



International Relations and Defence Committee

Corrected oral evidence: The Global Combat Air Programme

Wednesday 6 March 2024

10.35 am

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Members present: Lord Ashton of Hyde (The Chair); Lord Alderdice; Lord Bruce of Bennachie; Baroness Coussins; Baroness Crawley; Baroness Fraser of Craigmaddie; Lord Houghton of Richmond; Baroness Morris of Bolton; Lord Robertson of Port Ellen; Lord Soames of Fletching; Lord Wood of Anfield.

Also present: Lord Anderson of Swansea; Lord Howell of Guildford; Lord Hannay of Chiswick.

Evidence Session No. 1

Heard in Public

Questions 1 - 11

Witnesses

I: Professor Justin Bronk, Senior Research Fellow, Royal United Services Institute; Tony Osborne, London Bureau Chief, *Aviation Week*.

Examination of witnesses

Professor Justin Bronk and Tony Osborne.

Q1 **The Chair:** Good morning. Thank you very much for coming. We are very much looking forward to hearing what you have to say. We have quite a lot to get through and quite a lot of questions for you. We are also being joined by two members of the International Agreements Committee so that we can assist them with their review of the treaty associated with this programme. It is an important programme that has substantial implications for UK defence and UK defence spending. The principal object of today is to help the International Agreements Committee with some background on the programme.

This is a public session; it is being streamed live on Parliament's website. A transcript will be taken. We will send it to you to make sure that there are no changes of fact that you need to make. I remind members to give any interests pertinent to the inquiry when they first speak; in that regard, I should say that my wife is a shareholder in BAE Systems, as I discovered yesterday. I ask the witnesses to introduce themselves briefly when they first answer a question. As I say, we have a lot to get through so members of the committee will ask brief questions. Can we have answers that are succinct but, obviously, cover all the facts?

Let us start. As a background, there are not that many facts available in the public domain. Can you tell us about the key features of the Government's plan for a sixth-generation fighter and what distinguishes it from the previous generations? To what extent is it an airframe issue, or is it an issue with the kit that is inside it and possibly flying with it?

Professor Justin Bronk: Good morning. I am the senior research fellow for air power at the think tank RUSI. The sixth-generation ambitions, or moniker, for the Tempest programme—the GCAP—are, in essence, in the same category of marketing gimmick as the fifth generation, in the sense that what they actually mean is a new generation of manufacturing UK combat air platforms, following on from Typhoon. Most of what is being discussed would be relatively advanced and indigenously produced, along with Japan and Italy: a stealthy aeroplane with some sensor fusion features, a relatively long range, a degree of modularity, and a low probability of intercept and detection radar. That puts it fairly closely matched to American fifth-generation capabilities so I suggest that, in essence, what is being discussed is producing something that has never been produced successfully in the West—that is, in western countries—outside of America.

Outside of that, for most of the world, the sixth generation will probably be defined by whatever America does to replace the F-22 and whatever the Chinese do to follow on from the J-20, since superpowers tend to have the resources and technological maturity to define the bleeding edge.

Tony Osborne: I am the London bureau chief for *Aviation Week*, which is an American publication. I write on European defence. I agree with

Justin on those areas. The principle is that this aeroplane will have improved sensors, longer-range weapons and engines that will provide more electrical power; there is an expectation that this aircraft will have more electrical capability because of the computer systems and sensor systems on board. "This aircraft will be a flying supercomputer" is the phrase that has been used previously.

One of the principles is that this aeroplane is designed to have more freedom of modification—that is another term that has been used—and greater freedom of action than previous generations of aircraft. It will also be easier to spirally upgrade it. Obviously, it will be a much larger platform, given that it will be a low observable platform, as it must have those weapons internally. This means that it has to have a higher weight and a larger airframe—much bigger than the Typhoon that we currently operate.

Q2 Lord Robertson of Port Ellen: I declare that I am a senior counsellor with the Cohen Group in Washington. I once got an award from *Aviation Week*; I do not know whether that is a declaration.

I want to ask you about rival programmes by the US and our continental allies, but I also want to ask you about the idea of sovereign capability. We are now talking about what used to be called Tempest, with the Italians and the Japanese, but there are going to be other rival products on the market. The French will undoubtedly produce one; the Americans will have something on the market. How will Europe face up to external challenges if we are all producing our own aircraft at enormous expense and, at the same time, against adversaries who are investing in single structures?

Tony Osborne: The UK's aim of getting this platform in 2035 is ahead of those other nations—perhaps even ahead of the United States, although its next generation air dominance programme is very much in the black and we do not know a great deal about it. We know that there are possibly demonstrators flying but that is about it. We are not expecting that aircraft to be exportable. If the US then comes along with a follow-on to the F-35, which is going to be in service well into the 2060s and 2070s, so we are not expecting a follow-on to it, NGAD is not likely to be exportable, so there is at least one competitor possibly out of the way of FCAS/Tempest/GCAP.

You are right that France, Germany and Spain are working on SCAF/FCAS. The principle is similar but that is a much more encompassing programme; it is probably even a little more exquisite than what the UK, Japan and Italy are proposing. That aircraft is designed to carry the French nuclear deterrent, for example, and will go on French carriers. It will have a rather more specific role but, obviously, France will want to export it. So there is at least one potential competitor so far. The UK will be a fast mover—the first mover—into this space if it can get the aircraft in service by 2035.

On the adversarial elements, China and Russia are developing what they would describe as fifth-generation aircraft. The Su-57 has seen some limited service—it is apparently in Ukraine—but some of the elements that we would like from a next-generation combat aircraft are very basic. Russia and China are working basically on competitors to the F-35. We are seeing the J-31 out of China and the Russian Su-75 Checkmate. Some people may have seen a mock-up of that at the Dubai Airshow, but that is as far as it has progressed. Russia is seeking partners for that programme and has not had much success, so far. Pakistan has shown some interest in buying the J-31 from China and I expect, as Justin said earlier, to see future sixth-generation programmes emerging from China in the next few years. The rate of progress there is significant, being a superpower.

Professor Justin Bronk: Exactly as Tony said, the delivery target timeframes are different for the Franco-German-Spanish programme. French sources have repeatedly suggested over the last couple of years that delivery in 2040 is now unlikely. They are looking closer to 2050, partly because of the industrial and political disagreements between Germany and France over work-share direction and likely capability ambition.

In essence, France will produce an aircraft to replace Rafale. It has no choice; it is a core part of its sovereign decision-making and has been for a long time. One of the difficulties is that, because Dassault has a very strong airframe design pedigree, it had a very aggressive negotiating stance when the programme was being scoped and the French Government supported Dassault very strongly politically. So France has a strong design lead in the fighter components of that programme.

Germany, generally speaking, first approaches these things through an industrial lens, then a political lens and maybe, eventually, a capability one. France almost flips that. That leaves Germany with the ill-defined next-generation weapon system bit, which in essence are collaborative combat aircraft elements, so uncrewed things that will fly alongside the fighter. Germany is likely to have significant political problems in being able to produce and design things that have lethal effect and the required degree of autonomy, given that it took more than 12 years to get the Bundestag to agree to put weapons on a remotely piloted UAV.

The other bit is the command and control architecture or the combat cloud—however you define it. Again, its industrial value is very difficult to define, in terms of what it actually is, and because, as Tony said, the core fighter will be one of the legs of France's nuclear deterrent, Germany probably has some scepticism that France will actually allow it meaningful design authority in the command and control system for a nuclear French asset. So a lot of work-share disputes are baked into the Franco-German programme, which means that France will, as likely or not, end up going it alone. That will reduce the scope of what it can do compared with a collaborative programme.

Equally, for the GCAP programme, Japan is likely to have a significantly higher capability requirement than the UK because, bluntly, it needs something that can fight the Chinese in 2035 to 2060. We simply do not face and will not face that level of threat environment in Europe. Japan also requires a greater range than we do. Given that it also has more money than us, it is likely that, as Japan matures its capability requirements—not something it has typically done since the Second World War—we will see pressure from Japan to have a higher level of capability ambition in the programme than the UK or certainly Italy has, from a funding standpoint if nothing else. I think there will be tension here but, at the moment, GCAP partners are much more closely aligned in their desired delivery timeframe and rough capability ambition, compared with the competing SCAF/FCAS.

There is a range of Turkish-South Korean supposedly fifth-generation programmes on the market. I saw a fantastic description of what are currently “fifth-generation-shaped” fighter prototypes. I would caution both them and us, when looking at demonstrators. Look at the gaps from flying prototypes to front-line fighters. For example, from the X-35 to the F-35 was about 12 or 13 years; the YF-22 to the F-22 was again about a decade; and the EAP to Typhoon was similar.

It is extremely difficult to go from demonstrator to functional fighter, especially for anything stealthy. It has not only to be difficult to spot on radar but to do everything that the aircraft needs to do, including with sensors and sending and receiving electromagnetic information and energy, without giving yourself away—all while packaging everything with the power and cooling required, inside a clean design that means that you cannot have things like air scoops, which would normally be used to get cooling air in. There is a reason why only the Americans have ever done this properly in production quantities. The Chinese are, if not there, definitely very close to being there. Arguably, they are already there. The UK has done this in prototypes—BAE Systems Taranis, for example, is very impressive—but the move from that to a functioning combat aircraft in production at scale is a very big one.

Q3 **Baroness Coussins:** How would the comparisons that you have described differ if Saudi Arabia were to join GCAP, as has been reported? I also understand that Germany is reported to have said that it would probably rather be in GCAP than the programme it is in already. What difference would that make?

Tony Osborne: It would be a challenge initially, certainly for some of the other partners within GCAP—Japan, in particular, with its national approaches to defence exports—to have Saudi Arabia on board. However, I have seen some reports from the last couple of days that work is going on within the Japanese parliamentary parties to try to smooth that out.

As for Germany, the UK has experienced challenges with Germany over Eurofighter in the past. It has also just had the issue of trying to sell Typhoons to Saudi Arabia and that process being delayed by Germany, so

I am not sure whether we really want Germany on board. That is my honest answer.

Professor Justin Bronk: As I understand it, there are two areas of concern with Saudi Arabia as a partner. Given the enormous funding required to do a programme like this properly, the amount of money that Saudi Arabia is willing to bring to the table is extremely attractive from the point of view of the programme's viability.

On the other hand, the first objection is timing. An enormous amount of work has been done between the UK, Japan and Italy, at both the political and the industrial levels, to align the work-share agreements and the programme construct very quickly, compared with any previous programme, so that they meet Japan's absolute requirement to have something on the ramp, ready to fly and, if necessary, fight in 2035. To start adding another core programme member of the scale that Saudi Arabia would bring—especially with its funding—would almost certainly make it impossible to meet that deadline. You would have to unravel much of the work that has been done over the past five years.

So one of the big issues is timeframe: if Saudi Arabia were to demand being a full, core partner member, that 2035 timeframe would not be possible, at which point the Japanese would leave the programme. That is an absolute requirement for them. I have spoken to very senior Japanese air force personnel who have said, in those terms, that 2035 is an absolute cut-off for them; it has to be ready by then. I suspect we would have a similar view if we were sat next to the PRC.

A second and equal objection would be security, as Saudi Arabia has a fairly problematic relationship with Russia, from our perspective, and reasonably problematic relations with China in some areas, although to a lesser extent than the UAE. That is their sovereign right as sovereign countries that typically try to balance relations with a lot of the globe, especially fellow petrochemical-producing states. On the other hand, this is a core national security programme, so there would be a number of concerns from the perspective of technology transfer and core workshare.

Q4 **Lord Howell of Guildford:** Thank you, first, for inviting us. Generally, close co-operation with Japan on industrial development is something that we have been working on for years and is good but, at the moment, every light is blinking in terms of the total transformation of aerial warfare. If you looked at the papers this morning, you would have seen that there was a lot about it. We are talking 11 years ahead and about the vulnerability of all manned aircraft. How amenable to adaptation and flexible is this treaty that we are being asked to process, as well as the ecosystem generally? Your bet is that manned aircraft will still be needed in 11 years' time but, if that bet is wrong, how adaptable is this treaty to taking on all the other broader systems that will be there in the background?

Professor Justin Bronk: All of our defence planning and that of every allied air force suggests that piloted aircraft will still be a core part of air

force requirements in 2040 and, potentially, beyond. Actually, the last bastions of where you are likely to require crewed, as opposed to uncrewed, aircraft are likely to be of lower intensity in terms of threat, scale or mission set—for example, quick reaction alerts to intercept civilian airliners. It is difficult to assure a UAV, even with remote cameras or something; if you lose connection, a critical task does not get fulfilled. Another example would be looking into the cockpit of an unresponsive aircraft to see what the pilot's body language is, whether there is somebody else in the cockpit with them, whether it looks as though they have a gun or a knife in their back and what the passengers are doing through the window—that is, whether they are signalling or anything.

Equally, there are lots of examples over the past five or six years of UAVs being shot down without much diplomatic consequence on contested borders and in contested bits of airspace. For example, the Iranians shot down a roughly \$230-million RQ-4 maritime Global Hawk—something that is the size of a 737 airliner and is incredibly expensive—in the Gulf, and the reaction from the US was fairly minimal. In other words, there is now plenty of established precedent that shooting down uncrewed things does not trigger the sort of crisis escalation, diplomatic response or military response that shooting down a crewed aircraft would have.

Therefore, for things such as air policing and air defence, you will probably want crewed aircraft for quite a while. This is partly because part of the value in those interactions is that there is a strong mutual incentive for nobody to go kinetic, which just is not there with UAVs. It is also quite difficult to programme something automatic or, if you want to go further than that, something automated or even autonomous so that it is sufficiently safe around potentially unprofessional behaviours by hostile pilots—say, locking them up with the fire-control radar in “single target track” mode, dispensing flares next to them or going across the nose with the afterburners on; there is plenty of stuff that we see fairly regularly from Chinese and Russian pilots—so that it does not interpret those as threats and respond accordingly but also is not so docile as to be easy to outmanoeuvre and shoot down. Generally speaking, human pilots are incredibly good and well trained not just at interpreting the rules of engagement and the tactical situation around them but at placing it in what they understand of the political and operational context within which they are flying that day. That is something that is very hard to programme.

At the very front end, going inside hostile missile engagement zones—going downtown, as it were—will be ever more uncrewed, but you will still need at least some of those crewed fighters for the foreseeable future.

Lord Howell of Guildford: Just in case, drones are covered in the co-operation under the treaty, are they not?

Tony Osborne: I do not believe that they are. I believe that it is focused purely on the manned fighter. The UK approach to this programme is not as comprehensive as, say, the French-German SCAF programme, which

encompasses the autonomous, collaborative elements of the programme as well as the combat cloud. At the moment, GCAP is focused purely on the manned fighter; it is then up to individual nations how they approach and work on the collaborative platforms, such as drones.

Lord Soames of Fletching: I think the record will show—I say this in the interests of time—that Mr Osborne has already dealt with the points I was going to raise, so I will pass on this.

The Chair: Very good—thank you very much.

Q5 **Lord Alderdice:** Lord Howell asked about future-proofing to some degree. The UK's combat air strategy intends to make use of open systems architecture, which, in principle, ought to make upgrades simpler and more cost effective; it may also help with interoperability. Although that is a good idea in principle, how do you assess the prospects for this approach in practice in the design and development of GCAP?

Tony Osborne: It is part of the solution. One of the more crucial elements to this—it is something that the Swedes have done particularly well with the development of their Gripen—is separating elements of the aircraft's control system so that you have flight-critical and mission-critical elements. By not touching the flight-critical elements as you do upgrades, you do not have to certify it every time, so you can cut down the time that it takes to put a new weapon or sensor on the aeroplane and do it much faster.

There are challenges around developing the open systems architecture itself and the standards for it, as well as around making sure that everyone is in line to follow your standards. The UK has developed PYRAMID to do this work; it is an open-architecture system that the UK has developed and planned for future air systems. I am not aware, at least in my covering of this role, of that being used actively on a platform yet; it may be on the 2027 flight demonstrator, which is coming, but that is not clear yet so I am still waiting to see that open systems architecture be fully developed. Lots of those systems are being used in other countries. To be honest, I have not seen a great deal of evidence to suggest using them; these are not easy systems to develop and how open they really are is still under question.

Professor Justin Bronk: There are industrial sides to this, as well as significant UK regulation and international regulation angles, where progress is needed on both sides. On the one hand, exactly as Tony said, from a software architecture and flight control architecture design point of view, keeping the flight-safety-critical bits of the software separate and federated from most of the mission systems is something that the Swedes have done well and works brilliantly. It is also something that I know BAE Systems is well aware of and intends to do for this programme because it enables you to have a much cheaper and easier upgrade pathway through adding capability. Equally, there are quite a lot of ways in which software development in particular could be pushed through more rapidly if the Military Aviation Authority (MAA) took a different

approach to the inspection and certification of software from a flight safety point of view. Of course, that goes for partner nations as well.

There is both a government regulatory side and an industrial approach here. One thing I would caution against, if you see claims of orders of magnitude cost reductions compared with previous programmes, is this: although it is absolutely possible that you will have a significantly more efficient upgrade process in relatively open architectures when integrating things, as compared with Typhoon—indeed, it is required and, from what I have seen, looks likely—a core part of the business model of any fighter manufacturer is the through-life support, maintenance, upgrade work and integration.

It is fairly difficult to separate the cost angle, which clearly everybody wants to minimise—especially in the current financial environment—from the jobs piece, which is why we are doing this. Ultimately, the costs that the military is paying are people’s salaries and jobs. If you want to reduce costs radically, you are going to support radically fewer jobs. Ultimately, the jobs are being paid for by the money going into the programme, so there is an element of industry wanting to keep as much of the upgrade work within the group as it can, rather than having completely open competition with anybody on the market, because it supports more jobs. There will be an element of UK, Japanese or Italian government policy that will encourage this because we want sovereign onshore work.

Q6 **Baroness Crawley:** We have already started to talk about the cost challenges of implementing GCAP, and other members will probably want to come in on this. Typhoon exceeded its initial budget; what can be done to minimise the risk of cost overruns in major procurement programmes such as this, and what is the cost of not implementing GCAP?

Professor Justin Bronk: Almost every fighter procurement overruns its cost estimates. The best thing one can do, as a very first principle, is to be much more honest than we typically are in UK military procurement programmes about what we think it will actually cost. We have a long history of being extremely optimistic—to use the charitable term—about what we think a major capital programme will cost, then we desperately have to scabble around each year when it actually costs significantly more. That tends to lead to not just cost overruns against the estimate but significant continuing delays, because we do not have the money in year to keep things on track.

Every year of delay to any programme means keeping a workforce in work, therefore having to be paid for an additional year, even if the programme is not progressing significantly. This, as well as by repeatedly changing specifications, is how British procurement systemically ends up with programmes that arrive 10 years late, massively over budget with far smaller fleets. It is basically about unrealistic estimates of likely costs right at the start. We keep doing this. So there is that.

The Chair: Is that largely to get people to agree to the programme?

Professor Justin Bronk: Yes. Look, for example, at the way that the UK's aircraft carrier programme has gone. You see exactly the results of that not just in monetary cost but in people terms. For example, we now have carriers that had very optimistic estimates of the people required to crew them. Now that the carriers are in service, we are retiring—scrapping, I should say—frigates that have just gone through refit, because we simply do not have enough crew. There are consequences across the rest of the force structure from being unrealistic about these things.

Baroness Crawley: This seems endemic. It has been going on for years, since—a million years ago—I was an MoD Whip.

Professor Justin Bronk: This is not just the military's fault; it is a problem of the country trying to maintain a full-spectrum force on a manifestly inadequate budget. We can tell ourselves that things are world-class and fantastic, but it does not matter if the underlying reality is different. Eventually, it will catch up. Again, being realistic about the costs up front is crucial to keep the programme on track. If we want to do this, it will cost a lot of money and we will have to allocate significant additional funding from outside the core defence budget, as it currently exists. The current defence budget is inadequate to meet the needs of the current force, let alone a next-generation fighter programme.

Q7 **Baroness Morris of Bolton:** How complementary do you think the industrial capabilities of the UK, Japan and Italy are to the development of this sophisticated aircraft? Do we have the necessary skills supply?

Tony Osborne: Industrially, all three nations are like-minded and have done similar things before. We have all worked on similar programmes: the Japanese worked with the United States on combat aircraft; we have worked with Italy; and we have worked with numerous other nations. All three countries have the skills to put together an aircraft—almost independently, to some extent, if they wanted to. I am not clear on the extent of Japan and Italy's joint industrial capability, but we have experience in that area.

We have had to build up our skills rather rapidly. In the run-up to FCAS TI, which was the forerunner programme, it was realised that, in some cases, the skills were down to named individuals who were close to retiring. The whole programme has managed to rebuild some of those skills. It is not clear whether all those skills have been rejuvenated, but that is one of the advantages of a partnership: if we do not have many skills in one area, maybe Italy or Japan will have them. We are sharing that across the board, I hope, but we have rebuilt many of those areas.

Professor Justin Bronk: Broadly speaking, there is quite a lot of industrial complementarity between the three core partner nations, at the moment. In big handfuls, the Italians are excellent at hardware for sensors—for example, Leonardo makes much of the hardware for radar 2 for the Typhoon, which will form the basis of the main sensor on GCAP, at least initially.

Rolls-Royce is obviously one of the few global manufacturers that can make a fifth-generation, or even next-generation, combat aircraft engine. That is a result of Rolls, in essence, having nearly half the civil airline market for large turbofans. It has a huge R&D funding base, which bleeds through to its military engines. Of course, EJ200, with its largely Rolls-Royce core, is one of the most extraordinary fighter engines on the market. It is an amazing piece of kit, so there is good stuff from the UK side in airframe design, engines and that integration piece. The UK also has significantly more expertise in low observable technology than Italy or Japan.

Japan brings massive industrial scale and the ability to manufacture at an unbelievable quality, albeit often quite slowly and expensively. It has engine test facilities that we no longer have, which are very useful, and brings an extraordinary engineering base at a scale and quality that we do not really have in the UK anymore.

There is lots of complementarity. The issue will be in the slightly different approaches to security clearances, for example, and in different approaches to timeframe. We will see whether operational capability ambition remains linked. At the moment, it looks good.

Q8 Lord Bruce of Bennachie: To follow up on what you said, Professor Bronk, the Government are saying that the GCAP programme is essential to maintain our technical capability and that, without it, we would not be able to do so. Is that the case?

There is also a political point here. You mentioned the inadequacy of the budgeting. The political climate suggests that the public are probably ready for a debate that says that we need to spend more money on defence. The push-back is that we are sick and tired of hearing how much money is wasted in defence procurement. How do we put these things together to say that this is essential for our industrial capacity—if it is—and that the budgeting and planning are there to ensure that the money is spent effectively and the jobs are real and sustained, but not overcostly and overextended? How do we put all that together? Are the Government right that we have to do this and, if we do not, what would happen to our capacity? If they are right, how do we ensure that it is done in a way that is politically acceptable to the wider public?

Professor Justin Bronk: If we do not participate in GCAP, BAE Systems and the UK as a whole would for ever lose the ability to be end-to-end fighter developers and manufacturers. In that sense, it is absolutely essential if our sovereign choice is to remain in that game. It is the only way to do it.

There are other things we could do to remain a combat aircraft developer and manufacturer, for example in the uncrewed space. The UK did fantastic work on Taranis with BAE Systems, so we could go into the uncrewed space, but it would not give us the same scale and value, particularly in jobs, that a full-fat fighter programme would. That is why this argument has consistently been made so strongly.

On the issue of connecting it to the wider requirement to articulate to the public why we need to spend more on defence quite urgently, the difficulty will be ensuring that it is made coherently without mixing it with the current Russian threat problem. Bluntly, this is not going to be delivered in a timeframe that is relevant to whether we end up having a war in Europe between NATO nations and the Russians. There are some fairly urgent and worrying requirements to desperately uplift spending quite significantly on a whole host of capabilities to fix gaps to deter the Russians in Europe, which at the moment GCAP is directly competing with. The historical analogy would be: you are trying to articulate why Britain should fund development of jet turbine-powered aircraft in 1936—which we did, but at a relatively small scale because we were desperately trying to produce Spitfires and Hurricanes.

There is a need to separate out those two and to look at it in policy terms as two separate items, because GCAP is not going to deliver any actual combat capability in itself until 2035 at the earliest. Equally, quite a lot of the upgrade programmes for Typhoon are partly cross-funded within GCAP development efforts. For example, radar 2 for Typhoon, which is badly overdue, is also a core part of the sensor development for GCAP.

Again, it is interesting to look at Radar 2. The UK has managed to produce jointly with Italy a genuinely world-class e-scan radar—electronically scanned array radar. Typhoon is currently about 10 years behind Rafale having an e-scan radar installed, and we are installing them having spent all this money on developing this fantastic radar for air-to-ground and electronic warfare stuff. It will transform the capability of the aeroplane against high-end threats, but we can afford or are allocating so little money to actually installing them that we are installing 40 radar sets on 40 of the Typhoons out of the 107 that we are keeping. That means that, spreading the money out across the programme, you are looking at about £54 million to £55 million per radar; that is about two-thirds of the cost of a flyaway F-35A, which has a more capable radar as part of the package.

That is not to say that Radar 2 is not a good programme; it is that we penny-pinched it down. Having developed the capability, we are now buying so few that the unit cost is almost ridiculous. Again, that comes back to the need for us to actually commit to doing some things rather than a whole breadth of things, and doing them properly.

Tony Osborne: I just point out that when that radar actually arrives, it will probably be in service for only about a decade before, theoretically, GCAP replaces the Typhoon anyway.

Q9 Baroness Fraser of Craigmaddie: You have highlighted some of the risks associated with GCAP, particularly budget and cost, with changing specifications being another one. Are there others that you want to highlight, and do you have any recommendations that you would like to make regarding the implementation of the programme?

Professor Justin Bronk: I would say that the biggest risk is that if we have a major war between the US and China in this decade or the beginning of the next, and/or a war with the Russians in Europe, then all this will come to naught because we will all have to pile as much money as we can into desperately fighting a war at short term while the global economy melts. Without wanting to be alarmist, deterring threats to global peace between major powers is also crucial to GCAP and a whole host of other things we want to do in the 2030s.

Tony Osborne: Exportability has to be at the top of the list for anything that we develop. This cannot be an exquisite platform. We cannot pile everything on—the requirements list must be compatible with what other nations want. We cannot keep changing requirements for this aeroplane. We must make it as attractive as possible for other countries to want to buy it, and that also means a low price in order to make it attractive, otherwise we will not be in a very happy place when it comes to costs for the programme.

The Chair: Is there a danger that it might be too sophisticated for many other countries to want to buy it?

Professor Justin Bronk: There is a danger, particularly if Japanese requirements climb significantly in view of the continually evolving and very high-end Chinese threat, that we might end up having to incorporate technologies in the jet and its associated systems that we are not comfortable exporting to a lot of countries. Indeed, if we were looking to provide the RAF with the most capable platform we could then we probably would do that—or at least one would assume that we would do that, from a naive perspective. There is a reason why the F-22 is unexportable; it is because the Americans wanted something that would dominate all the competition, so they put things that were their most sensitive technologies at the time into it. There is a reason why NGAD will probably be unexportable.

There is a decision to be made about limiting capability if we wish to, not just from a cost-control and de-risking point of view but to make it easier to export. Countries such as Gulf Cooperation Council (GCC) nations are much smarter than they were 20 or 30 years ago about being sold, in essence, tuned-down versions of equipment and weapons. I think it will be a more difficult trade off to keep balanced, but it is certainly something that all the partner nations and the industry players are very aware of, and they are working their hardest to try to find that balance.

The Chair: We do not have much time left but I nearly forgot Lord Houghton.

Q10 **Lord Houghton of Richmond:** I just need to declare relevant interests in the register: SecureCloud+, which provides the secure, collaborative working environment for Team Tempest and potentially GCAP; and Thales, which I advise, will no doubt be a member of Team Tempest but also a subcontractor for some of the subsystems.

Ministers have been somewhat euphoric at the Dispatch Box about not just GCAP but AUKUS. I can understand how both programmes, which are 50-plus years in their imagination, are attractive to, as it were, the tilt to south-east Asia—the sense of global Britain. I can understand why the big defence primes want them and the supporting lines in respect of retaining our place as a tech superpower, if there is truth in that. But from the perspective of the defence programme, which is already dominated by the nuclear enterprise, the payment of pensions—which a lot of people just do not realise is in there as well—and, dare I say, carrier strike, the cynic in me tells me that we are on the verge of entering into two things which will last half a century and become non-discretionary, and their affordability will become non-discretionary, such that the balance of the defence programme will be—as I sometimes used to say to the old Prime Minister—that we will end up as Belgium plus nukes. This is a ridiculous course of action.

What can you say? You have mentioned how we can, in a way, attempt to reduce the potential costs of participation, but from an international relations perspective, how can we maintain flexibility and limit the risks of being completely painted into a corner by giving ourselves some policy flexibility? Who knows, within a year or two we may have a Government who want to better match our aspiration with our money, rather than try to find the money that this particular Government have been reluctant to find.

Professor Justin Bronk: On GCAP—

The Chair: If you want to think about that—we are really pushed for time—you could provide an additional answer in writing.

Professor Justin Bronk: As a short upfront answer, we are already fairly painted into a corner diplomatically, in the sense that walk-back, cancellation, downgrading or whatever of GCAP—or AUKUS, of course—would be diplomatically damaging with Japan and Australia. There is no way around that. Any decision to do so would need to be taken with pretty strong reasoning. This is not to say that major defence co-operation agreements do not break down—of course they do—but there would be a significant diplomatic cost. The euphoric messaging around some of this stuff is not an accident, I suspect; it is designed to generate the political will to create buy-in that then forces the allocation of funding.

The Chair: The last question is from Lord Hannay, who is from the International Agreements Committee.

Q11 **Lord Hannay of Chiswick:** Can I test what you said about the American project being unexportable? No doubt that is the correct judgment that you are making today, but we are talking about a period quite a long way down the road, and there are plenty of examples of the Americans changing their view on exportability under pressure from diplomatic developments and so on. Surely it is a bit risky simply to say that the American aircraft not only is but will be unexportable.

I was also a bit puzzled by your characterisation of a situation in which there is conflict between the West and Russia or China completely killing off this project. That is not what happened in the Second World War, when both sides accelerated their attempts to get superweapons.

Professor Justin Bronk: In air power terms, for example, the largest and most advanced aircraft project going into the Second World War was something called the "Ideal Bomber" project. It was a specification that came out of the RAF's "Ideal Bomber" study but it never materialised because we ended up producing Halifaxes and Lancasters as came out of two previous medium bomber specifications, which were what we used at the time. We then spirally developed from there; the V bombers that came afterwards were from a different specification.

You are absolutely right that we accelerated the development of a whole host of things but we stopped the development of most things for a good few years while we desperately produced what we could at the time. At some point, there would no doubt be longer-term development—assuming that the world is not a cinderblock—but I suspect that it would be deleterious for the programme as currently envisaged were there to be a major war, not least because of the inevitable massive disruption to the global economy. This goes particularly for anything to do with Taiwan, since around half of the world's high-end chips come from there.

On the American programme, I agree that there is a reasonable probability that, at some point, the US may revisit the exportability of both Next Generation Air Dominance—its future fighter programme—and the B-21 Raider. The likely candidates for that are Australia, first and foremost—if it were to choose to try to buy it, that is, as it would be very expensive—and, potentially, Japan. That would be interesting from an NGAD point of view, of course, but Japan has historically had real difficulties with running security clearance processes because of the way Japanese culture treats the thought of a Japanese person betraying Japan; it is very difficult to ask the sorts of penetrating questions that you need to run a serious vetting process. For really sensitive American technologies, there may be challenges there.

The big issue for NGAD, in terms of it being a competitor on the export market to Tempest/GCAP, is that it will, I suspect, be far too expensive for most countries because of the range requirements placed by the Indo-Pacific theatre. You are probably looking at a combat radius target in the region of 1,000 nautical miles, and you have to carry all your weapons and fuel internally because it needs to be stealthy, so you are looking at an airframe that is probably larger and heavier than that of the F-111.

The best predictor of costs, both to acquire and to operate, is still the maximum take-off weight. If you want stealth, you can shift that curve up hugely, but as the max take-off weight goes up you will have a commensurate significant increase in the costs to operate and to acquire. I would be surprised if NGAD was anywhere below \$300 million a tail to buy and \$100,000 an hour to fly. I suspect that, even if countries that do not face Indo-Pacific range requirements were allowed to buy it, it would

not be considered the best value for money. The F-35 will probably be the competition for the foreseeable, and by that I mean not what the F-35 is now but what it will be in 10 or 15 years' time.

The Chair: Thank you both very much indeed. The next set of witnesses will face a much better-informed committee. I am very grateful to you. I remind you that you will receive the transcript, which you can take a look at.