

Science and Technology Committee

Oral evidence: [The Draft Spaceflight Bill](#), HC 1070

Monday 27 March 2017

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[Watch the meeting](#)

Members present: Stephen Metcalfe (Chair); Victoria Borwick; Chris Green; Dr Tania Mathias; Matt Warman.

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Witnesses

[I](#): Richard Peckham, Business Development Director, Airbus Group, Joanne Wheeler MBE, Partner, Bird & Bird, and Paul Davey, UK Business Development Lead, Lockheed Martin Space Systems Company.

[II](#): Mark Thomas, Chief Executive Officer, Reaction Engines, and David Ashford, Managing Director, Bristol Spaceplanes.

Written evidence from witnesses:

– [Airbus](#)

Examination of witnesses

Witnesses: Richard Peckham, Joanne Wheeler and Paul Davey.

Q1 Chair: Good afternoon and welcome. Apologies for the delay in getting going this afternoon. You may have noticed that another form of transport is being debated in the Chamber, and that has delayed some of our colleagues, but we are now under way. I understand that one of the panel has to leave shortly before 5.30 to catch a flight. Do not worry, we will make sure we accommodate you. Perhaps to start with, you could, for the record, state your name and in what capacity you are here today.

Joanne Wheeler: My name is Joanne Wheeler and I am a partner at Bird & Bird.

Richard Peckham: My name is Richard Peckham and I am business development director at Airbus UK.

Paul Davey: I am Paul Davey, business development lead for our civil space business in the UK.

Q2 Chair: Thank you. In your view has the absence of a national launch capacity been a major technical barrier to growth in the UK space sector?

Richard Peckham: To date, no, it has not, given the way the market has been in the past. I do not know how many people know this, but the UK developed its own launcher back in the 1970s. A satellite launched on a British rocket built in the 1970s is still flying—Prospero. The rocket was Black Arrow. It was launched from Australia in those days. Although it was designed and developed in the UK, it went to Australia. The Government withdrew from being part of the launcher, but at that time it was probably quite a good decision; there were enough other countries doing launches.

In the UK, we have built a good satellite industry. Traditionally, the satellite industry has been quite big, expensive satellites, and the launcher market has been okay for the existing market. In recent years, what has changed is that suddenly there are a lot of small constellations of satellites. Rather than one big satellite, there are tens, even hundreds, of smaller satellites that fulfil a similar function but are different or complementary.

The market has changed quite drastically in recent years, and companies building small launchers find that the availability of a low-cost launcher is an impediment to growth. Part of that is because if you are a small satellite you are generally hitchhiking a ride on a big launcher that has a main customer with a big satellite. You are more or less a hitchhiker and you are not first in the queue. If there is a delay with the main one, you get delayed, so you do not have certainty about when you can launch. Obviously, to buy a launch yourself is out of range; it would be too expensive, so there is now definitely a perceived gap in the market for low-cost small launchers.



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Paul Davey: As Richard says, quite accurately, with the Government's emphasis on satellite applications and the benefits we can get from space data, as a nation we need to be able to put up small spacecraft as and when we want to. We have not been able to do that before. We had to wait for someone else who was launching and go when they launched. If they are delayed for a year, you wait a year with them; so, having the ability to launch on demand, as it were, and having that system available as an export from this country to other countries would be of reasonable economic benefit to the nation. We have not done it since 1971. With the investment the Government have put into satellite applications, it is about time we had the ability to put spacecraft into orbit when we want to. There has been a lot of industry interest in doing that, and a number of groups are preparing to work out how we do it.

Joanne Wheeler: Building, developing and manufacturing small spacecraft is something the UK does very well. If the UK had sovereign capability to launch them, it would mean easier access and it would be cheaper. We would not be at the beck and call of other sovereign states. It would be excellent to boost the growth of the small satellite industry in the UK.

Q3 **Chair:** What do you think prevented us from doing that earlier, or is it just that now demand makes it worth while?

Richard Peckham: I would say it is the latter. There had not previously been the demand. There were enough launchers in the market to satisfy demand as it was. New technology and business models have changed the dynamic quite rapidly; so, demand has risen, which is why a lot of companies are looking at developing low-cost launchers. There is a lot of interest out there to do it, and other competing states will also be looking to host launchers; so, in a sense the UK will be in competition with other potential locations from which to launch these new low-cost launchers.

Q4 **Chair:** The Bill sets out the framework that would create the opportunity to do that. When you first saw the Bill what were your impressions of it? Does it do what it says on the tin?

Richard Peckham: I defer to Joanne.

Joanne Wheeler: It sets out a very good, robust, high-level umbrella, a framework that is flexible enough to implement what the UK would look to do moving forward with different types of technology. It is a robust framework, but now we need to look at how it is to be implemented under the legislation. It is an excellent framework, particularly as it was drafted in six months; it is a pretty good start.

Richard Peckham: Airbus itself does not build rocket launchers. We are a 50% shareholder in another company, Airbus Safran Launchers, which builds rocket launchers. For instance, they build the European Ariane 5 and are now developing Ariane 6. We passed the Bill to them. Our company would not be the one doing the launching and it affects us less.



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The reaction from them is very positive. They have experience of space laws in other countries. Their reaction is that this looks positive towards people who want to operate, as compared with some other jurisdictions. Otherwise, I am afraid I am not an expert, but I can at least pass that on from our company that does launches.

Paul Davey: Lockheed Martin has been in the space launch game for a long time. We see the right way and the wrong way to do it. If we take the US, for example, which has had an established launch base for a long time, we can see that the UK has a unique opportunity to do it right the first time in a way that is not too constraining and is not particularly heavy on regulation either. We have an opportunity to get it right first time and do it the way that suits us.

Q5 **Chair:** Does the Bill do that?

Paul Davey: I am not an expert. From my reading of it, it looks to be fairly broad and not too constraining in that sense. Beyond that, I would not have a legal view of the Bill. I have read through it, and it seems to be going in the right direction at this stage.

Q6 **Chair:** As was pointed out, it has all happened very quickly. It is a draft Bill at this stage. Draft Bills normally allow for a form of consultation. Can you tell us what form the consultation has taken, whether you have fed into it and, if so, what you said about the Bill?

Richard Peckham: I know that Airbus Safran Launchers responded to the consultation on fairly specific areas where they believe there could be some changes. One thing that was picked up was liability. Obviously, where there is “may have” in relation to a capped liability, that is an issue. Given the breadth of the Bill, there is that flexibility in primary legislation—as long as it is clarified when one comes to secondary legislation. I have seen a copy of the comments, but, like Paul, I am not a legal expert. Where they have suggested a few changes they are quite minor; so, overall the impression is that it is an operator-friendly Bill, which should encourage people to come to the UK.

Paul Davey: In general, the industry has had a chance to look at it. For example, I have seen the notes put together by the Royal Aeronautical Society, which gathered comments from various quarters. In the run-up to it, we were able to support the UK Space Agency with early discussions and meetings; for example, we attended a meeting with the Space Agency and the FAA [Federal Aviation Administration] in Washington, so we tried to bring some expertise to that. Since the Bill has been published, we have had only a brief look at it, but the industry in general has had a chance to comment on it. Pretty much everybody I know in the industry has had a look at it.

Q7 **Chair:** Do you want to add anything, Ms Wheeler? It’s not obligatory.

Joanne Wheeler: There have been a few responses, and I plan to feed back some detailed comments to the Space Agency as to aspects and



gaps potentially not addressed. I use that term lightly, because I think it is quite a robust framework.

Q8 Matt Warman: The consensus seems to be that the current regulations assume, as I think Airbus put it in its submission to our previous inquiry, that satellites are big and launched one at a time, and the modern world has moved on a bit. Does the panel feel that the Bill now addresses those changes in the kind of regulations that are needed?

Joanne Wheeler: I think you are right. The previous Act in 1986 was drafted in a world where very large satellites were going into geostationary orbit. You are absolutely right about that. The world is changing quickly. To give three examples of the need for flexibility in the draft Bill—CubeSats and nanosats, mega constellations and in-orbit servicing—a number of questions arise. Does the Spaceflight Bill allow those aspects to be licensed under it? I think the answer is yes. Section 1(2) is broad enough to cover launch operations and any other activity in space. Does it also allow for different licensing approaches to those things rather than a very detailed six-month approach? I think it does. Section 7(5) is flexible enough to deal with CubeSats and what is called a traffic-light approach. I also think it deals with mega constellations and in-orbit servicing missions with a technical assessment liability. It does not mention the consent of the host state—the satellite you might be attaching to—but that is a minor detail.

Moving forward, the procedures that will be implemented under the Bill are quite important. If you are licensing 700-plus satellites, you cannot deal with one satellite on a case-by-case basis, but there is flexibility. For example, section 10(1)(c) allows an operator licence to be granted for one or more particular spaceflight activities, so families of satellites can be licensed together. That is very important, because nowadays there is quite a competitive state environment. Belgium, the Netherlands, France and the US all allow a licence to cover many satellites. In the US, you can even license a constellation. I am comfortable that the space Bill allows those new technologies to be licensed and that there can be a framework for licensing them in a different manner.

Richard Peckham: I have nothing to add; that was very comprehensive.

Q9 Matt Warman: One thing that has come up elsewhere is that it is possible that the licensing would be per mission rather than per operator. Is that okay from your relative commercial or other perspectives?

Richard Peckham: It certainly needs a change from the approach that was designed for one big satellite; you could have a fee, for instance, paid on one satellite. If you had to pay that fee for a constellation of, say, 100 satellites that effectively are doing the same mission as one satellite did previously, clearly there has to be a simpler way of doing it to keep it cost-effective and not kill the commercial opportunity.



Paul Davey: That last statement is key. To bring new entrants into the market who want to build small spacecraft, launch them and deal with data services downstream, we do not want the barrier to entry cost-wise to be too high.

- Q10 **Matt Warman:** Within those different models, the difference between vertical and horizontal is probably fairly crucial in terms of launching. Is a single bit of legislation able to cover those two very different modes? More specifically, is this single bit of legislation able to cover those modes?

Paul Davey: I would take a view from Joanne as to whether it covers both. They are very different things.

Matt Warman: Exactly.

Paul Davey: Horizontal launch is a very different game from traditional vertical launch. There are not many operators doing horizontal launch. I can think of one in the US. It requires a completely different set of parameters to operate an aircraft that has to fly over the ocean, for example, to launch a vehicle. One has to consider that the aircraft or vehicle may be non-operable and you have to bring the whole thing back, whereas with a vertical launch rocket the vehicle is in place on the launch pad, and if something happens, you can stop the countdown and look for and address the problem. When you are ready to go again, you restart the timer. That is different from flying a rocket under the wing of a jumbo jet over the ocean in a range; so, they are different prospects.

Joanne Wheeler: I absolutely agree. I come back to a previous point. I think this is robust enough to deal with both aspects, but it comes down to implementing regulations—the secondary legislation.

- Q11 **Matt Warman:** The Government are targeting a 2020 launch and regulations might not be finalised until 2018-19. Do you think that makes a 2020 launch possible?

Richard Peckham: I would say 2020 is very optimistic for a number of reasons. For horizontal launch, if you are using an existing airport I suppose there is less infrastructure required. For vertical launch, if you have to go through all the planning process, environmental assessments and all the things you need to do once you have chosen your site, in parallel with all the legislation and so on, I would say 2020 is very optimistic.

- Q12 **Matt Warman:** When you say very optimistic, would you characterise yourself as very optimistic, or are you using it as a euphemism for impossible?

Richard Peckham: I would say it is close to impossible, but it would not be far behind that; you could be not too far away from 2020. Lockheed might have a different view, but I would say that hitting 2020 will be pretty high impossible.



Paul Davey: It is a complex equation, and it depends on things like resources, for example. It is pretty tough to answer that unless you address it on a launch-system-by-launch-system basis. We would have to go away and think about that a bit harder—if you want us to.

Joanne Wheeler: There are two things. I am impressed that this was drafted in six months. That shows eagerness and an appetite to move forward. I agree with what Paul said about resources. A lot of aspects need to be considered, including resources within the Space Agency and other agencies to push it through.

Q13 **Matt Warman:** With sufficient resources, it could happen.

Joanne Wheeler: Maybe I would be a bit more optimistic.

Q14 **Victoria Borwick:** I want to go back to the regulations that Joanne touched on earlier. It is always quite hard to regulate for technologies that are in development but not yet fully operational. How much do you think technological development over the next 10 years will change? Inevitably, nobody can look into a crystal ball. How do you accommodate that with legislation? Taking that a bit further, do you think there should be different provisions for different areas or different processes? Do you have an overall view?

Joanne Wheeler: That is a very good question. Let me start answering it by saying what the Government need to look at with all of these technologies. They need to balance Government risk, safety, security, viability, reputation and all the environmental sustainable use aspects with encouraging the commercial use of technology in a competitive state environment, innovation, economic growth, benefits to society and the competitiveness of the UK.

In the last few years we have seen big changes, with mega constellations, in-orbit servicing, nanosatellites and so on. To expand on what I said earlier, does the Bill do enough to legislate for that? There is a catch-all term in section 1(2) that should deal with any other activity, even in-orbit servicing. There would need to be different proposals in regard to how those are licensed, because I do not think the licensing system at the moment is flexible enough. Obviously, that would be in secondary legislation.

To give the example of mega constellations, it is inefficient to assess risks on a case-by-case basis. We need to lump some of these satellites as families, and streamline missions, which is a bit like what the space industry is starting to do with the traffic-light approach. We need to look at best practice in other states to group licensees together—for example, what Belgium and France are doing with a series of satellites—and look at licensing different groups of constellations.

We also need to change the insurance. At the moment it is third-party liability insurance per satellite at €60 million. That simply does not work for constellations. We need to look at different models—for example, a



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fleet policy, a bit like ships—and have a cap of €500 million to cover that. We need to look at different models of licensing.

Chair: I am going to suspend the sitting for a Division in the Commons. We will reconvene as soon as the Committee is quorate. If there is more than one vote, it is unfortunately unlikely that we will be back in time to hear any further evidence from you, Mr Peckham, but thank you very much for your attendance today. I apologise that it has been somewhat chaotic.

The Committee suspended for Divisions in the House—

On resuming—

Chair: We will now resume the sitting. I hand back to Victoria Borwick.

Q15 **Victoria Borwick:** Ms Wheeler, you were halfway through talking to us about the regulations and whether they need to be for different purposes or different areas. Perhaps you could also touch on whether or not you think they are already too stringent. Could you give us an overall view, please?

Joanne Wheeler: I have already mentioned that the Spaceflight Bill allows different aspects to be licensed in the future. It really depends on how the secondary legislation is implemented. I mentioned that we need different ways of granting licences. I then dealt with insurance requirements for third-party liability and how that may need to be changed. That touches on a previous question.

At the moment, liability deals in effect with large satellites in geostationary orbit, the highest orbit. That is fine for €60 million per satellite, but if you are trying to launch 30, if not more, satellites at once, or have a constellation of 700-plus satellites, you will not have a commercial business plan if you are taking out insurance at €60 million per satellite. Working with insurers and the industry, I think the Space Agency can come up with a model that is workable, possibly based on shipping and fleet insurance, for example. There are ways and means of moving forward with that.

To cover your point about different aspects and forms of technology, we also need to look at Earth observation. We probably need some form of data policy there, but again there is a hook for that in schedule 1 to the Bill. We need to look at how to charge for licensing. There is also some flexibility as to charging in schedules 1 and 9. There are different ways of looking at how to license—looking at the different characteristics of the company, the directors of the company and so on. At the moment, some of the requirements are too stringent in the way licences are processed and in the insurance requirements, but I am comfortable that the space Bill gives enough flexibility to change that moving forward.

Q16 **Victoria Borwick:** Do you think there is enough flexibility as the technology develops?



Joanne Wheeler: There is enough flexibility in various sections—1, 7 and 10—and the schedules as technology develops. There is enough flexibility in the Spaceflight Bill. However, the caveat is that it depends on how it is implemented.

Q17 **Chair:** You do not think the Bill goes too far and gives too much power to the Secretary of State to regulate potential space activities. Section 63, in particular, seems to give a very wide and general competency.

Joanne Wheeler: That is a good question. A major challenge is maintaining enough flexibility while keeping a balance between Government risks, security and flexibility, but also encouraging commercial aspects. A degree of discretion needs to stay with the regulatory authority to make sure that there is an acceptable balance between risk and benefits, looking at rules that are transparent and proportionate to the risk and so on.

Moving forward, we need the regulatory authority to look at what is a safe and reliable system; what is best practice, looking also at the competitive state environment; and what is the international legal and political landscape—with responsiveness to technology and the sheer amount of assets up in space—to support commercial operators and maintain the credibility, which is very strong, of the UK licence. I think section 63 can stay.

Q18 **Dr Mathias:** To continue with the insurance point, we were told that other countries have less onerous insurance requirements than the UK. Do you see anything in the Bill to show that we might change that?

Joanne Wheeler: I did a bit of research on that. Sometimes the UK, with third-party mandatory liability, gets a bit of a bad press, but there is also mandatory third-party liability in Austria, France, Luxembourg and Netherlands. It depends on how it is applied. A third-party liability regime per satellite at €60 million does not work for constellations. It does not need to be big constellations; it can even be smaller constellations. In that sense it could be more onerous compared with the Netherlands and Luxembourg, which have more discretion. I believe that in the Netherlands third-party liability can be anything from about €20 million up to €60 million. It can come in at a lot less than €60 million per satellite. There are no third-party liability requirements in Italy and Spain; it is voluntary in Belgium and Sweden. However, they deal with far fewer licences than the UK, so it is not necessarily a direct comparison.

The US has a different system of maximum probable loss, so an applicant needs to demonstrate that they have something called financial responsibility. They take out an insurance policy—the maximum available in the market—or up to about US\$350 million, and the state takes some warranty above that. Insurance in the UK is not based on law; it is also based on policy, so the space industry has some discretion there.

Q19 **Dr Mathias:** Will the Bill make us more or less competitive?



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Joanne Wheeler: On the traffic-light approach and CubeSats and nanosats, if it is applied correctly, and nanosats really do meet the green criteria and could be potentially exempt from third-party liability, it would put us in a good position. Different models of third-party liability insurance would make us more competitive.

Q20 **Dr Mathias:** Does the Bill allow for that?

Joanne Wheeler: Yes. Section 10(2) of the Bill specifies limits of liability in regard to third-party insurance.

Q21 **Dr Mathias:** It provides that an “operator licence may specify a limit on the amount of the licensee’s liability” to indemnify Government. Could that give rise to the operators having unlimited liability?

Joanne Wheeler: Yes, you are absolutely right; 10(2) is a caveat of section 32. It sets out an obligation to allow an operator to indemnify the Government against claims altogether, which exists at the moment. Section 10(2) says that the Government may be able to put a limit on that, and section 35 says that a regulation can also impose a limit. Yes, it is possible for an operator to be required fully to indemnify the Government. Of course, the Government will go through various checks and balances to see whether that is really necessary for high-risk technology.

We had an unlimited system before 2015. A cap was put on it to put UK operators on a level playing field. That was very valuable in supporting commercial operators, but the UK Government still require licensed operators to get a licence, and discretion as to unlimited liability is probably still worth the Government having as long as they apply it correctly.

Q22 **Dr Mathias:** On third parties, section 30 mentions people and property on land or water. It does not appear to include damage caused to other aircraft in the air. Do you think that is a problem?

Joanne Wheeler: That is very perceptive. It was one of the gaps I identified in the legislation. Section 30(2) deals with injury or damage to persons or property on land and water caused by any craft or space object. It says that for any damage on land and water there is strict liability; you do not need to prove fault, but under the liability convention that also includes aircraft in flight. One of the gaps is why does that not include aircraft in flight? Then it would be a complete translation of something called the liability convention. That was my question too.

Q23 **Dr Mathias:** We are thinking of the same thing. If the Government do not indemnify licensees’ uninsured liability, do you think it will put off potential operators?

Paul Davey: Definitely. With small sats and various classifications for small spacecraft—they can be quite small—anybody operating—

Q24 **Dr Mathias:** How small?



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Paul Davey: CubeSats, for example, are very small and are additives. You can have a 3U, which is three bolted together, or 6U, and then you go up the path towards tens and twenties of kilos. Universities produce these things. There is a whole range of different masses of spacecraft. Of course, at the lower end, if the costs are prohibitive because of insurance regulations and what have you, it will become very difficult for people to enter the market, and then it becomes the domain of people operating traditional spacecraft of hundreds of kilos, up to thousands of kilos. The answer to your question is that it could become prohibitive.

Q25 **Chair:** Ms Wheeler, you mentioned that you were planning to get in touch with the Space Agency about points not addressed in the draft Bill. Could you give us an overview of what those might be?

Joanne Wheeler: It is really important that the secondary legislation implements licensing procedures properly. To deal with a lot of the points raised by Dr Mathias and Ms Borwick, it is important that the procedures are dealt with properly and that they are transparent, clear, reasonable, commercially feasible, proportionate and so on. On other aspects not in the Bill, we must make sure that there are enough resources in the entities that are pushing this forward, particularly to meet the deadline.

As to specific gaps, maybe I will give headings. Commercial players more than ever wish to move satellites around, either because of what is called bring into use spectrum—making sure the spectrum works and they can meet the regulatory conditions—or because there are more acquisitions, more consolidation and more M&As in the industry. To relocate a space object, there will need to be some form of consent given to the Government. There is nothing about consent in regard to moving space objects, apart from a general condition in schedule 1 about notifying intended deviation from notified orbital parameters.

Because of the way the commercial market is operating, there is also more about transfer of an object from the UK to another country. Again, consent would probably be needed by both countries. That is not dealt with at all in the Bill. Maybe it simply is caught up by “any other international obligations.”

The comment about damage to aircraft in flight, flowing from international law, was a very perceptive one. There are potentially other aspects in schedule 1 to which the Government might want to hook criteria, but it would also be useful for commercial operators, to give them transparency—for example, whether the UK would actually want a satellite operation centre in the UK, to be able to control satellites.

Space debris regulations and making sure database standards are kept up to date will be important issues. There is also the question of spectrum filing status before you grant a licence, and potential obligations on the Space Agency to notify all the criteria of a satellite to the UN to make sure that we all know what is up there, when it is up there and what it is doing.



Chair: Thank you very much indeed. If there is anything that you feel we have not covered today, or that you want to add to what has been discussed, please feel free to write to us and we will accept it as written evidence. There has been a bit of coming and going this afternoon, but I am very grateful for your attendance and evidence.

Examination of witnesses

Witnesses: Mark Thomas and David Ashford.

Q26 **Chair:** Good afternoon and welcome. I am sorry for the delay, but we are there now. To start with, for the record, would you state your name and whom you are representing here this afternoon?

David Ashford: I am David Ashford, founder and managing director of Bristol Spaceplanes.

Mark Thomas: Good afternoon. I am Mark Thomas. I am the chief executive at Reaction Engines.

Q27 **Chair:** Fantastic. As I am sure you are well aware, the Bill aims to create a regulatory framework to enable commercial spaceflight operations to be carried out from spaceports in the UK. What has inhibited the development of space operations from the UK in the past and is this Bill going to be the answer to all our desires?

David Ashford: I do not think that law has been an impediment in the past. One of the previous panel members said that we had a launch capability in the 1970s with Black Arrow and we gave it up. That created momentum against UK involvement in launch vehicles.

Mark Thomas: The previous panel cited demand as the change in the industry, the technology changes around satellites and the development of smaller satellites creating a greater demand for availability of launches that cannot be satisfied by the current launch solutions. I think we have seen an evolution in the industry and we are stepping into a new paradigm effectively. This is the ideal opportunity for the UK to take its place and its lead in that new market.

Q28 **Chair:** The draft Bill itself does not mention spaceplanes specifically. Do you see that as a problem?

David Ashford: I think it is flexible enough to cater for that. To be quite honest, I am not a legal person—I am an engineer—and I read the Bill looking at how it might affect what we are trying to do. It seemed to me that it will certainly not hinder but probably help.

Mark Thomas: I see it as an enabling framework. It is good that it is not too prescriptive. The areas where it is left open are the right areas. It is rich for consultation and the space industry can play a big part in developing that before it is finalised.



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On the spaceplanes issue, we are still ourselves beginning to understand what those could be, what they could look like—their size, shape and what capability they could have. What is impressive for me in the Bill is that it responds nicely to all the work that was done by the industry and Government working groups from a few years ago, including the Civil Aviation Authority and others in 2014. It is a really neat response to that. All the things that those groups said were necessary as a next step have been catered for in the Bill.

Q29 Chair: You mentioned that you are not quite sure what this is going to look like yet. Do you both want to give us briefly an oversight of where the technology is with regards to spaceplanes? What do you think the timeline might be for moving from theoretical to practical?

Mark Thomas: I am pushing it from the engine perspective. One barrier to a paradigm shift in the launcher industry has been the propulsion system, using conventional propulsion; David may disagree with me on this because he has found a way around that. We see that you can unlock a greater potential if you can find a more efficient form of rocket engine, which is effectively what we are developing. So, we are pushing a new capability that could enable greatly reduced cost launch platforms with a higher level of availability and reliability. From our perspective, that means we hope we are on an engine-development journey—technology and engine development—that will not mature for another five years or so but that will support the next-next generation of launchers, perhaps, from the mid-2020s onwards.

Q30 Chair: You think that is how long it will be before you are ready.

Mark Thomas: Yes. From our perspective, yes, we see that today's conventional technology will serve its purpose. We have seen the efforts that greater reusability with conventional rockets seems to be the trend, and some of the horizontally launched platforms that are under consideration for the 2020 requirement are using conventional rocket systems. If you look beyond that, we see the potential for a real shift and transformation in the industry.

Q31 Chair: Before I ask David to answer the same question, once your engine is developed to the point at which it is hanging underneath a wing, what will the game changer be? How will it change things?

Mark Thomas: The game changer is that it is incredibly efficient. That is the primary change. Your fuel requirements and the size and cost of the vehicle are dramatically reduced, and it allows a level of reusability that is far beyond current expectations—not tens of uses but hundreds of uses of that vehicle, more aircraft-type operations—which I think everybody agrees is the route ultimately to ultra-low cost access to space.

Chair: Thank you very much.

David Ashford: Our long-term aim is to form a teaming arrangement with a big aircraft company to develop something like this [*holds up*



model], which is an airliner that will fly to and from orbit; it will be fully reusable. It has two stages—carrier aeroplane and an orbiter—both stages with pilots and wings for horizontal take-off and landing.

What we are saying, which nobody else is—which is a challenge in terms of credibility and an opportunity, because if we are right we and whoever teams with us stand to become market leaders—is that you can use only proven technology to build a spaceplane like this. It has new engines but existing technology, jet engines and rockets. We have separated out the jets from the rockets on the lower stage. The best evidence we have as to why you can use proven technology is that, if you go back to the early 1960s, the pioneering days of spaceflight, where converted ballistic missiles were used from launching satellites, it soon became fairly obvious that throwing away a vehicle each flight could never become sustainable. Therefore, most big aircraft companies at the time had quite big teams looking at spaceplanes—aeroplanes—for launching satellites. The consensus was that it was the obvious next step and just about feasible with the technology of the day. If it was just about feasible then, it should be straightforward now. A lot of the designs looked like this [*holds up model*].

My first job at Hawker Siddeley Aviation (Advanced Projects Group), which tells you how long ago it was, was working on spaceplanes. I can honestly say I have been working on spaceplanes for longer than anybody else I know. We knew how to do it then, and we could have done it, but it did not happen because the money went into the race to the moon—project Apollo—and so the aircraft company design teams, manned mostly by aeroplane engineers, were disbanded. The lobby that said, “Let’s have an aviation approach as opposed to a missile approach” was weakened.

Q32 **Chair:** Do you think the Bill will reignite projects like that?

David Ashford: It will certainly make it easier for them to proceed. We need to partner with a big company. Spaceplanes are a major development programme, but we have designed a little demonstrator, which is like this [*holds up model*] but the size of a light aeroplane—this is the size of a jumbo jet—with no new technology, conventional aerodynamic structure engines. We could have it flying for the odd 10 million pounds, which people find hard to believe, but we are prepared to be put to the test.

Mark Thomas: It is interesting that you relate it back to the Bill and whether it enables these quite futuristic concepts. Potentially it does, as long as we do not become fixated on the 2020 mission, which is to get a first operational system in the UK, and we do not breathe a sigh of relief and think that we have done it, we are there and we have a launch capability. We have to look beyond that, obviously, and see these more visionary concepts.

Q33 **Chair:** How realistic do you think that 2020 ambition is?



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Mark Thomas: I am not quite in the “pretty impossible” camp that Richard was in, but it is certainly very challenging. We have seen various proposals, including wet leasing a US system, where the full operation is a US system, US manned and US operated. Speaking as a British company, that is certainly one way to achieve that aim, but where does it leave us and others in that sector?

David Ashford: Our little demonstrator could be flying and carrying the science payload up and down to near-space in 2021. We cannot honestly claim 2020.

Q34 **Chair:** Before I hand over to Matt Warman, this is a draft Bill and draft Bills encourage consultation, and provide, hopefully, an opportunity for consultation. Have you both had the opportunity to feed in to the Bill process?

Mark Thomas: Formally, I have not responded to the Bill, although I have had dialogue with the UK Space Agency around that particular point on the objectives for 2020, their realism and potential road maps and routes to get there, which I feel has been very positive.

Q35 **Chair:** Will you respond formally to the Bill?

Mark Thomas: Yes.

David Ashford: Our main interest is certification. We need a safety management system that will ensure adequate safety but not break the bank. If you are developing a new business jet or an airliner, the certification process is very expensive; you need to give or take a thousand test flights. There is no way a pioneering spaceplane company can afford that. We have had discussions with the CAA and given evidence at the various consultation workshops leading up to this, and there is a way ahead to do that, given good will, and I think the Bill allows for that.

Q36 **Matt Warman:** You have broadly covered this, but, to be clear, you seem fairly happy that the CAA takes the view that a spaceplane meets the definition of an aircraft and that is transposed into this Bill. Is that fair?

David Ashford: Yes.

Mark Thomas: Yes, sure.

Q37 **Matt Warman:** They have also indicated, though, that spaceplanes will be classified as experimental. Is that going to put people off? Does it open up opportunities? Is it a problem?

David Ashford: One thing I am not clear about is this. We want to be able to carry fare-paying passengers at the experimental stage, which at present is not allowed for, but we have a work-around solution to that, which we discussed with the CAA and we think it could be made to work.



Q38 **Matt Warman:** What is that?

David Ashford: We design to an existing airworthiness code. With airliners you get a very thick book, full of requirements; so we take the most appropriate one and design to that. We would have to write new chapters to cover rocket engines, operations in space, re-entry and thermal protection. We propose to write the chapters ourselves and discuss them with the CAA. We would design to that and do enough flight testing or experimental testing or analysis to get a type certificate.

Matt Warman: Yes.

David Ashford: But this type certificate would have unusually severe operating limitations, such as you would nominate specific pilots. There would only be a handful of pilots who would be allowed to fly it.¹ You would fly in good weather only, treat each flight like a test flight with full instrumentation and post-flight analysis. In collaboration with the CAA and the insurance companies, we would evaluate any deviation from nominal as it happens and gradually relax the operating conditions.

Mark Thomas: I am with David on this one. If you throw the entire rulebook at it, then it is going to be a very difficult exercise. So, some flexibility is needed, and the experimental tag is very useful and gives us the ability to explore some of these options and solutions for that initial operational capability, and then we can build on that. We are really trying to minimise, as it says, the risk to the uninvolved public. That is the key thing here.

Q39 **Matt Warman:** But it will not preclude you from taking passengers so long as they are happy with being experimented on.

Mark Thomas: If we are allowed to explore these routes, that should be possible. I have always taken a view that it is a ALARP-type approach. You get the risk to as low as reasonably practical, and that is a judgment, but as long as we are prepared to hold hands on that one there is definitely a route through this.

Q40 **Matt Warman:** Finally, have you had any contact with the European Aviation Safety Agency about developing regulations for spaceplanes?

Mark Thomas: Yes. The encouraging thing is that we have been working for some years on that. Specifically, we have been working on the engine side with the Civil Aviation Authority, the Department for Transport and the Space Agency as part of a working group. That started some years ago. We are definitely not starting from a clean sheet of paper here. Some really useful work has been done to understand how you adapt the aviation rules to this new world, effectively.

Q41 **Matt Warman:** How far along are those conversations?

¹ Note by witness: You would nominate the sites from which it could fly—perhaps only one.



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Mark Thomas: They are quite well progressed. I am very encouraged by what I can see. I do not see it being a huge hindrance to us.

Q42 **Matt Warman:** This is sub-orbital and orbital.

Mark Thomas: Yes.

David Ashford: We have spoken informally to EASA, but we recommended, and it was agreed fairly early on in the consultation process, which was the precursor to this Bill, that it would be much better for the UK for the CAA to be responsible; it is under our control then.

Q43 **Chair:** Following on a little from that, schedule 1 to the Bill basically says that safety requirements relating to the design of a spacecraft could be a condition or “may”—let’s use the accurate word—be included in the licence. Can you think of a scenario when compliance with such safety requirements would not be necessary and perhaps it would be better to replace “may” with “must” comply with safety requirements?

Mark Thomas: That is a very good point. We all want to ensure that we have a safe solution here. You have to place that onus on somebody, and that suggests that it sits with the operator or with the prime for that consortium or group of companies that deliver that capability. It could easily be read as a “must” here.

David Ashford: I would agree with that.

Q44 **Chair:** Thank you; that is useful. Finally, given the speed at which the commercial spaceflight sector is developing, do you think this legislation and the regulatory approach being adopted will be fit for purpose in, say, five or 10 years' time?

David Ashford: It seems to me that the Bill is very flexible and a lot depends on the detail. That, it seems to me, will be worked out as people try to do it. If we got the money to build our little demonstrator, the first people we would talk to would be the CAA. I do not see a lot of need to talk to anybody else, from a safety regulation point of view.

Mark Thomas: From my perspective, we have to keep the pace in this activity. It is a bold step that has been taken, which I support wholeheartedly. It is very encouraging that we have seen a Bill within six months, and to see the iteration of that in an equal period of time would be fantastic. Then, as the previous panel said, the key thing is how it is implemented. That is the greatest area for getting it wrong as well as right.

Q45 **Chris Green:** Britain is a fairly congested country in terms of occupation of land space, with plenty of shipping at sea and aviation quite busy in our skies. When you are designing spaceplanes, whose safety is paramount? Is it the crew, other aviation or people on the ground or at sea?



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Mark Thomas: That is a great question. If you look at a spaceplane, as we might have in our minds at the moment, it is not conceivable to think that it is going to achieve the out-of-the-box reliability and safety targets of a civil airliner. We have been on a long journey in civil aviation to get to that point, with some incredible achievements, but if you look at a loss-of-life rate of one in 10 million hours, you are going to be significantly off that.

When you are talking about the crew, they need to be made aware that there is a higher risk level associated with that vehicle than a civil airliner. It is closer to general aviation, in truth. We have to do our utmost to protect the uninvolved public. That is one reason why the spaceport locations are where they are, operating out over the sea, but there is still going to be a concern there as well. I think you need to know that you are effectively dealing with two different risk levels there.

Q46 **Chris Green:** Presumably the pilots, when they are applying for their job and everything else, will be fairly experienced and will appreciate the risks, but there is always that concern for bystanders and other aircraft as well.

Mark Thomas: That is exactly right. If you think about the spaceport set-up and if it did become a cluster of high-tech industries that are sited there, and for tourism, then you have to think very carefully about how you lay out such a site, where the exclusion zones are and where the operational piece takes place, and make sure that the public are sufficiently safeguarded as well as anybody who works in and around that operation.

Q47 **Chris Green:** Section 30 of the Bill focuses on protecting third parties—essentially people and property on land and water—from harm caused by spaceflight activities, such as debris or parts falling off. Would you also expect the licensee to be liable for damage caused to other aircraft? Is that an expectation?

David Ashford: The aviation industry has set a precedent. For every 10 people killed in an air crash, roughly one is killed on the ground. That is the sort of balance that civil aviation has achieved. So, if you are talking about horizontal take-off spaceplanes—which are aeroplanes with a rocket engine that fly high, so it is really an aeroplane—that is a realistic precedent. If you are talking about vertical launch—throwaway launch—vehicles where you need self-destruct mechanisms included, it is slightly different. There is nobody in the air to be worried about, but safety on the ground is then paramount.

Q48 **Chris Green:** I suppose one expectation would be that in normal aviation you fly to a city perhaps, or over cities. You would not intend doing that, would you?

Mark Thomas: Not typically, no. This sort of vehicle is going to be in the atmosphere for a very short amount of time, over populated areas for a minimal period, but it is a high-velocity object with a lot of energy.



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David Ashford: Yes. We would start off in remote areas, and only when safety was approaching aviation standards—which, as Mark said, is a long time away; we would start off with the experimental standard and work towards it—would we fly over London.

- Q49 **Chris Green:** Certainly when you are looking at an industry that is hopefully taking off, that is developing, the unlimited liability for insurance could be a concern. Are you concerned that section 10(2) of the draft Bill states that an operator licence may specify a limit to the licensee's liability to indemnify Government?

Mark Thomas: Yes. That is the one that has caught most attention. It certainly did in the previous panel, and if you take some of the smaller companies pushing innovation and perhaps wanting to break into that industry, that could be really off-putting for them; it could be a significant issue, hurdle or barrier to entry. It is the one that we would like to work on jointly. There is hope or encouragement that there is a “may” there, not a “must”. Maybe it is one that does warrant a “may.”

David Ashford: I plead ignorance there. What is the situation with civil aviation on liability? Is it unlimited? I do not actually know, but, whatever it is, I would suggest it applies to space or certainly spaceplanes.

- Q50 **Chris Green:** Section 31 states that the Secretary of State may indemnify the licensee in respect of the excess that is uninsured. If the Government do not indemnify the licensee for excess, would operators be able to obtain insurance or would the premiums be prohibitive? I know we touched on it.

Mark Thomas: The previous panel is probably best placed to answer that one.

Chair: If anyone from the previous panel hears this, perhaps they could submit a written response to that.

David Ashford: We have had preliminary discussions with insurance companies, and this was before the Bill came out. They will just work out the risk. It will be done on a conventional insurance basis. I do not see any showstoppers there. It will put the price up a bit.

- Q51 **Victoria Borwick:** Can we go back to launch capacity? To what extent is the UK launch capacity currently constraining the growth of commercial spaceflight and particularly the development of spaceplanes?

Mark Thomas: I will let David take the spaceplanes piece of this, but, as to the space sector and growth targets, all the community involved in that has cited it as an impediment. If we do not have a greater launch availability, that is potentially going to stop us from achieving our growth targets in the UK, and it has to be in conjunction with lower-cost access to space and be appealing to the guys and girls who are developing small satellites. That is the opportunity, frankly, but I do see this virtuous circle that occasionally gets drawn where, if you can put something out there



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that is lower cost, it will drive a greater demand, and if it can be combined with higher availability that will potentially drive further innovation and even lower-cost solutions.

We need to take that first step, frankly, and put something out there because that is the thing that is going to unlock this. Right now, today, it is an impediment in the sense that, as we heard earlier, people need to hitchhike on a launch platform, on a launcher. There is no guaranteed slot. There is a risk in that operation, and they would like that greater sense of security and confidence that they will get their dates and their items into orbit. It is a target-rich area.

Q52 **Victoria Borwick:** Do you want to comment on that?

David Ashford: Very briefly, adding to what Mark has said, a proper spaceplane, once it is well down its learning curves, once you have enough people using it and you have economies of scale, can slash the cost of launching satellites by at least 100 times, possibly even 1,000 when they are really mature, in service in large numbers and you have long-life rocket engines. We are talking some time away. "Game changer" is a tame cliché to describe the impact of spaceplanes, which are going to revolutionise spaceflight much as the steam locomotive revolutionised land transport. It is that level of transformation.

Q53 **Victoria Borwick:** Is the UK a commercially viable location or are more equatorial latitudes preferable?

David Ashford: You can do a lot from the UK, but for certain launches you want to go equatorial. If it is a spaceplane, that is straightforward; you can just fly everything down there.

Q54 **Victoria Borwick:** Can the spaceports be developed as a purely commercial enterprise, and do you know anybody who is spearheading on that sort of approach?

Mark Thomas: Yes. We are certainly associated with a few of the spaceport consortia; one that is particularly active has generated quite a visionary concept for what that might look like ultimately. You could effectively bank on it having a cluster effect, where it pulls in high-tech industry, because we have seen the full range of possibilities from very small operations in remote locations right through to that full business model. There is a great potential. Again, it requires some bravery, and the grant announcement of £10 million to go towards encouraging those efforts is hugely helpful, so we can get people who operate launchers connected up with people who operate their own site locations. That is quite a powerful effect.

Q55 **Victoria Borwick:** Finally, the Government, I know, are keen to be facilitators rather than funders, inevitably, given the cost of some of the other major infrastructure projects and the need, therefore, to fund them rather than other projects. What makes spaceports different?



Mark Thomas: I am not sure it is necessarily different. Our model has been one very much based on private and Government partnership. We raised £33 million of private investment before we received a Government grant, but the two together are quite powerful when we go out for future funding rounds. It is quite an interesting and appealing mix for people to see both elements there. Spaceports have the ideal opportunity to make that same connection.

Q56 **Victoria Borwick:** To clarify, you have some funding and it is not a matched funding.

Mark Thomas: It is not necessarily matched, no. Our model was very much that the company evolved or developed off the back of pure private investment before it stepped into the world of strategic investment, industry investment and Government funding. We have funding for an element of our programme, for which we are hugely grateful, but I guess I am saying that that blend looks very appealing to people, when you go out for future funding, to see those different elements in the pot, that they can work together and enable innovation effectively.

David Ashford: The bottom line is that what you need for a spaceport, cutting it to an absolute minimum, is a long runway and clear airspace. The rest, if it came to the crunch, could all be provided by the operator. If you need a propellant storage facility, you could drive in with a tanker lorry; if you need a tracking radar, we can provide that, and so forth. I do not think spaceports, as such, need a lot of Government support. They should be self-funding. If you look at the amount of money required to convert an ordinary airport into a spaceport, it is very small compared with the amount of money needed to develop the launch vehicle.

Q57 **Victoria Borwick:** There are a number of disused aerodromes across the country. Had you a vision on one of them?

David Ashford: No. The CAA has done a very good job in selecting six or seven viable ones. I would go along with that.

Q58 **Chair:** You mentioned a long runway and airspace. Airspace in the UK is quite congested at times. Do you think that will have an impact on the potential growth of this perhaps burgeoning industry?

David Ashford: As I understand it, that by itself will not require new legislation but modification to the existing air traffic control protocols. We do not want to go around hitting airliners, obviously, and the way to avoid that is to fly where there are very few of them, so there is plenty of warning. We would just avoid any possible conflict.

Mark Thomas: One proposal to look at segregated airspace initially is a sensible way forward. For me, it is about enabling that first step of an initial operational capability. It will not be the perfect solution, it will not be the thing we live with forever, but at least it gets the piece moving and we will learn from that. We will build on it and start to bring in higher levels of safety and reliability, and we will start to understand how we



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can integrate with airspace and air traffic on a more routine basis; but until we take that first step it is all very theoretical.

Q59 **Chair:** In a way, the system will operate as if it were a plane but with additional capacity, facility and power.

Mark Thomas: That is correct, yes.

Q60 **Chair:** Would you, therefore, envisage the pilot of such a vehicle having to have an aviation licence as well as a space licence?

Mark Thomas: It will probably be very close to the pilots who flew in the X-15 in that they will start as pilots and get their astronaut wings pretty quickly. The hypersonic X-15 in the US was the plane in which some of the Apollo astronauts flew and got their astronaut wings before they did on the Apollo mission, so we may be seeing the same situation. It is going to be in the atmosphere for a very short period of time, but during that period of time it is going to operate very much like an aeroplane, so that is the obvious place to go.

David Ashford: Yes. We would start off using only accredited test pilots, and the training required to fly spaceplanes would be decided as a result of operational experience.

Q61 **Chair:** Thank you. This is the final question from me. If you were to fast forward from here—so the Bill is in place and it has passed its parliamentary procedure—what do you imagine the risks to be in fulfilling the Government's vision and the reason they have put this Bill in place? What will stop it delivering its ambitions?

Mark Thomas: It is the one I flagged earlier, without overdoing it or overplaying it. We are trying to create here an opportunity for UK industry, for the UK really, and it is on a path towards our ultimate targets and ambitions for the space sector—10% by 2030. So, we have to think very carefully about that first step and ensure that UK industry is not crowded out in that very first step, because that could be hugely demoralising and punishing for the people who are innovating and pushing some of those next-generation solutions.

Q62 **Chair:** What would crowd them out?

Mark Thomas: I am thinking particularly, should we choose to do it, about how we would implement a US system—a launch capability in the UK. They exist today, they are out there fulfilling a job and there are others coming along close behind. One suggestion the CAA made in 2014 was about wet leasing a US system. We must make sure we do not approach that in too flat-footed a way but in a way that still allows an opportunity for the UK industry beyond that.

David Ashford: The main risk is lack of investment capital. Spaceplanes are going to revolutionise spaceflight eventually, and if the UK wants to develop the world's first spaceplane industry, which it could do, we need the money. The particular challenge I have is that we are trying to team



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up with major players and we are having great trouble engaging in dialogue with them. It may be that I am not a very good salesman.

Q63 **Chair:** Putting that aside, do they give you any reason why they do not want to engage in discussions?

David Ashford: It is sort of, "Spaceplanes aren't in our strategic plan, dear boy, and we only have limited private venture funding," which is meant to close the conversation down. I then say, "No, they are not in your strategic plan because it is a disruptive technology, but the first one of you guys that puts it there hits the jackpot," and there is a very long pause.

I will give you an example. About three years ago, I wrote to David Willetts and asked him if it would be possible for his Department to introduce my company to potential industrial partners. I received a nice letter back saying, "Sure." Nothing happened for a year. I talked to my MP about it and he got a similar commitment from Jo Johnson. There has not been a single introduction. I do not think it is the fault of the UK Space Agency; it is the fault of the big companies that just don't want to know, because it is so new and big corporations tend not to be very radical in their thinking.

Mark Thomas: The Space Growth Partnership and Space Leadership Council have cited vertical integration as being key to making this industry successful, and it is reaching right down into the SME community as well as academia to ensure that we get the whole supply chain and the benefit of that innovation.

Q64 **Chair:** What would be the motivation and/or benefit for the large companies that you are talking about?

Mark Thomas: The key word used was disruptive. If you are not a disruptor, you will be disrupted. You kind of need to get there first. What BAE Systems did with us—they invested in our company—was a very bold step again. It was quite a visionary thing to do and they really got it that disruptive capability was going to be part of their business going forward. Investing in a company like ours gave them that opportunity, amongst other things.

David Ashford: We think there is a chance for a big company, if they invest in this technology, to make an enormous profit. The first company to back the winning strategy stands to become market leader. It is a big opportunity. The challenge is to engage in dialogue with them.

Q65 **Chair:** At the moment they are risk-averse in that.

David Ashford: Yes. It is the nature of big corporations. What we lack in this country is a medium-sized aircraft company doing business jets and general aviation.

Chair: Thank you very much indeed. I am going to draw the session to a



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close. Can I thank you both, David Ashford and Mark Thomas, for your attendance this afternoon?