. We will know very soon the type and volume of applications we are getting through that process. The data is not available quite yet.

Q171 Chair: To go back to my question about effective enforcement, are you happy that the extended restrictions are being enforced effectively?

Andy Sage: It depends. At the airports we operate, we have implemented an automated process by which that can occur. We think that is a much safer way of doing it than depending on phoning an airport, which has workload implications for very busy towers and is potentially unreliable and not easy for the public to access. That gives us



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some concern about whether it provides an incentive for the public not to follow the correct procedures. That is really important to us.

Q172 **Chair:** Are there any other comments?

Special Sergeant Taylor: The apps that are available are extremely good. There is a lot of information in them. The big challenge is communicating their availability to the domestic user of drones. That is something that needs a lot of focus.

Q173 **Chair:** You think that the average domestic user may be blissfully unaware of all of that.

Special Sergeant Taylor: There is an element of users who are unaware of the apps. When they find them, they are extremely useful. Certainly, the commercial fraternity is fully aware of them and uses them daily. You can see them in use. There are ways you can see that they are being used.

Q174 **Chair:** Through the app, you can seek your authority to—

Special Sergeant Taylor: You cannot seek authority through the app, but you can see whether the location you want to go to is in one of the flight restriction zones, so it is extremely useful. It is also dynamic. If there are temporary restrictions in place, you can see those as well. The app has been a quantum leap forward. The challenge is in educating the domestic users of drones that that is available to them. That is a challenge that we all need to embrace and go for.

Captain Pottage: I agree with much of what the other gentlemen have said. The flight restriction zone is adequate as it is. It was not previously. The previous 1 km was woefully inadequate; 5 km is the bare minimum to keep aircraft and drones separated during their landing and take-off phases. The app is a great step forward.

There is a bit missing. I mentioned that I represent helicopter pilots as well. They operate away from conventional airfields. Essentially, that is their job. We still feel strongly that there is a need for a temporary flight restriction zone to be placed around the landing sites of ad hoc landing zones for emergency helicopter activity.

Q175 **Chair:** How does it work with an air ambulance landing in the middle of the north Norfolk coast, for example? How do you impose a temporary restriction around that area for a casual user who happens to be flying at that point?

Captain Pottage: The first thing would be to require that there is a temporary restriction zone. We would suggest 1 km, unless it is co-ordinated with the helicopter pilot. As Kevin said, the app can be dynamic. It would be possible to make that temporary restriction zone visible to app users on an ad hoc basis.

Q176 **Chair:** The app has the capacity to pick up an air ambulance or any other



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helicopter landing in a particular location, so it could tell app users about a 1 km restriction zone.

Captain Pottage: Yes, I believe so.

Q177 **Chair:** At the moment, the regulations do not provide for that.

Captain Pottage: They do not require that.

Q178 **Chair:** They do not require it.

Captain Pottage: That is correct.

Q179 **Chair:** You are suggesting that it is a further iteration that should happen.

Captain Pottage: Yes. The reason is that helicopters and drones absolutely need to be kept away from each other.

Q180 **Chair:** It is more dangerous with helicopters.

Captain Pottage: Much more so. Helicopters are uniquely vulnerable to collision with drones in a catastrophic manner.

Q181 **Chair:** At the moment, someone could be happily flying a drone where a helicopter lands without any idea that they may be causing a safety problem.

Captain Pottage: Correct. Not only that, but there is an attraction in flying drones to video or witness emergency situations.

Q182 **Chair:** That might actually draw people in.

Captain Pottage: They are a bit of a honey pot. There was an example during the floods in Lincolnshire a couple of weeks ago, where the RAF were delivering sand bags. They had to suspend their task, because drones were in the area.

Special Sergeant Taylor: Can I clarify that?

Q183 **Chair:** You might know about this, Kevin.

Special Sergeant Taylor: I do. I put that emergency restriction of flight in place. Let's be clear on this. It was not because of drones. It was because a fixed-wing and a rotary—an aircraft and a helicopter—were coming to take photographs at the time, while the Chinook was operating. Our police drone and a drone from the Environment Agency were operating. We did not have issues with drones during the floods in that regard. That ERF was put in place because of fixed-wing and rotary traffic that was coming in.

Q184 **Chair:** Was it a media helicopter commission?

Special Sergeant Taylor: No. The tipping point was one private helicopter and one private aircraft that were coming to take photographs of the floods.



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Q185 **Chair:** My God.

Captain Pottage: The information that I have is slightly different, although I bow to Kevin's knowledge of the details, which is probably better than mine. Irrespective of that, the point about emergency sites being a bit of a honey pot for drone activity is valid. Most importantly, helicopters and drones need to be kept well apart, unless they are co-ordinated.

Q186 **Chair:** Andy, would you support the idea of a 1 km restriction zone around any helicopter landing anywhere?

Andy Sage: Anything that improves the situational awareness of anybody operating a drone is going to help, whether enforced through regulation or merely through best practice. As we have said, at the moment the app—

Q187 **Chair:** Where we are talking about something of a serious safety nature, best practice is not really good enough, is it? We need regulation, don't we?

Andy Sage: That would require a change in the regulation from our CAA.

Q188 **Chair:** You would support that.

Andy Sage: Where there is clear evidence to back the safety risk, I think it would make sense.

Special Sergeant Taylor: Can I back up what Tim said? He has a valid point. During emergency incidents, we also suffer from people turning up with drones, be they commercial operators from the news or members of the public who want to come and film. We have no legal restriction so that we can ask them to leave the area if they are in the airspace. If there is no restriction on the airspace, we have no legal right to ask them to leave. We can only ask them politely.

We have spoken about the situation at Wainfleet during the terrible floods. That process worked very well. It took 30 minutes, and it was really good, but it is not a process that is designed to be used for short-term, immediate flight restrictions on airspace. It would therefore be extremely useful to have a power that enabled us, as police, to declare that, due to an incident, there was a restriction for drones.

Q189 **Chair:** Am I correct in understanding that, if at the moment someone flies a drone into the extended restriction zone around an aerodrome without permission, they commit an offence?

Captain Pottage: That is correct.

Q190 **Chair:** By whom is it prosecuted?

Captain Pottage: By the Civil Aviation Authority, I believe.



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Special Sergeant Taylor: It depends. If it is a commercial operator, the Civil Aviation Authority will take care of it. If it is a domestic user, the police force take care of it. We have a memorandum of understanding with the Civil Aviation Authority as to who deals with which category of offences.

Q191 **Chair:** Okay. That would obviously extend to your suggestion that there should be a temporary 1 km zone around a temporary landing.

Captain Pottage: The important point, as was mentioned earlier, is that it is not a flight exclusion zone, but a flight restriction zone.

Q192 **Chair:** I understand that.

Captain Pottage: As long as it is co-ordinated, it is fine.

Q193 **Chair:** Understood.

Andy Sage: Ultimately it is the responsibility of the drone pilot to operate their drone close by, in visual line of sight, and to be aware of other users around. What Tim highlights is the need to provide the user with enough data and information to give them a positive chance of doing that in a safe manner. As we move forward to more valuable commercial operations that may be operating in this sort of area beyond visual line of sight, there will be a fundamental change in the way we regulate and manage airspace. Then the sorts of measures that Captain Pottage is highlighting will become absolutely essential.

Q194 **Bill Grant:** My questions are around access to the flight restriction zones. I note Tim's comment, which I wrote down, that your mantra is that every flight should be a safe flight. We would all welcome that. There was a special emphasis on helicopter risk, which seemed to be hard data. The word "vulnerable" may not be correct, but it strikes me that helicopters may well be more vulnerable to impact by a drone.

How could the system for requesting access to flight restriction zones be improved? Should a system for requesting access be standardised across all airports? Who should drive that standardisation, if you feel it is appropriate?

While you are thinking, perhaps I could make a wee comment. There is an area beside the Clyde in Glasgow where the air ambulance and the police helicopter are co-located. For the general public, there is no indication that that is a take-off and landing slot. I sense that places like that will be dotted around throughout the UK. Having listened to you, Tim, I think they may be at greater risk and may need special attention, because they in themselves are not airfields or aerodromes.

Captain Pottage: The flight restriction zones are only placed around certain categories of airfield. They are not around every place an aircraft would operate from. To a large extent, that sounds sensible and proportionate. I suggest that it probably needs considering in the round, in the light of experience and examples such as the one you gave.



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Although a place may appear relatively small on the map, it might have a high frequency of use or density of traffic. That would be my take on that.

Q195 **Chair:** Can we have the question Bill asked about standardisation answered by one of you?

Andy Sage: I can do that. NATS feels very strongly that a consistent means needs to be presented to the public. We regard drone users as falling into three categories: clueless, careless and criminal. To try to help those who are careless or unaware, it needs to be made easier. We have made the step of implementing what we have called the airspace user portal, which provides the public and commercial operators with a single place through which permission can be granted. We can then forward requests to the appropriate authorities that have the permission. That delivers a consistent means of access to the public.

Q196 **Chair:** In the aerodromes you are responsible for, do you have a standardised process?

Andy Sage: Yes, that is correct. We were proposing to forward requests to the airports that we do not manage as well, so that it provides a single access point for the public. We can then forward requests to our operation centres, our airports, other airports and the police—whoever is required to give access.

As well as giving consistent means of access to the public, it means that, when disruption occurs, the airport and the police are much better placed to undertake an assessment of the risk and to identify those who are acting responsibly, because they have some knowledge of who is meant to be flying there at the same time. We may come on to counter-drones later. We believe that the use of that technology in the absence of an expected traffic picture is of limited value. Therefore, we believe that the process adds a lot of value.

Q197 **Bill Grant:** To summarise, standardisation across the UK would be welcome, almost essential. That would be driven by NATS. Would it be in partnership with the Civil Aviation Authority and BALPA? Who would partner driving it forward?

Andy Sage: I believe that, at the moment, the CAA publication advises the public to go to the airspace user portal in order to find out where to go for permission.

Q198 **Chair:** Does standardisation need to be pinned down in regulation? Do we need to force it through? At the moment, it seems that some aerodromes do it, but others do not. It is not an acceptable situation, is it?

Andy Sage: We have nearly 170 aerodromes across the UK to which this regulation applies. Many of them are very small. We believe that it is



simply not viable to expect zones to be enforced effectively using phone calls.

Q199 **Bill Grant:** You touched on what I understand is the NATS airspace users portal. I believe that may be in its infancy as regards volume of requests and how you manage those requests. Is there any indication how it could be used or improved going forward? To pick up your words, there are what have been referred to as responsible users and co-operative drones, but obviously there are also those who are not responsible and those who are unco-operative. How do you intertwine those to make the very clear statement that every flight should be a safe flight? How do we manage that? What role does the portal have?

Andy Sage: You are quite right. The portal is in its infancy. It is currently under evaluation at our centres, with the police and at six airports, with the intention of rolling it out across the rest of NATS's airports and making it available to others later in the year.

You are right. It would not prevent a determined criminal from acting in an irresponsible way, but we believe that managing approvals in a data-based manner helps at times of disruption to distinguish the irresponsible user from those who are meant to be there. That will speed up the ability of police and airports to deal with the situation.

Q200 **Bill Grant:** I am trying to understand the process. Let us say that I am a responsible drone user. Does NATS expect you to apply within a particular time period? You would not expect someone to apply at 9 o'clock to fly a drone in a restricted space at 12 or within the next 20 minutes. Do you need advance warning, say 24 or 48 hours, to manage a movement system that is seeking—again, I come back to what is essential—to make every flight safe? Do you need that time and notice?

Andy Sage: Yes. At the moment, we need time to be able to do that. Our hope is that, once we have finished our evaluation, we will be able to shorten that period.

Q201 **Chair:** Do you state how long before people want to fly they have to apply?

Andy Sage: Yes. At the moment, it is many days, because this is a process that we have been running for decades and have only recently automated to deal with the extra workload. Part of the evaluation is to bring that down to hours, not days.

Q202 **Bill Grant:** I am trying to imagine myself as a drone user. Have you refused an application? Has any application for access to restricted airspace been refused? Has there been any adverse reaction to any such refusal?

Andy Sage: I do not have that information to hand, but I am happy to follow up.

Q203 **Chair:** If you can come back to us with an answer, that will be good.



Andy Sage: By all means.

Q204 **Graham Stringer:** There has been a large increase in airprox incidents, largely due to drones. Are the figures accurate?

Captain Pottage: Yes, they are. They are certainly not an overestimate—put it that way. They may indeed be an underestimate. There has been a suggestion by some drone manufacturers and some drone user groups that the figures are bogus. I don't know whether that is what you are referring to.

Q205 **Graham Stringer:** No, I am just interested. One of my concerns is that, as you say, there might be an underestimate. If two planes with pilots come close to each other, they confirm each other's report, whereas if there is a drone and a pilot, the drone may not be seen, or it may be a mistake.

Captain Pottage: You raise some interesting points. First, aviation has grown up with a responsible methodology that we report incidents. Whether it is my mistake, someone else's mistake, an accident, a near-accident, something that could have happened or something that did not quite happen, we report it. We report it for the benefit of everybody. That is a key pillar of what makes aviation safe. If I see something, I report it. Basically, I am a safety professional. That is my job, and we take it seriously, so I take great issue with any suggestion that the reports are spurious or bogus.

Secondly, you say that they may well be under-reported, for the reason you suggested. I would agree with that. In addition, pilots spend most of their time—counter-intuitively—looking inside. We fly via instruments. As soon as the aircraft takes off, my head is inside, looking at the instrument panel. We fly as though we are in cloud all the time. Most of my focus is inside the cockpit, so I am not going to see the drones that I nearly miss.

When I am looking outside, I am only looking pretty much straight ahead. I will not see any drone that approaches me from underneath, from above, from the left, from the right or from behind. I am only looking at a very small sector of the sky. Drone reports are probably gross underestimates. That view is borne out by the UK Airprox Board, which has a similar logical approach. Yes, the figures are valid, and yes, they may well be an under-reporting of the problem.

Q206 **Graham Stringer:** What should the policy response be? The figures are pretty worrying. I saw the CAA yesterday. They said it was most unlikely that a drone would bring down a commercial airliner, because it has at least two engines. As a passenger, I am not totally reassured by that.

Captain Pottage: No. As an airline pilot, I would say that you are correct not to be reassured. I am concerned that the CAA had that view.



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There has been no testing of a drone against a large commercial high bypass jet engine—none at all. Anecdotal evidence suggests that it would cause a catastrophic failure, causing a blade to shed and not to be contained within the engine cell. In the same way, when a Southwest Airlines 737 had an engine explode, it penetrated the cabin and there were fatalities. It is a very serious issue.

When we talk about drones, everyone has a slightly different concept. Is it something this big, this big or this big? How heavy is it? Obviously, the risk increases with the mass; 250 grams is probably a relatively safe minimum level, but anything above that will cause damage, to a greater or lesser extent.

We know, as a matter of fact, that we did extensive testing against aircraft windshields at speeds within the operating envelope. It was a small drone, weighing 1.9 kilos, and it penetrated the windscreen. No one would volunteer to sit on the other side of that windscreen and say, "It's okay. It is only going to crack it," or whatever. It did not. In one test, it went straight through it, like a hot knife through butter. In the other, it penetrated the windscreen, causing it to shatter and delaminate, covering the cockpit with glass on the other side. It is a very serious issue. We chose windscreens not because they were identified as the most vulnerable area but because, first, it is likely, and secondly, we could arrange testing on windscreens. We could not do it on engines or other parts of an aircraft. Yes, the risk is very real. Don't let anybody tell you that it is not, because that is not true.

Q207 **Graham Stringer:** What should the policy response be?

Captain Pottage: The policy response should be to do everything that is possible to make sure that drones and aircraft do not come into close proximity. We should increase the number of compliant users who use the portal and ensure that a flight restricted zone is robustly enforced. As Andy said, ensuring greater compliance allows the outliers—the non-compliant—to stand out far more quickly. Then you can take action, whether that action is apprehension and defeat of the drone, perhaps in the slightly longer term, or immediate response: what should the aircraft do, what should air traffic control be saying to the aircraft, and how should the issue be handled to ensure that there is no collision?

Q208 **Chair:** You talked about strict compliance with the restriction zones. What are the penalties for not complying?

Captain Pottage: We were asking for it to be treated in the same way as reckless driving offences are considered. I believe we requested a fine of up to £5,000. Off the top of my head, I cannot tell you whether or not that went into the legislation.

Special Sergeant Taylor: Breach of the air navigation order is a summary-only, low-level offence, dealt with basically by fine. Our successful prosecutions have been based on cautions as a result.



Aircraft endangerment, which is extremely difficult to prove, is the one that becomes triable. We have spoken to the CAA about how we go about doing that in relation to a couple of situations we had in Lincolnshire. It is extremely difficult. You have to be able to prove categorically that the aircraft was endangered, not just that somebody was flying close to an airport. Flying close to an airport with no aircraft taking off or landing would not be considered by the Civil Aviation Authority to be endangering an aircraft, if there isn't one to endanger. Those are the challenges.

We have spoken about entry to restricted airspace. We need to address that. A non-standard flight application potentially takes 21 days, and we do not want commercial operators, who are playing by the rules, to decide that it is just too difficult. If we are not careful, we would lead those who comply to cross the line and go back. It is really important that we allow that access.

Q209 **Chair:** We should make it an easy process.

Special Sergeant Taylor: We should make it easier.

Q210 **Chair:** With shorter notice.

Special Sergeant Taylor: For a lot of commercial applications, 21 days is too long.

Captain Pottage: We would support that move. I suggest that the minimum time would be in the order of 12 hours for the requirement for other pilots to plan their own flights in knowledge of drone usage. It is not necessarily just about access to the flight-restricted zone; if there are other low-level drone operations, pilots who fly low level—not just military, but others who do it legitimately and with reason—may need to be aware of that as well. Therefore, 12 hours would probably be the minimum notice to co-ordinate that.

Q211 **Chair:** Is there a case for treating more seriously breaches of the restricted zones, given, as Tim said, the catastrophic consequences of collision?

Special Sergeant Taylor: I would say so. A summary-only offence is a very low-level one, and a repeat of that would not escalate it. Typically, in some of the prosecutions, the fines have been about £100. Is that in the public interest?

Q212 **Chair:** It seems to me akin to the health service; it should be a never event. Do we not need to get across the message that there are very serious consequences for flying a drone near an aerodrome?

Special Sergeant Taylor: Without a shadow of a doubt, the deterrent for those offences needs to be increased.

Q213 **Chair:** Do you agree with that, Andy?

Andy Sage: Yes, I do. The public need to feel both a real fear of enforcement if they act in an irresponsible way and an eagerness to find



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information to make sure they do not do so. I am pretty sure that, if you were close to the boundary fence of an airport, it would be difficult not to see that, but if you are 5 km away, the threat may not feel real.

Q214 Stephen Metcalfe: I want to touch on some of the other risks that drones present. Before I do that, Tim, earlier you said that helicopters and drones do not mix; they could end up in a catastrophic event. Have there been any catastrophic events, or any incidents involving collisions?

Captain Pottage: There have been collisions, particularly in the US. The one I am particularly thinking about was against a military helicopter, which is battle hardened. It caused significant damage through a crack in the rotor; it was not a catastrophic event.

Q215 Stephen Metcalfe: It could easily have been.

Captain Pottage: I suggest it could have been. The particularly vulnerable part of a helicopter is the tail rotor, which spins very fast and generally is not protected or shrouded. The whole of the aircraft's flight is predicated on the tail rotor working. A simulation study that we did through QinetiQ and the MAA showed that if any size drone anywhere at any time strikes a tail rotor there will be only one outcome.

In addition, many helicopters are of very light construction. They are certified to a far lower standard of impact resilience. If they are HEMS helicopters, police helicopters and light helicopters, a drone will go straight through the plexiglass. It is only about a quarter-inch thick, no more, and will offer no protection whatsoever. The only protection the pilot will have will be their visor and that is it. Heavier and larger helicopters like CS-27s and CS-29s have a far tougher windscreen that is bird strike resistant and would offer some protection.

The important point is that the current certification standard maximum is that it should be resilient to bird strike. What we have shown is that, while it may offer some protection, it does not offer adequate resilience against drone strikes, which are far more severe and have far greater potential for damage than bird strikes. No aircraft is certified against drone strikes.

Q216 Chair: We had a pretty horrific incident in north Norfolk involving geese and helicopters, so they can be catastrophic in themselves.

Captain Pottage: That is correct. It was over the marshes, wasn't it?

Chair: Yes.

Q217 Stephen Metcalfe: Other risks could be presented. We have had conflicting evidence about the way drones could potentially swarm. Could you explain what constitutes a drone swarm and expand on what some of the risks might be?

Captain Pottage: Technology is available to co-ordinate drones with a single user. There are many examples of that available for PR and



advertising reasons and for sound-and-light shows. Drones can be co-ordinated with a single user and that would be a swarm, but they do not need to be sophisticatedly co-ordinated to constitute a swarm; it could be just two, three or four people—pick your number—with drones operated in a co-ordinated manner. They could very easily cause significant disruption. We saw what happened with one drone; it was quite concerted and of long duration. If that is doubled or tripled, the problem becomes exponentially greater.

Andy Sage: I confirm what Tim says. With the technology, it is possible. We have certainly not had any evidence of sightings, or risks posed by such swarms, other than what we all see at major events and suchlike. We have not yet seen that as a threat in our sightings.

Q218 **Stephen Metcalfe:** In other words, it has not been used in a malicious way yet.

Andy Sage: No.

Q219 **Stephen Metcalfe:** Kevin, do you want to comment?

Special Sergeant Taylor: There have been issues about swarms at air events, as you said, and particularly around Ministry of Justice areas; for example, six people got together and flew six drones at once, so we know that can happen.

Q220 **Stephen Metcalfe:** What was the purpose of that?

Special Sergeant Taylor: Drug delivery.

Q221 **Chair:** To a prison?

Special Sergeant Taylor: Yes.

Q222 **Stephen Metcalfe:** Were all six doing drug deliveries?

Special Sergeant Taylor: All six, on the basis that some would fail and some would get through.

Captain Pottage: That example is not a sophisticated automated swarm, but it is a swarm none the less; it is a multiple drone event.

Q223 **Stephen Metcalfe:** Is the more accurate word “surge”? It is a rush at something to deliver something. It is easier to take down one than six.

Special Sergeant Taylor: Exactly.

Q224 **Stephen Metcalfe:** Is surging ever used as a term to describe drone activity, rather than swarming?

Special Sergeant Taylor: I have not heard that.

Q225 **Stephen Metcalfe:** I have just invented a new description. Are there any other risks—we have heard about drug deliveries to prisons—that drone swarms could present? Presumably, there is disruption to restricted



airspace.

Captain Pottage: We have identified various risks that I am happy to discuss in a secure environment. I do not feel able to do so here.

Stephen Metcalfe: That may be very useful to the Clerks.

Q226 **Chair:** In light of that, it might be worth arranging a separate discussion, if there are things you feel we ought to be aware of that you do not feel able to talk about here.

Captain Pottage: I would welcome that.

Q227 **Stephen Metcalfe:** Drone ownership is growing; it is unclear exactly how many drones are out there, but, as more drones are made available and technology advances, do you think that swarms for malicious use will become a greater issue?

Captain Pottage: I do not think I can answer that. I do not think it is necessary to swarm to cause a problem; it just multiplies the problem.

Q228 **Stephen Metcalfe:** For drones, you now have to think three-dimensionally in terms of observation and the way you protect your environment. It is no longer about protecting it at ground level; you have to think about the airspace as well. Are there ways that individuals can potentially protect themselves from the risk of being, let us say, overflown and having their properties observed? I suspect it is more difficult in urban than rural areas. Is there any evidence that this is starting to cause concern for people?

Special Sergeant Taylor: We get the odd call about it, and we do a lot of public engagement. Rural communities tell us that they feel their properties are being watched and that people are using drones potentially to do a recce to see what plant, machinery and so on is there. It is a concern for us. At the moment, in Lincolnshire there is no proven link between that and organised crime, but we should keep an open mind. The likelihood is that organised crime gangs use them for carrying out such recces, potentially where they are looking to steal plant and machinery and for ATM-type jobs. That is a real risk.

Andy Sage: I share the concern about public trust. It is something we are working on quite hard because it could yet be a major obstacle to the industry developing for a positive purpose. We are working with industry at the moment to try to determine whether we can find a way for the public to identify whether a drone near them has been approved and what sort of activity it is undertaking, in an anonymous way. We believe that, in the absence of any information, the public will think the worst when that may not necessarily be the case.

Q229 **Stephen Metcalfe:** Are there any other risks either to people or animals that drones present that we have not identified and should be aware of?



Captain Pottage: There is the risk of a drone falling out of the sky. Although small, if it hits someone, it will kill them. The limit is about 60 joules, from which the 250-gram weight limit has been derived. Anything more than that falling from any significant height is like a brick hitting you. As far as I am concerned, the biggest risk would be a catastrophic accident with an aircraft and the ground risk that would cause. The sorts of things you could think about over a densely populated area are very concerning.

Andy Sage: That remains our primary concern. Today, the law is very clear. You cannot fly over a crowded area; you need special waivers from the regulator to be able to do that. As we move towards more complicated operations where the pilot may not be in the vicinity of the drone, there are huge challenges to be overcome in demonstrating that a safety case can be made that does not pose a problem to people on the ground. The new safety case guidance that the CAA is using addresses both the air and ground risk in equal measure as we move forward, so it is being treated seriously.

Special Sergeant Taylor: The legislation on the distance you need to be away from people and so on is very comprehensive for commercial operators. Domestic operators choose to do what they choose to do. Commercial operators generally are very sensible and operate within the rules. I keep coming back to the education piece. It is really important that we engage, educate and make it as simple as possible, so that we do not have people wandering off doing their own thing because they are concerned about the legislation and getting too wrapped up in it.

Captain Pottage: I agree with what Kevin said, particularly about increasing the degree of compliance by whatever means possible. That is not where our area of concern lies.

Q230 **Mr Gyimah:** My first question is to Special Sergeant Taylor. What effect has the proliferation of drones had on UK police forces in terms of how they do their work and their resources?

Special Sergeant Taylor: I represent Lincolnshire and can only talk about Lincolnshire. When talking to colleagues at national meetings, our experience tends to be the same. To put some stats on it, we have looked at the number of calls we get in relation to nuisance drones. To give an example, last month Lincolnshire police had 12,660 calls for services. Of those, five were complaints about drones. Putting that into perspective, it is 0.04%. We get 10 times more calls about concern for wildlife and 10 times more calls for firearm incidents, so in the scheme of things it is quite small.

We have had two prosecutions in the past four years, and we robustly enforce. We look to educate where possible, but we will enforce. From our point of view, it has not been massive. In a sense, it is a victimless crime. We know only what we are told. There are occasions when we are not told because there is no victim and nobody is affected by it or has



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seen it. I am sure there is a little bit more than we get calls for, but hopefully that puts it into perspective for you.

Q231 **Chair:** It is a victimless crime until something catastrophic happens.

Special Sergeant Taylor: It is certainly not victimless in that sense, but it is victimless when it comes to reporting. Unless somebody has been affected by it, it would not be reported. We encourage people to report whatever they see.

Q232 **Chair:** No doubt there is mass ignorance of the rules anyway among non-drone users.

Special Sergeant Taylor: Among the public, there is still the education piece to go through as to what is and is not acceptable. When we engage at country fairs, people ask us, "Is it okay for a drone to be over my property?" The answer is that it is not. People will not necessarily report it unless they know it is wrong in the first place, so there are challenges. Going back to basics is the first step.

Q233 **Mr Gyimah:** Are there any thoughts or suggestions on how additional pressures on police forces can be alleviated?

Special Sergeant Taylor: I think the pressures come at the upper end with specialist groups—for example, counter-terrorism and serious organised crime elements, of which we are not a part. I do not want to go off on a tangent with manufacturers, but there is no standard recording of drone telemetry. When we want to interrogate a drone for forensic purposes, it is extremely difficult, complex and expensive. There are specialist departments that do that, but the threat, harm and risk of the offence would need to reflect that level of intrusion.

Q234 **Mr Gyimah:** There are obvious positive aspects to drones as well for police forces, so it would be helpful to get a sense from you, as well as everyone else, as to how they have assisted you in your duties.

Special Sergeant Taylor: Our drone unit has been active for 20 months. In that time, we have done more than 450 deployments. Without a shadow of a doubt, people are alive today who would not have been alive if it was not for the drone in Lincolnshire. One very small example is a chap who had been involved in a road traffic collision and wandered off and fell into a ditch. He was found by the thermal camera on the drone, unconscious and hypothermic. He was taken to hospital and made a full recovery. When offenders go to ground, there are area searches for them as well. Those are plentiful; those jobs are just business as usual for us. There are other areas.

Q235 **Chair:** They have been used to find people who have gone to ground.

Special Sergeant Taylor: Yes. The drone is an aerial asset, similar to our manned NPAS helicopter service; it is a similar solution in its capability. We do recces. If we have intelligence that somebody might be in an area, we can do a recce for entry and exit warrants. We have also



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been successful in detecting by thermal means cannabis farms and removing them. We have had multiple cannabis farm convictions. One chap got three years; another pair got 12 months and 14 months respectively.

When it comes to reducing crime, especially the organised crime gang element, it is a great tool, especially in Lincolnshire where we are so rural. We have so few officers on the beat, and we have big areas to search. Vulnerable and missing people are probably at the top of the list for the type of deployment we get. Searching large open areas for vulnerable and missing people is one of the key things. We have been extremely successful, with a little bit of luck, in doing that in Lincolnshire.

Andy Sage: We could do more collectively to make the public aware of the benefits that drones bring, such as those wonderful examples. To give you another completely different but real example, at the moment we are working to trial drones in the North sea as an augmentation to the helicopter service, to provide inspections at dangerous times that would otherwise put helicopter pilots and others in danger.

Q236 **Chair:** Just explain that North sea point again. What are they doing?

Andy Sage: It is the ability to undertake remote inspections a long distance from the coast near Aberdeen. For example, on a remote rig or installation you might suspect there is a gas leak. With the right sensors, you are able to inspect that rig without putting anyone in danger. There are many other examples we are working on at the moment.

Captain Pottage: I support that. Likewise, there are power line and wind turbine inspections. BALPA is pro-drone. There are many good uses for emergency services in places where it is dirty and dangerous to be flying, as well as responsible recreational use. It is a new dawn of aviation, and we need to embrace it. We are pro-drone, but it needs to be sustainable and safe.

Q237 **Darren Jones:** I have some basic questions. How do we detect a drone?

Captain Pottage: In multiple ways. The mark 1 eyeball is pretty reliable. Various technologies are available. Kevin has some expertise in detection via the radio frequency. There are also radar methods—micro-Doppler and so forth—which are particularly effective. I will let others give more detail.

Special Sergeant Taylor: As I am sure you have heard before, there is no silver bullet for this problem. The accumulation of technology gives the best chance of detection. As to where we are right now, probably the best option is RF—radio frequency—detection. That is all well and good as long as the drone is talking to some form of ground control station and there is RF between them. If it is programmed to fly autonomously, that option does not exist. It would still need GPS, and the way to defeat that would be by jamming the RF or blocking the GPS.



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There are obvious and serious implications in jamming RF, especially given the frequency band drones work in. The majority of drones operate in the 2.4 GHz frequency band, which is where all wi-fi works as well. If you barrage jam that frequency, you are likely to take out any wi-fi in buildings, point-of-sale systems, in-car cameras and so on, so the implications are extremely wide-ranging.

Q238 **Chair:** You could create havoc.

Special Sergeant Taylor: You certainly can create havoc.

Andy Sage: I have a simple point. The radars we use today are the only means of unco-operatively detecting an aircraft as part of our core business. They cannot see drones; drones are too small and fly at too low a level. Anything that can emerge through regulation to make it mandatory for drones to be remotely identified and tracked will help us manage that traffic, but none of it will prevent a criminal act from overcoming it. There are a number of technologies available to do that. They themselves also have to be safeguarded, in the sense that to switch on the kit near an airport is not a straightforward matter without understanding its effect on the infrastructure, the landing systems and everything else at the airport. That is also of concern to us.

Q239 **Darren Jones:** On technology, Tim, I think you said in your written submission that Germany, France, the USA and Israel had good drone detection systems.

Captain Pottage: They do.

Q240 **Darren Jones:** What are they using that we are not?

Captain Pottage: They are using micro-Doppler. A company in the UK, since taken over by a French company, provides systems, so they are commercially available now and pretty effective. As Kevin said, to cover all eventualities there probably needs to be a suite of sensors and, ultimately, they need to be optically identified. The technology is there, but there is a discussion about who is going to pay for it. Whether it would be the UK Government, the airport or some other level, I do not know. I believe that has held up discussions on it.

The most important element for pilots is detection. Don't let the desire to have some mechanism for defeating drones hold up the implementation of detection equipment. If we know where they are and, more importantly, where it is safe or where one is in the way, we can take action to avoid an accident.

Q241 **Darren Jones:** If the micro-Doppler stuff is the best technology, presumably we would use it in the areas where we are most worried, which would probably be airports. Are we using it at airports with you guys at NATS?

Andy Sage: Each airport makes its own assessment of the security risk.



Q242 **Darren Jones:** But you do not do that; the airport owners do it.

Andy Sage: That is correct, and we support the implementation. The key point we want to make is that, drawing a parallel with the way we manage normal air traffic management today, if all we did was switch on radars, take the raw data and present it to air traffic controllers, there would be chaos. It is only when you can correlate that with the identity of those flights and their expected flight plans that you can see the outliers and those who are where they should not be.

I would draw the same parallel here; if at a time of disruption I switch on the equipment and detect multiple drones, it does not help an airport to make an assessment as to whether to continue operations in some way or reduce the number of movements. As Tim said, the trick is to be able to detect the drones but to do it in a way that allows you to make an informed risk assessment at that moment, based on known intelligence and any other factors that might enable the airport to maintain some level of operation, and demonstrate to those intent on disruption that the effect is not as great, while ensuring safety.

Q243 **Darren Jones:** That takes me to my second question. I think the Committee notes the delay between airport owners and Government about who is paying for this kit. We might want to pursue that later. We have just moved on to what you do if you detect a drone. How do we know whether the drone is malicious?

Special Sergeant Taylor: That is one of the challenges. The telemetry is not readily available. That would be one of the advances we need. We want to know who are our friends and who are our foes.

Q244 **Chair:** If you can rule out all the legitimate people, you know who to target.

Special Sergeant Taylor: Yes. Detection is about the pattern of life. You have to realise that radar as one effective format of that will give you a picture, but you need to know what the normal picture looks like anyway.

Andy Sage: I can give you a specific example. Very recently, in one of our towers, a drone was sighted by a pilot who was about to push back and depart ready for take-off. Within seconds, that tower was able to confirm that the drone had been approved and was known to the tower, according to the airspace user portal, which they were immediately able to access. That prevented a false negative, if you like, so operations could continue. It is the distinction between those acting responsibly and approved and those who are not that is key; otherwise, you can imagine a chaotic situation quickly emerging and having no option but to cease operations when perhaps it is not necessary.

Q245 **Darren Jones:** Outside that type of example, presumably we are blind to whether it is a guy down the road flying his drone or a criminal or something else.



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Special Sergeant Taylor: We do not have that information electronically. At this time, there is no single source that would give information as to whether it is a friendly drone, one known to us and so on.

Andy Sage: It is similar in many ways to the way in which today NATS manages normal airspace infringements by light aircraft into controlled airspace. We often have no idea of their altitude, identity or intent, and that can cause a great deal of havoc and disruption, as you can imagine. This is much the same; we have no idea.

Q246 **Darren Jones:** Is the main difference between drones and light aircraft that there are more drones and they are easier to get hold of and fly, so the risk is higher? Is that the difference, or is there something we need to learn?

Andy Sage: We can at least detect infringements by light aircraft because we can see them on the radar.

Special Sergeant Taylor: Light aircraft have identification equipment on board. As long as that is switched on, you can identify the registration of the aircraft. At the moment, as far as drone technology is concerned, that is not yet developed.

Andy Sage: It is very different.

Captain Pottage: You could launch a drone from the boot of your car. You ask how we know that a drone is malicious. That is one part of the equation. It is about the reckless or the ill-informed as well. Are they dangerous? That is my concern. Are they where they should not be without permission, or infringing the rules as they currently are, be it height or area restrictions?

Q247 **Chair:** The clueless and the careless in Andy's definition.

Captain Pottage: Yes.

Q248 **Darren Jones:** You have said that, broadly, we are not very good at detecting them, and if we are good at detecting them we do not know whether or not they are malicious, which does not fill me with confidence. My third and final question is, if we have detected them and we think they are malicious, how do we deal with them?

Andy Sage: At the moment, major airports are working closely with airlines and NATS to come up with a standardised way of assessing that risk so that, depending on where the drone is, an estimation of its weight and where it is sighted, they can make a standardised assessment in consultation with the airlines about how to maintain operations or whether to close. A lot of work has been happening since the Gatwick events last year to try to make that easier.

Q249 **Darren Jones:** That is responding by saying, "There are some drones here, so we're going to stop what we are doing," but from a policing



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perspective is there an offensive approach? Do you shoot them down? Do you catch them in nets? What do you do?

Special Sergeant Taylor: There are a number of effective ways at different levels. Probably the most effective is electronically jamming them through radio frequencies and GPS. That is probably the most contentious because of the fall-out from doing so. That has been looked at; trials have taken place. The military has that. Like IED jamming, it has been around for a time.

Q250 **Chair:** What happens to a drone once it has been jammed?

Special Sergeant Taylor: Once the radio frequency is jammed, it will try to return home, back to where it has come from. If you want to stop it completely, you jam the GPS and that brings it down because it no longer knows where it is and it will want to land.

Q251 **Chair:** It will fall.

Special Sergeant Taylor: It will vary a little bit depending on the manufacturer.

Andy Sage: Depending on the manufacturer, it may return to base, hover or simply drop. All of them behave in different ways.

Special Sergeant Taylor: That is certainly the most effective way to do it, and it is not a complex thing to do. The issue is around legislation and making sure it can be done safely, given the impact it has on other equipment and the environment around it. That is going on and needs to continue to develop.

Q252 **Darren Jones:** There is a controlled drop; it does not just fall out of the sky.

Special Sergeant Taylor: It would not just fall; it would be a controlled drop. There are other devices as well, such as nets that can be shot from the ground, but they have to be within a certain distance. There are various devices, but the most effective by far would probably be electronic jamming.

Andy Sage: Tim raised a very good point. There is a lot of focus on the effector side of things to prevent the drone. The focus is understandably on that, given the events we had before Christmas. Tim made the point that that should not get in the way of airports deploying reliable detection systems that they can then integrate, because with the right information they stand a hope of managing disruption, even if they are not able to deploy effectors due to law or other restrictions.

Q253 **Darren Jones:** Outside the military, what capacity do we have to jam radio frequencies? Do airports have this?

Special Sergeant Taylor: Legislation will prevent it.

Q254 **Darren Jones:** Do you know what legislation that is?



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Special Sergeant Taylor: First, it would be aircraft interference. If drones are treated as aircraft, it would be classed as aircraft interference.

Q255 **Darren Jones:** If we wanted to give more organisations the ability to take down drones, there would need to be a change in law to provide for that.

Special Sergeant Taylor: Absolutely.

Andy Sage: They are regarded as aircraft in law.

Captain Pottage: To return to a point made earlier as to what the response should be, BALPA, along with colleagues in air traffic control and GATCO, discussed the problem and the immediate effects up to 30 minutes to an hour ahead of a drone being sighted, and what should be done. Ultimately, some decisions need to be made in seconds or minutes, not hours and days. We worked hard to come up with a considered protocol of what actions pilots and air traffic controllers should take. We urge others to adopt that and build on those principles, and look further down the road for actions that should be taken. I believe that NATS and the CAA are looking at some sort of resilience, and we would like to be involved in that.

Q256 **Chair:** Before we finish, do any of you have anything you want to say finally? Is there anything you came along this morning expecting to tell us but have not yet said?

Special Sergeant Taylor: I would like to reinforce the point about community engagement and education. We probably need to start with schools. As a force, we try to engage with schools as much as we can. If there was some sort of national programme included somewhere in the curriculum, it would be a big benefit.

Q257 **Chair:** You think it is not sufficiently part of the consideration about how we respond to a potentially quite dramatic increase in drones.

Special Sergeant Taylor: Some people see drones as toys. We need to educate them that they are not toys; they are serious pieces of equipment that have an impact on the safety of the community. They are readily available. You can go into a high street store and buy one with cash, and nobody knows who you are; it is not registered to you and so on. We need to reinforce the educational piece and start with youngsters.

Q258 **Bill Grant:** Off the top of my head, almost every airfield has vantage points where people gather in their cars to observe aircraft landing and taking off. Should there be warning signs or advisories? A sign itself will not prevent people who want to break the rules, but could there be awareness signs, not intentionally to deter? Those vantage points exist around airfields. Should we signpost them to make people aware of the risks of drones? Do they exist already?

Special Sergeant Taylor: They do.



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Q259 **Bill Grant:** They are already there.

Special Sergeant Taylor: They are around prisons, airports and air shows. They put them up around air shows. It is pretty good.

Q260 **Bill Grant:** It will not deter, but it will make people aware of the risks of drones.

Special Sergeant Taylor: Yes.

Andy Sage: I want to make a final point to reinforce something Tim said earlier. So far, we have yet to have any major collisions in the UK. Until we better understand the exact risk, we have to take it seriously. Therefore, I agree that airprox data and the number of sightings must be taken very seriously until we understand otherwise.

Captain Pottage: Take the collision risk seriously and act on it; do not believe the deniers. That is my closing point.

Q261 **Chair:** Thank you all very much indeed for a very interesting session. We appreciate your time.

Examination of witnesses

Witnesses: Elaine Whyte, Tris Dyson, Julia Jiggins and Sean Cassidy.

Q262 **Chair:** Welcome, all of you. As with the first panel, if you have any interests that you feel you ought to declare, please do so at the start, as you introduce yourselves.

Sean Cassidy: My name is Sean Cassidy, and I am the director of safety and regulatory affairs for Amazon Prime Air, which is our drone delivery programme. By way of background, it is hard to believe that I have 33 years' experience, starting with military aviation and then moving into commercial aviation. It has been my full-time career to date. My current remit as director of the programme is developing partnerships with aviation regulators and policy makers and working in partnership to develop the means by which we safely introduce commercial drone operations.

Tris Dyson: I am Tris Dyson, executive director of Nesta Challenges. Nesta is the UK's innovation foundation. We exist to support innovation for public good. We have been designing and developing the Flying High challenge programme, with funding from Innovate UK, over the last year and a half to understand how to accelerate the development of urban drones, and how we can make the best of that commercial opportunity, but doing so in a way that maximises the public benefit and engages cities and citizens.

Q263 **Chair:** In a safe way.

Tris Dyson: Exactly.



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Julia Jiggins: I am Julia Jiggins, head of civil avionics strategy for Thales in the UK. I am responsible for looking at long-term opportunities and future technology, particularly around digital aviation, communications autonomy and how technology can move from the current air transport and aviation space into future aspects, such as drones or urban air mobility.

Elaine Whyte: I am Elaine Whyte. I formed and now lead the PwC UK drones team. We support our clients to exploit this technology here and now, and we are also using it to disrupt ourselves. By way of background, I served for 20 years in the air force as a safety and airworthiness engineer. It may be worth my declaring at this point that we have been working with Nesta on the Flying High challenge. Both Thales and Amazon are clients of PwC, although we have not worked with them directly in the drone sector.

Q264 **Chair:** Thank you. With a panel of four, if you all answer everything we will be here until midnight, so don't feel obliged to answer everything. Can I start by asking those of you who have an understanding of it about the ways drones have helped, or indeed hindered, emergency services operations, whether police, fire, search and rescue and so forth?

Tris Dyson: We have engaged with the police, particularly in the west midlands, and with the fire and emergency services in areas like Bradford, and with the healthcare sector in various places, including Southampton.

Q265 **Chair:** Is Bradford a pilot?

Tris Dyson: Bradford has been engaged in the first stage. We have not entered the piloting phase yet. Emergency services are using drones on a daily basis. The story we heard earlier about how drones are used for reconnaissance so they can better respond to incidents, better identify the nature of the problem and deploy more effectively, is how they are being used, whether it be fire, search and rescue, and so on.

The limitation is that, currently, they are used by an operator who accompanies the drone in an emergency response vehicle and operates it at the scene. The transformation that can happen is when they are able to fly beyond visual line of sight and get there ahead of the emergency services. That is where our engagement with the fire service and so on comes in.

Q266 **Chair:** The emergency services can start planning before they get there.

Tris Dyson: Exactly. The drone can go up to a certain height very quickly and get eyes on it, even before it has arrived on the scene. It can tell the fire service, say, the nature of the fire, whether it is a chemical fire or what type of incident it is, and then the proportionate response required can be delivered much more effectively. It magnifies what they are already doing, deploying them at the scene. As the police officer said



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earlier, they are already saving lives and making much more cost-effective delivery of public services.

- Q267 **Chair:** Is the technology already there to go beyond line of sight and carry out the function you describe? It is just setting the regulatory framework to enable it to happen safely. Is that right?

Tris Dyson: I would largely agree with that. The technology is pretty sophisticated, but it has to be shown how it can work together through the automated systems, the UTM and the drone system. A lot of testing and development needs to happen to prove that it is safe and to prove it is effective, and that it will integrate effectively with services.

You are right; it is largely permission, which includes regulation but also cities or whatever it might be having a say over what happens over their airspace, and engaging with and permitting this stuff to happen. At present, that is happening outside the UK. That is the disappointing thing. A lot of the testing development is happening in cities in the US. There are already beyond visual line of sight services operating in places like Finland, Switzerland and Australia.

- Q268 **Chair:** Why is it not happening here? Is it tardiness in setting the regulatory framework? Is it the funding of large-scale trials? What is the constraint?

Julia Jiggins: A number of test areas have been established. NBEC, out of Cranfield University, is one key area that provides a corridor to test beyond visual line of sight. That allows radars for detection and the integration of multiple drones. Thales has been participating in a key part of the NBEC corridor, and we have also participated in trials overseas. We have an area in west Wales for trialling drone activity.

The big thing about moving from visual line of sight to beyond visual line of sight is the fact that you increase the range significantly. Therefore, you need to integrate more technology, and you are getting to the limit of the technology, particularly on battery life and durability. How a drone safely lands is a key technology at the moment, and a limiting factor. We are building the corridors and we need more safe test areas in the UK.

- Q269 **Chair:** I am trying to understand why we are behind the curve, as you indicated, Tris. Is it because we are a more densely populated country and it is more difficult than in the forests of Finland, or are there people, either in Government or elsewhere, who are not doing what they ought to be doing to facilitate this?

Tris Dyson: It is not that it is not happening, but it requires a lot more co-ordination and an iterative approach to regulation. The regulators need to engage with the technology as it develops—the CAA is starting to do that—and to help create the permissioning environment in order to learn from it and iterate the regulation. It needs to be a bit like that.



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The CAA has recently developed the capacity to do that. It has set up an innovation unit that is supporting a number of us in developing these projects, but it is fair to say that we are behind the curve. It is about co-ordination, as is happening in the US, with the stakeholders, often represented by cities and bodies within them, the drone industry, the technology providers who can provide the end products, the service users—the emergency services might be an example—and the regulator working together in an iterative fashion.

Q270 **Chair:** We need to up the tempo a bit in this country. Is that right?

Tris Dyson: Yes.

Q271 **Chair:** What is the main use driving the innovation in US cities? Is it emergency services or commercial?

Tris Dyson: I point to Sean and probably Elaine as well. The future of drone services is enormous. There is a big industry waiting to emerge through these automated services. About a third of them are public benefit use cases—emergency services, healthcare and all the rest of it—and the rest are probably things like parcel delivery and that sort of thing. The US has seen the opportunity, and the FAA is pushing for it in a more aggressive fashion than we have done to date here.

Q272 **Stephen Metcalfe:** Back in May, I was fortunate enough to visit South Bend, where they are working with Notre Dame University doing exactly that and setting up a testbed. Bristol University apparently is getting involved as part of that, to try to work out how we can bring it to the UK. Are there any other good examples we should be looking at, where a university, city, local authority, fire and rescue service work together to create the testbed, that perhaps we have yet to achieve here in the UK?

Elaine Whyte: I do not doubt Tris's view, but I am not quite sure how we benchmark where the UK is compared with other countries. I suggest that that might be a view rather than something we could definitively baseline.

Within the UK last year, Operation Zenith took place at Manchester airport. There was a demonstration of how drone technology could be used in controlled airspace. It involved a number of different players at the time and showed, for example, how an aircraft part could be transferred from one side of the airport to another in minutes—whereas if you had to transport it by road it could take up to an hour—and how, therefore, you could achieve a degree of efficiency by doing that. Zenith was invested by industry last year. A number of players were involved, including NATS. It showed the complexity of what would have to take place in a small ecosystem testbed but, equally, that it was achievable.

Julia has already referred to other testbeds that exist in this country that are also bringing together examples of how drones can be used in different airspace and how it looks. We have heard NATS talk about beyond visual line of sight trials in the North sea. We know there are a



number of case studies using drones beyond visual line of sight, because they have presented the CAA with the safety case evidence that is needed to demonstrate that they can undertake that role in a safe and proportionate way.

What we need to achieve potentially in this country is more transparency and more sharing of what we are achieving in all those examples. I reflect on what we have achieved with CCAV, the centre for autonomous vehicles. That is one centre of excellence bringing together an understanding of the research and investment that is taking place.

Q273 Chair: Are you suggesting something similar for drones?

Elaine Whyte: There is an opportunity for us to do that. I see drones potentially as a subset of robotics. If we take robotics in the round, how can we bring together the learning we are getting from industry, Nesta's Flying High and different Government investments—pathfinder projects from the DFT and Innovate UK—to create a centre of excellence and learning, so that, rather than a perception of where we are, we have the confidence of where we are as the UK?

Julia Jiggins: Initiatives like the Future of Flight, which we launched this year, are a very good way of helping to co-ordinate and raise the baseline for where we are, and in which parts of the whole ecosystem. In the UK, we have all the elements, from radar technology and use cases to core technology, and we have some exceptional designs for drones and air vehicles that are leading edge. Co-ordination and visibility is key. A considerable amount of testing is required to show sustainability and scalability and increase public perception.

Q274 Chair: We have the components, but we need to create something greater than the sum of its parts. Is that a fair comment?

Julia Jiggins: Yes.

Sean Cassidy: Lest things sound too dour, I should point out that we did our first trial delivery here in the United Kingdom in 2016. That was our very first delivery.

Q275 Chair: Did it get there?

Sean Cassidy: We did our first delivery. It was a great event and there were some very good learnings. Over the years since we had that first event, we have developed a very close and collaborative relationship with the Civil Aviation Authority. We are very proud of the fact that we were one of the applicants accepted on the innovation hub programme.

In point of fact, I have found the members of the innovation hub team very flexible, pragmatic, forward-leaning and innovative in working through constructive problem-solving. It has been a wonderful experience working with them. We will be meeting them this coming Monday as part of identifying the things we have to do in terms of safety requirements,



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mitigations and the like to point towards realising a commercial delivery operation in the UK.

Q276 **Chair:** Sean, can you point to one American city that appears to be ahead of the game in innovating in all this? Where would you point to?

Sean Cassidy: That is a very dangerous question for me. Let me just say that the Department of Transportation had something called the IPP, or the innovation pilot project. There were 10 different locations around the United States. Various cities have different kinds of use cases that they are highlighting. I am from Washington DC, and just north of there they have pioneered a project where they do delivery operations between hospitals. That is one use case that is being highlighted just north of us. Further afield, around Reno in Nevada, they are doing medical operations—delivery of defibrillators and IEDs. There are manifest use cases. I would not necessarily pick one over the other, but it is a great active effect.

Q277 **Chair:** In what timescale do you expect Prime Air to be a functioning delivery option for Amazon customers?

Sean Cassidy: Another difficult question.

Chair: Yes, that's the point of this.

Sean Cassidy: As a matter of policy, we do not talk about specific locations or timelines. Suffice it to say, we are working very diligently.

Q278 **Chair:** Is it coming within the next 10 years?

Sean Cassidy: Yes.

Q279 **Chair:** Within the next five years?

Sean Cassidy: I am very confident that we will be doing something within the next five years.

Q280 **Chair:** Globally, or in this country?

Sean Cassidy: Well, our aspiration is to be a global enterprise, in line with our business. Certainly, the UK is one of our key partners.

Q281 **Chair:** Do you make a decarbonising case for this sort of operation? Do we have the potential to reduce carbon emissions by using this sort of delivery for the final mile?

Sean Cassidy: Absolutely. As a matter of fact, one of the strategic goals for our company is to realise delivery operation and distribute against all our different delivery nodes, to achieve a net zero carbon footprint. I submit that if you compare a highly efficient unmanned aerial vehicle powered by electric motors with rechargeable batteries with any other means of ground conveyance, from an overall carbon footprint and emissions standpoint, it is a great alternative.

Q282 **Darren Jones:** Do you have any math on how many jobs it requires



today to deliver your parcels from where they start to where they end, compared with how many jobs will be required to maintain and deal with drones, and what the difference is at the end?

Sean Cassidy: Fortunately, my remit is dealing with safety and regulatory affairs and compliance. On the business enterprise side of our house, they are looking at those kinds of things. Generally speaking, over the 20-odd years that Amazon has been in business, we have been constantly innovating on behalf of the customer, which involves introducing new levels of automation and technology. That has allowed us not only to better serve the customer but to grow the size of the operation, hire more workers and grow the enterprise. In the United Kingdom over the last decade, we have invested something in the order of £9.3 billion in the economy here and created over 27,000 jobs. That is a good example of how automation and economic growth work hand in hand.

Elaine Whyte: Can I add something on the skills front for drones? The here and now for drones commercially is not in the parcel delivery aspect but in capturing data on clients' assets. I consider the drone ecosystem to have four different parts. You have to have the permission to fly, and we have covered quite a lot of that in terms of the regulation in NATS and the function of the UTM to support that. You then need to capture the actual data, which is the flying of the asset. You then need to do some analysis of that data, when you have it, and then you want to present it back to stakeholders via some form of platform, ideally through the cloud. Those are four very basic steps. You can see within each of those segments the different skills that will be born and grow from those different parts.

From my perspective in PwC, the skills I seek are not those of the programmers, who will necessarily do the hardcore data analysis. I am much more interested in the relevance of the data going back to my client's business. It is much more about business understanding and the human insight you get from the business understanding that integrates that technology back into the business. The skills I am looking for are curiosity and interest in the technology, but all four segments require very different skills. These are high-end skilled jobs that complement where we would like to go as the UK.

Q283 **Chair:** I am conscious that we are running quite a long way behind schedule, so if you could try to be as succinct as possible I would appreciate it. Back to you, Sean. What changes in drone regulation or technological advancements are needed to roll out Prime Air?

Sean Cassidy: That question is not relegated strictly to Prime Air; it relates to many different use cases and applications. One of the foundational things that has to happen is that we definitely have to have full commitment to a move towards something called performance-based regulations, where you focus on the outcomes of technology rather than prescribing specific technology. Let me give you a very practical example.



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I have my cell phone right here, as everybody here does; you probably have more than one, I am guessing, in your jobs. If you have a way to electronically convey a unique digital signature for a vehicle or a control station or something, and you are able to use a current improvement technology, why not do that, as opposed to having to go through other technologies that may be more costly and require a lot more layers of bureaucracy to implement? If we have that kind of technology-agnostic approach and are just focused on regulations that permit a number of solutions for electronic conspicuity, tracking and the like, it will move us further along.

Q284 **Chair:** Taking that into account, what changes are needed to facilitate an operation like Prime Air? Beyond line of sight, for example, is an essential element.

Sean Cassidy: Right. That is a very good question. My background, as I explained, comes from military but mostly from commercial aviation. In that world, access is defined by equipage and capabilities. What we need to understand clearly as an industry are the threshold values that we are expected to meet in safety and performance. You may have a situation whereby you want to operate in an environment that may be a little more congested and populated, so you might have to invest in additional technologies to ensure the safety of flight.

In our case, a good example of that is the considerable investment we are making in developing sense-and-avoid technology, independent sensor-based technology that resides on board the aircraft, which would be somewhat resilient to communications outage and the other things the previous panel was talking about. If we had a clear understanding that we could meet a safety case for the application of technologies, it would be very helpful in making business decisions.

Q285 **Chair:** But are you working with the innovation unit, or whatever it is called, at the Civil Aviation Authority, to identify what is needed to facilitate that sort of service?

Sean Cassidy: That is exactly what we are doing right now.

Q286 **Chair:** As things stand, even if you had the technological ability to do it, you would not be permitted to introduce a delivery service for customers in this country.

Sean Cassidy: The challenge we have is that we are dealing with a set of regulations and rules that are derivative of manned operations and never envisioned deliveries via unmanned vehicles. As in other countries, you have the ability for limited opportunities for exemptions, variations and waivers to begin limited operations, and we intend to take as many opportunities as possible to demonstrate that we can do safe and viable operations.

The important point of the question is that, at the end of the process, hopefully, we will emerge in partnership with the regulators and come up



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with a new set of regulations that are performance based and can embrace and accompany the enterprises, without the need to achieve operating approvals through special permissions and exemptions. It should be normalised.

Q287 Chair: As I understand it, public support for parcel delivery via drones is low. Why do you think that is? What do we need to do to overcome that to reassure people, particularly on safety, and make it possible?

Sean Cassidy: I read the PricewaterhouseCoopers report on that. One of the key points is that some assumptions are being made about public acceptance or embracing of these things when they have not really experienced them yet. At Amazon, we have innovated relentlessly on behalf of our customers. Part of that has been about driving down the price of the products we sell while driving up the convenience of the operation and reducing the time it takes to get product out to our customers. Every time we have done that and made a step change that has made for a quicker and more efficient operation, our customers have been delighted. Once they see us achieve the reality of a 30-minute delivery for something they desire via a drone, they will be equally delighted with the new delivery option.

Q288 Chair: Do you have a particular programme as a company to seek to build public acceptance, or do you think it will just happen as the innovation continues?

Sean Cassidy: When you think about certification and airworthiness, typically, people describe those programmes as very technical. Actually, in the UK, the United States and elsewhere, part of the airworthiness and the acceptance—in fact, part of the certification—of those programmes also involves community outreach. It is very important that you address not only the technical items on the reliability of vehicles and the onboard systems but the non-technical issues as well—public acceptance, education and the like—so that you can disabuse people of some of the assumptions they are making, which are not necessarily grounded on data.

Q289 Bill Grant: I would like to take some of your time to explore the potential social benefits—you touched on community outreach—from what I would suggest is a growing drone industry. To touch on Elaine's comment, I think you mentioned Operation Zenith, a trial at Manchester airport for the movement of aircraft parts. Sean, you mentioned the use of drones for hospitals. How do you see drone technology benefiting the NHS and its many patients? Where can we integrate drone technology to improve the wellbeing of patients in the NHS? Is it possible?

Sean Cassidy: That is probably a little bit out of my wheelhouse, because we are focused on refining and developing our delivery operation. Speaking more broadly, if you have the ability safely to convey a product from one point to the other, be it a medical or consumer product, or what-not, everybody benefits. The work being done right now



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in developing industry-based standards that define specific technical implementations and specific guidelines for inter-operations is going to benefit the medical community and others. It is one of those concepts whereby a rising tide floats all ships.

Tris Dyson: We have done a bit on that with some of the NHS trusts. The delivery of things that need moving fast, and that are time-critical and important from a health outcome perspective, can potentially be massively improved through drone technology. That could be anything from important results of tests that you need to get back, to organ transplant or blood plasma delivery; it could be a whole bunch of things. Quite a lot of that currently relies on couriers on motorcycles or blue-light vehicles going through busy traffic areas, and it could make a difference to people's life expectancy.

Q290 **Bill Grant:** You see that as something in the future.

Tris Dyson: Yes.

Q291 **Bill Grant:** How far down the line?

Tris Dyson: Because of the current limitations in being able to do that, it is not happening now. But if you could fly Amazon parcels around London, you would be able to do the same thing, more or less.

Q292 **Chair:** Of course, it is already happening in Africa.

Tris Dyson: Exactly, yes.

Sean Cassidy: To go back to the very first question that you asked, about emergency services, one other aspect that is very much related and relevant is that, with the key emergency services, when some critical medical delivery is going from point A to point B, it is very important that other operators that may not be as exigent in terms of their operation give a wide berth to the emergency services. That speaks to electronic conspicuity, identification and everything else. If we were doing a delivery operation around a certain city or locality and there was some emergency directive or life-saving operation, we would be obligated to accommodate them and permit them to conduct that operation safely.

Q293 **Bill Grant:** Elaine, do you have any comment? You mentioned material things, such as aircraft parts. Do you see a read-across?

Elaine Whyte: Absolutely. We recently undertook a public trust survey on the use of drones, and the responses from that showed that 80% of the public are in favour of drones when they are being used by emergency services—police, fire, and search and rescue. However, it showed that only 26% are in favour of them being used for package delivery. The journey that we are going on as a society is demonstrating how package delivery is a tech for good when it is used for emergency services in reducing the risk to life, potentially in urban areas, as Tris described, and that will be when we increase acceptance. That is the place to look first of all for how we want to use package delivery.



Q294 Bill Grant: Can I take the panel from packages and parts to the movement of humans using drone technology? The Committee has received conflicting reports as to whether that is at all possible or viable for the future, although I think a test has been done in Dubai, and Uber seemed to suggest that it has a future. Can we have the panel's views on whether it is going to happen and, if so, when?

Julia Jiggins: There are lots of tests and trials going on globally with vehicles that are car size in dimension. They were clearly seen at the Paris air show two weeks ago, from a number of countries. Boeing had two on display; one was a four-passenger vehicle and one a delivery vehicle.

They are only in trials and tests; their flying time at the moment is for seconds and minutes, and they do not have duration or scalability. Effectively, they say that the technology is all in place, and it is now about getting sustainability. They are talking three to five years, and some of them quicker. Again, it is about making it economic. A trial in the United States is meant to be starting next year, taking people from the airport to downtown New York, on a dedicated route with a certain duration. It is not fully flexible—it is not able to go just anywhere—but the technology is there.

Q295 Bill Grant: Are there any other comments?

Tris Dyson: There are contradictory reports as to how viable the technology is. As I understand it, the main challenge is around the battery power. You need to be able to lift one of those things, which, particularly when you are talking about vertical take-off and landing, is huge, particularly if you want to cover a useful distance. There is that, and how long it takes to make the vehicle work.

Then you have to figure out the use case that will actually make it viable. You can certainly see a scenario whereby it could replace helicopter flights, but then you have to think through the realistic journey type for which people will use that type of vehicle. Perhaps it could be on the Heathrow to Gatwick route where there would be a high volume of people going from one to the other, or somewhere where there is no sensible transport alternative. Those are the questions that need to be asked as to whether we are going to see it in the near future.

Q296 Bill Grant: As a nation, we are slightly behind the curve. What do Governments primarily, but also industry, have to do to reap the benefits of drone technology, and selfishly, for the United Kingdom, what do we have to do? What do the Government have to do, in parallel with industry?

Sean Cassidy: Basically, it is just to follow the game plan evolving right now. We were involved initially with the Department for Transport on the pathfinder programme and now with the innovation hub. We are realising that the point where we are working on operating protocols, guidelines and safety mitigations will provide the building blocks for future



normalised regulations. The innovation hub is a great example of a public-private partnership, with funding provided through the good graces of the House of Commons, along with contributions in kind through partnership in our research and development. I could not be more thrilled to be doing this in the UK right now. It is a very good example of something that is happening in the here and now.

Elaine Whyte: I would like to see a vision of where we want to go and some guiding principles to deliver that vision.

Q297 **Chair:** Presumably, Government need to be involved in driving that.

Elaine Whyte: There needs to be a co-ordinating authority, and that would fall to the Government. Within that vision, we need some guiding principles. Top of my list would be that, whatever we are replacing, the new process has to be more environmentally friendly than the old one. Flying taxis and flying cars will be a challenge. We have already discussed it on parcel deliveries. We need clear articulation of the societal benefits that will be delivered from that new method.

Julia Jiggins: The other thing we need to look at is the skillset. There is a lot about education and use and application, but to develop this technology, particularly with data analytics, a different skillset needs to be developed and brought forward.

Tris Dyson: I agree with a lot of that. We need a more co-ordinated and iterative approach, and we need a champion, which is perhaps difficult, given that there is a lot of political transition at the moment. That is needed to drive this forward.

Public engagement cannot just be thought of as a PR exercise. Good story-telling is part of it, but, ultimately, these are going to be flying over people's heads, which means that, if only through the city as a proxy—probably more than that—you need to engage with people on where and how they operate, because that can inform the development of regulation and the way you iterate it.

Q298 **Stephen Metcalfe:** On the question of skills, the world generally is changing, not just around drones, and everything seems to come back to data and data analytics. Do all your organisations try to create links with schools and colleges to help students understand the link between what they study and where they could potentially work in the future? The world is changing so rapidly that sometimes those links have got lost over the years.

Sean Cassidy: That is a great question. One thing that immediately comes to mind is that, at Amazon, the Prime Air programme did a national build-a-drone contest with a bunch of schoolchildren in the UK. Man, talk about some creative kids. The winner got to come to our lab and do a tour, and we basically designed a drone, and created a concept, along the lines of their ideation. That is great, because it takes things that are conceptual, in the STEM programmes that my two kids are



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taking in school right now, and actually translates them into something tangible. I see more opportunities to partner with schools and universities to that effect.

Tris Dyson: We do a lot of programmes with schools relating specifically to AI and smart technology, and upskilling in that, which is primarily what we are talking about with drone technology—absolutely. There is quite a lot of that type of activity happening, and there may be a deficit in actually making stuff; that may be an area where there is less focus in the UK educational context.

Julia Jiggins: Thales works with universities and schools, at all ages, and does a lot of work in the practical application of science. There is a general aspect whereby people are very focused on building and physical aspects, and a lot of the new technology is about data or software and is not so visible. It is all about trying to broaden the interaction to that wider scope, about ecosystems and how the bigger vision happens. The gaming industry is very good at trying to bring that forward.

Elaine Whyte: We are sponsoring tech apprenticeship degrees for undergraduates, and we have an initiative called Tech She Can, which started off by trying to encourage young girls aged between 10 and 13, who are at a decision point about where they want to go in life, and expose them to what a career in technology could look like. Tech She Can is now evolving into Tech We Can, but that is the age where we want to demonstrate the opportunities and how you can have an exciting career in this area.

Q299 **Stephen Metcalfe:** Fabulous, thank you. Keep up the good work, all of you. I have a relatively short question on SOARIZON. Could you tell us a little bit about it and how it could play a role in ensuring safety in the drone industry?

Julia Jiggins: SOARIZON is a digital platform that allows a drone pilot to do the full aspect of planning a task, from insurance to weather and 3D map planning, when applying to fly recreationally in a controlled area.

Q300 **Stephen Metcalfe:** It is for use by both recreational and commercial users.

Julia Jiggins: Yes. It is up and live now, and currently available. It is used by drone pilots particularly to make sure that they are compliant with the situation as today. A particular interest has come from the insurance industry, which finds it a very useful tool to make sure that a pilot has taken account of everything that is required.

Q301 **Stephen Metcalfe:** Is it live and dynamic, in the sense that we were hearing from the previous panel about exclusion zones around helicopters in emergency situations?

Julia Jiggins: It is live and dynamic. It is currently being launched in the UK, and it will be launched in the United States later this year, and in



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France. One of the key things about the platform is that each country's regulation is different. The registration system for drones in the United States is further ahead than what we have in the UK. Where there is automatic registration, we can automate more of the requests for a drone to fly in a particular area.

With drones having GPS, we are able to track them, so a secondary aspect is that downloading the data on to the system provides a very good database that we are building up. It allows regulators to see how drones are currently being used and what the applications are for, for questions of planning. We have done a number of examples, because our Crawley site is within the restricted zone for Gatwick. We have done some applications, using the tool, to do photography over our site, so we have taken the tool through and applied it.

Q302 Stephen Metcalfe: In an emergency situation, where flight planning might have to change at very short notice, how is that information fed into the platform from the emergency services?

Julia Jiggins: You can download it, and a lot of it is now digitally communicated between the drone and the platform. Because it uses a 3D mapping tool, if you are used to a smartphone—

Q303 Stephen Metcalfe: Sorry, what I am asking is how the information from, let's say, the air ambulance, gets on to the platform at a minute's notice.

Julia Jiggins: The tool picks up all the NOTAMs that the CAA puts online all the time, so it always has that additional platform. If you are part of the tool, you do your planning, and then you do a final check and go live to the tool.

Q304 Stephen Metcalfe: Presumably, this is a commercial venture on your part, and you are hoping for an expansion in the number of drones using it to make it cost-effective.

Julia Jiggins: Yes. We have two levels. There is a basic service, which is a freemium, or whatever terminology you want to use, and is for anybody. Safety-wise, you can do the basic steps to plan a mission. It encourages you to make sure that your drone is fit for purpose, you have insurance and have planned the route and checked the basic NOTAMs.

There is a paying aspect, if you want to do more drone planning regularly, which is much more attractive to the commercial aspect. A person doing it for recreation could use the tool, effectively, free of charge, because they are not generally out of line of sight, and there is a more educational aspect. For the commercial and civilian users who are doing much more complicated planning and so forth, where there is extra capability and extra tools, there would be a paying fee.

Q305 Stephen Metcalfe: This may be a difficult question for you to answer, but are there limitations on the system?



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Julia Jiggins: At the moment, it is an iterative development, and we are developing the online tools with what is digitally accessible. The more that is digitally accessible across airspace management and the regulations, the easier it is to integrate. It is also about looking at how public perception is going on drone usage, and we are still learning about how people want to use drones. There are limitations, but from where it is today it will iteratively develop over time.

Q306 **Stephen Metcalfe:** Who is your biggest client?

Julia Jiggins: We have a number at the moment. I would not say that we have a biggest one, but we have been working with Network Rail, for example, on a lot of the infrastructure, with the Forestry Commission on surveillance over large areas, and in agriculture, where people want to check the quality of a large space systematically.

Stephen Metcalfe: Thank you very much.

Q307 **Mr Gyimah:** We have touched on this in various aspects of the discussion so far, but I would like to crystallise some of the answers around the economy, particularly what the panel sees as the positive and negative effects on the economy that an uptake in drones will have. I have seen comments from the PwC report, but it would be good to get your thoughts.

Elaine Whyte: We published a study in May last year that estimated that the economic value of the drone economy by 2030 could be as much as £42 billion, which is nearly 2% of GDP, with £16 billion of productivity savings. The report also said that, to achieve that figure, three things need to happen. We need to see technology advancement, which we have heard quite a lot about today. We need regulation expansion. Again, I think we have an understanding of that. The third factor is societal acceptance, which is what drove us to undertake the recent public trust survey, so that we can understand society's viewpoint at this time.

Q308 **Mr Gyimah:** Tris, for Nesta, do you want to comment on that at all?

Tris Dyson: We have been working closely with PwC on some of this. It is worth saying that what is quite interesting about the drone sector is that there are, we think, about 650 drone companies across the UK. They are small, start-up technology companies, so it is early stages in the development and quite exciting from that perspective. Then there are the big incumbents as well. There is a real opportunity to stimulate a lot of grassroots innovation at the moment.

We have been looking at the individual potential cost savings for services in healthcare or fire and emergency settings, and they are definitely significant. It depends on what scenario you are looking at.

Q309 **Mr Gyimah:** Can you expand a little? Currently, most drones bought here are bought via Amazon and manufactured elsewhere, so when you talk about the impact on the British economy it would be helpful to get



some sort of texture around that. What types of jobs do you mean, and what skills are needed? You have touched on that, but where is the economic activity? Can you tell me a bit more?

Elaine Whyte: I can give the example of a client we have been advising recently. They have a significant real estate portfolio. We have undertaken a pilot study with them so that they can understand how drone-collected data can help them to understand the condition of the outside of that real estate. They can then use the data they get back to determine where they need to take corrective and preventive maintenance activity. What we have shown for them is that it is 65% cheaper and 83% quicker than their traditional method of inspecting the external condition of the real estate. We are talking about large buildings over a sprawling estate. That is one example.

Another example is that we at PwC have used drones ourselves to undertake a stock count as part of our audit procedures. We are in the early stages of seeing how we adopt the technology moving forward. As part of that audit function, undertaking a stock take is a key part, when you have to understand the material value of what will go on to the book. We did a pile of coal in south Wales; it took half an hour to collect thousands of images and put them together to undertake a volumetric measurement of that pile of coal. Traditionally, that would have taken four hours to do. We showed that it is faster, cheaper and safer to use a drone in that environment. The safety aspect really becomes apparent in the oil and gas industry as well, when we see how they are using drone technology for inspection right now.

Q310 **Mr Gyimah:** That is very helpful. What can the UK do to harness that economic potential?

Elaine Whyte: I have suggested that we need more central co-ordination opportunities to bring together all the different learnings that we are hearing about, so that we can share insight from things such as Zenith, pathfinder and Nesta's Flying High project, and understand where we want to make our investment, moving forward—whether we want to invest in X, Y or Z—what it is going to deliver, and what the benefits are, so we can track it. We see from the CCAV environment that we are creating a centre of excellence in the UK that can have global reach, and there is an opportunity for us to do that moving forward.

Q311 **Mr Gyimah:** What role do you see Government having beyond regulation, which we have touched on, in stimulating that growth and harnessing it to its full effect?

Elaine Whyte: We are already seeing a role there. Nesta may be better placed to talk about how their project is supported by Government on that front. It is more about the need for vision and overall co-ordination.

Tris Dyson: I am happy to talk about that. We have spent about a year and a half designing this challenge with Innovate UK funding support. There are a number of elements. There is a technology challenge, a



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public acceptance challenge, and a kind of demand stimulus challenge, before the market exists, if you like.

On the design, you start with where the public and cities are broadly in support—around emergency support and healthcare services, construction and that sort of thing—and develop those services and technologies, rather than the ones that are more contentious. You prove them in a series of test environments, where you are also working with the drone operator, in conjunction with the prospective customer, who is not yet a customer: for example, an NHS trust or fire and emergency services—someone who is going to use it. At the same time, you need to work with the city to allow the permissioning for this stuff to happen and think through the planning implications.

You are dealing with a large volume of small start-up companies that need to be able to iterate rapidly, or, if they are not able to prove the viability of their technology, we need to get them out of the way. At the same time, the regulator needs to help with the permissioning and allowing things to progress through the demonstration stages to live environments in cities. You also need to be able to iterate and adapt the regulation to allow for more of that to take place. That is more or less the prescription we have come up with.

From the public perception perspective, we think that will familiarise people with the public benefit use cases and help them to think about where drones may or may not operate in cities. That lays the groundwork for the type of decision-making infrastructure and thinking that will allow for some of the other commercial opportunities, including parcel delivery and others.

Mr Gyimah: Thank you.

Q312 **Chair:** As with quantum technologies, does there need to be some sort of national strategy that goes with the vision, to ensure that all the different elements get driven forward in an organised and planned way? Is that the sort of thing you are envisioning?

Elaine Whyte: That is exactly what we envisage, so that we can make sure that the investment goes into the right areas and the benefits can be identified from all the different tiles—

Q313 **Chair:** Is it significant enough economically to justify some sort of national strategy?

Elaine Whyte: I think 2% of GDP by 2030 is significant enough, yes.

Q314 **Darren Jones:** I would like to hear a bit more about the city-based environment and the use of drone technology. I should declare my interest as the chair of the all-party group for connected places, which works with the new catapult. The Flying High Challenge report looks at that. What were the most exciting outcomes from that report for a city-based environment, and what do we need to do to bring them into



reality?

Tris Dyson: It differs from city to city, but the city and its citizens, as I said, are quite keen on their use for public services, emergency blue-light response, and that sort of thing—all the use cases we have talked about. Some of the cities we have engaged with are also quite excited about potentially being vanguard cities and being seen to be at the forefront of technology development, particularly in areas where you might not ordinarily expect it—cities such as Preston and Bradford, for example.

It has been interesting because the primary regulator, the CAA, is obviously the main player in regulating that airspace, but the larger cities in particular are going to need and want a voice. If you think through all the potential risks and disadvantages around noise and visual pollution and all the other things we have talked about, people are going to expect their local authority, city government and so on, to have a grip on that, as well as being the ones that provide some of the landing infrastructure, the permissioning and all the rest of it. It has to be done in tandem with the cities; that is a big and important move that the Government could encourage.

Q315 **Darren Jones:** There would be new powers for local authorities to be able to be held to account properly by citizens.

Tris Dyson: Yes. Maybe it relates to Elaine's co-ordinating function. The cities need to work hand in hand with the CAA, NATS and everybody else, and the drone operators, so that things are joined up, and they are not at odds with one another, essentially.

Q316 **Darren Jones:** The CAA is quite small, isn't it? Presumably, if it is going to start to take on that role for a lot of our major cities, it is going to have to expand as well.

Tris Dyson: Yes. Sean talked about the support that they are getting through the new innovation function. That is very new. I agree that they are a solid team and they are really helpful, but they are new and small, and they have a funding limitation. They do not know what is going to happen after a certain period of time, when that will, hopefully, be addressed. The capacity and capability is not really there yet; it needs building up significantly.

Q317 **Darren Jones:** Do you want to add anything from your experience, Sean?

Sean Cassidy: Imagine, if you will, that there was a requirement every time you drove your car from one city to the other, and there were different noise and emission requirements that you had to meet. Those are some of the challenges we would face, were we to have an environment where there was a patchwork of ordinances, requirements and restrictions.



You were talking about the role of the UK Government. To the extent we can, one of the highest orders of benefit that would come out of that intervention would be to create a consistent standard that would allow for seamless operations among a number of different communities, cities and operating areas. That does not mean that operators would get a pass, or that they might not have different levels of equipment and performance requirements to operate in certain areas—no different from my responsibility in flying from a thinly travelled airport to a very complex area. As long as they are consistent, published and understood, it will get us away from the notion that we will have a kind of Balkanised approach towards how we regulate and address drone operations.

Q318 Darren Jones: From a technology perspective, what else do we need to think about in making drones work as we want them to in our cities? Do we have all the other infrastructure in place, or are there things we need to do?

Julia Jiggins: The actual technology for autonomy, as I said, is fairly well understood. We need effectively to determine what the minimum safe standard is and what technology you need for different complex situations. A big aspect is to determine how we identify a drone in a space and how we specify sense-and-avoid technology, which is very key, particularly if you go beyond visual line of sight.

An area that generally does not get as much focus is how you enter and leave the airspace in a normal operation. That is different in a rural and a city community. It is about some of the basic infrastructure on how you enter and leave the space and how you generally operate—the rules of the road, but for a drone operator.

Q319 Darren Jones: You would need a drone park for take-off and landing sites, and all that stuff.

Julia Jiggins: Yes. Again, that slightly goes with public perception. As we have seen with trials, there is general acceptance that in car parks and sports fields it is okay to launch and set down a drone. It is not so obvious when it is somebody's back garden. It is about controlling that, but the technology needs to be integrated. As Elaine said, we need a clear vision of what is acceptable and what is normal operating sense. It has to cover a commercial operator as well as a recreational drone operator.

Q320 Darren Jones: In terms of connectivity requirements, and that type of stuff, are our cities in a good place?

Julia Jiggins: It is variable. Generally, as a rule, with a drone you are looking at satellite technology. The ability to have GPS is the key technology there. You would be looking at the ability for 5G to give support, particularly in cities.

Q321 Chair: Is it dependent on 5G?



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Julia Jiggins: No, it is not dependent on 5G, but 5G could enable and enhance it, and offer an alternative approach. There is a lot more testing and evaluation that needs to be done on the right combination of technology to give a safe flight and make drones effectively agnostic to the operating environment.

Q322 **Darren Jones:** Elaine, do you know from PwC's perspective, if we were looking at other cities around the world, which city is No. 1 in a PwC-style league table for the introduction of drone technologies?

Elaine Whyte: It is too difficult to make that judgment. That was my challenge right at the beginning: the difference between the perception and reality of what we are saying. We have some wonderful use cases out there. A lot of them are driven by the geographical needs of the country. We have reflected on Zipline, which works in Zimbabwe, delivering blood, because they do not have the infrastructure. We are much more likely to see farming and rural use cases somewhere like Canada.

In the UK, the challenge will be how we work in an urban environment, and we have heard the complexities involved there. The important thing is to get the test and evaluation environment right so that we can learn and share that learning, and try to grow together at the right pace.

Q323 **Darren Jones:** We all have our own interests, but I am pitching for Bristol. Why did you pick Cambridge, Sean?

Sean Cassidy: We had an existing innovation hub there, so there was already a good tech foundation. It was a leveraged position to work from. We have a great team there and a test site where we can do deep dives in the technology. It just worked out rather well.

Chair: It is not far up the road to Norwich.

Q324 **Bill Grant:** Can I make a pitch for Ayr? There are some lovely coastal routes and beautiful scenery—unbelievable. Anyway, that may not be pertinent.

I am trying to envisage the deployment of parcels and packages. I don't have in my mind's eye a central hub where they would be deployed by drones. I am visualising, particularly for rural areas, that you could have an articulated lorry loaded with parcels for a given series of postcode areas and multiple deployment of drones from that movable hub, or is that not practical?

Sean Cassidy: That is a possibility. We believe that the best approach is to be very methodical and stepwise. The current initial deployment has us oriented around operating from one of our fulfilment centres to a fixed radius. Once we demonstrate that, and prove the viability and safety, there are all kinds of options.

Bill Grant: I was thinking that, with the limited airtime available because of battery technology, they would not be going a long distance, so you



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could take the parcels to a central hub and have multiple deployments and returns back to base.

Q325 **Chair:** What is the radius you are currently reaching?

Sean Cassidy: It is 7.5 miles. That is our current delivery radius, roughly 12 kilometres. Again, that is for the system as designed right now. This is the starting point. We are already envisioning other systems that would be more purpose-built, for maybe longer distances and different payloads, and maybe shorter distances in a more urban environment.

Q326 **Chair:** Presumably, the distances in Africa for delivering blood and so forth are much longer than that.

Sean Cassidy: Elaine would probably know a bit more about Zipline distances.

Elaine Whyte: They are using fixed-wing drones so they have a longer range, whereas I imagine Sean is looking more at quadcopters, which have a shorter range.

Q327 **Chair:** What sort of distance can the fixed-wing drones do in Africa?

Elaine Whyte: I am not sure offhand, I am afraid.

Tris Dyson: I do not think that they are necessarily electric—that is the difference—whereas I imagine that you are doing fully electric.

Sean Cassidy: We are doing fully electric. On a point of accuracy, we just had a public debut for our delivery vehicle, and I would be more than happy to send you the link to that. It is a good comprehensive overview of our vehicle. It is not a quadcopter; it is capable of wing-borne flight and then reverting to vertical capability as well.

Q328 **Chair:** If you could send that through, it would be useful.

Sean Cassidy: Absolutely. I would love to share it with you.

Q329 **Darren Jones:** There was some discussion as to whether the video of your Amazon blimp and the swarms of drones coming out of the bottom was real. Is it real?

Sean Cassidy: Which video?

Darren Jones: There is an Amazon blimp, with drones coming out the bottom.

Sean Cassidy: I applaud the graphics folks who manage the CGI animation stuff, but that is not one of our operations.

Darren Jones: It is not real. Okay, thank you.

Sean Cassidy: But it is very entertaining.



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Chair: On that note, we need to bring it to an end. It has been absolutely fascinating. Thank you all very much indeed for your time. We appreciate you coming.