

**A Keynote speech by Air Chief Marshal Sir Andrew Pulford
Chief of the Air Staff, Royal Air Force**

Title: '*Anything is Possible*'

Introduction

Foolishly optimistic, based on faulty calculations and impracticable, so said an eminent scientist. I will return to this withering assessment later.

Fellow Air Chiefs, ladies and gentlemen, welcome to the Royal Air Force's (RAF) Air Power Conference 2016; we have a new venue and a new approach. And what an excellent place for us to meet, the home of the Institution of Engineering Technology where reminders of innovation are all around us.

I am once again extremely grateful for the generous support of our sponsors: BAE Systems, Lockheed-Martin and Northrop Grumman – our main sponsors – and also to Airbus Group, Boeing, General Atomics and Leonardo our other sponsors, and to Draken International, our exhibitor. Without your support, hosting this event in central London would simply not be possible. Many thanks also to the Royal United Services Institute, with whom we have again partnered to deliver this event. Thank you to you all.

Our conference title is: *Inspiration and Innovation: the Essence of Air Power*. But is that a statement of fact, a rhetorical question or an aspiration of a future condition we hope to achieve? Is it all three?

What I am more certain of is that we share a problem - air power is not immune to change. If we cannot inspire our people we will fall short. If we cannot drive innovation in our approach we will become less effective and irrelevant.

Inspiration and innovation is our theme and naturally the subject of my remarks today. I will do this in two parts: first, a little more about the conference and our approach, for we are trying to do things differently. In part 2, a look back at a relevant case study to contrast that with our situation today, before concluding what it might mean for air power tomorrow.

Unpacking it more thoroughly is our shared conference mission.

To business. This is an opportunity to discuss our issues, share new ideas and develop our thinking. This is about our collective conceptual development - old and, most importantly, new.

Part 1 – Conference Challenge and Approach

Let me begin by taking a few minutes to set the conference agenda in context and consider the challenge I have set for it.

The challenge

It is an understatement to say that since its birth in 1903 air power has progressed rapidly. Power and performance have risen beyond all expectation and combat effectiveness with it. Airmen the world over have successfully ridden this 'aeronautical wave'.

But the world is changing around us very rapidly indeed. Society and technology are creating a new operating environment which brings with it new challenges and vulnerabilities. A near instantaneous global transfer of ideas and 'stuff' is at its epicentre.

We will need to adapt if we are to build on air power's achievements of its first century. But where must we adapt? How should we do it? Is it within our ability to do so? Or is our future now likely to be increasingly 'shaped' by the growing influence of areas such as space and cyber?

The four sessions of this conference are essentially a compare and contrast vehicle through which we can examine our twin-themes and, perhaps, derive some relative order of importance to them.

Our approach

We are doing things differently this year so let me say something about our new approach. The changes impact our design and its delivery. Each of the four sessions are semi-self-contained and no two are the same in their delivery. We have invited presenters with a diversity of views, experience and age.

For the first time, our discussion is not limited to delegates in this room as we are providing a livestream to the Royal Air Force at our main operating bases. It is important to me that my people have the opportunity to hear what we have to say because they are unequivocally part of the solution to the challenges we face. It is why some of my younger members are sitting here with us in the front row today.

To help you all engage with the agenda we have our conference application, which offers you an interactive experience regardless of your location. Please check your delegate pack and download it if you have not done so already as you will also be able to ask questions of presenters through this tool and them, you.

To close Part 1, I'm going to start that style of engagement with these three high-level questions that I would like you to consider¹. We will push these to your device shortly and I will return to your answers in my closing remarks.

Which brings me to those paraphrased remarks - 'foolishly optimistic, based on faulty calculations and impracticable!' That was the candid assessment of Dr Alan A Griffith², a senior scientist at the Royal Aircraft Establishment, when asked by the Air Ministry to examine the idea put forward in 1930 by Flight Lieutenant Frank Whittle RAF for the design of a gas-turbine jet engine.

Part 2 – Frank Whittle and our situation today

In Part 2, I will use Whittle's experience set against our conference agenda to pick out some key, enduring themes, and then consider the situation we face today. My aim being to identify what might be important for us as we go forward.

Whittle's career

Whittle's career - which many of you will already know quite well - can be summarised as follows: a hard-working and gifted engineer, he led a determined pursuit of his revolutionary idea, that of propulsion by the ejection of hot gasses thereby removing the limitations of propeller drive.

¹ These questions, presented on a supporting slide, were: Q1) *Has the context in which we seek to inspire our people and encourage their innovation fundamentally changed? And what does this mean for the future?*; Q2) *Of the factors to be examined in the 4 sessions (technology, 'fighting systems', leadership and organisational culture), rank them in descending order of your perceived importance to: a) Inspiring our people, b) Promoting innovation, c) Successful warfighting;* and, Q3) *Is the space environment or cyber domain about to dominate inspiration and innovation in the 21st C, as air power did in the 20th C? And what does this mean for air power in the future?*

² There is a certain irony that Dr Griffith, the man who had dismissed the original idea in 1930, had himself made a significant contribution to Whittle's success, as it was he who made the breakthrough in 1926 that shaping turbine blades in an aerofoil shape like mini-wings allowed the engine to 'fly' in an un-stalled condition.

That this vision was realised came in spite of many personal, professional and institutional knock-backs along the way. His technological breakthrough was marred by poor behaviour and decision-making across industry and government which delayed the delivery of the project. Ultimately though, the superiority of his designs eventually won through. But how does Whittle's experience map to our agenda?

Technology

Let's start with technology. A key question might be: is technology the 'beating heart' of innovation, or is it merely the 'blood' which flows through the veins giving innovation life?

Whittle was the not only engineer considering the technical problem in the early 1920s but his genius was being able to put it all together in a way that would work reliably enough for it to be fitted to a modern combat aircraft. His practical challenge was immense: compressor performance would need to go up 10-fold, air pressure by two-fold, combustion intensity many-fold; and, a narrow 400mm turbine would need to deliver 3,000hp. And the parts to produce this improvement were yet to be manufactured.

In the context of the Great Depression and with war on the horizon again, it is quite remarkable that Whittle got his project for an entirely new propulsion system moving at all. His challenge then is one we would recognise now - and hence my first theme - which is, how to get your ideas heard and adequately considered? Especially so when the technology is offering something which inevitably only the 'few' can conceive and the 'many' cannot.

Let's move onto 'fighting systems' and start with their relationship to technology.

'Fighting Systems'

A key question might be: which should come first - developing the technology then working out the 'fighting system' into which it can fit or, identifying the fighting system you want and then develop the technology you need to deliver it?

In Whittle's case I would argue it was essentially the latter. Whittle's revolutionary product - the gas turbine jet engine - was seeking to evolve an entire 'fighting system' that was already in existence, namely, the combat capability of the RAF by allowing its aircraft to go higher and faster than anything in existence.

The introduction of remotely piloted air systems originally did the same but now, arguably, the opposite is occurring. We are designing new 'fighting systems' and evolving the technology to fit them. Hypersonic propulsion is another example.

But 'fighting systems' also have to harness people and the organisation, as well as technology. It seems to me that this was actually Whittle's biggest challenge – people couldn't conceptualise an alternative future to the one they understood today?

Two themes emerge. First, we need to understand better the relationship between technology and 'fighting systems' so that we can apply ourselves more effectively. And second, that a sharper focus on the people and the organisation might well yield bigger and faster benefits in our future 'fighting systems'.

Leadership

To leadership and a key question might be: did Whittle's experience indicate a failure of leadership or was it actually an example of successful leadership? This is a tricky one to answer because there were many leaders who influenced his story over a 12 year period.

The negative influences were led by Dr Griffith's self-interested, biased analysis because Whittle's ideas did not match his own. The Air Council opted not to protect Whittle's 1930 patent because they deemed his idea to have no military purpose. The Rover company worked behind Whittle's back on alternative engine designs and were allowed to do so by the Air Ministry.

The positive counterpoints were his Cranwell chain-of-command which pushed Whittle's ideas forward. Dr Pye at the Air Ministry, once a sceptic of Whittle's ideas changed his views 180 degrees to convince the Ministry to fund it. And Air Vice-Marshal Tedder, then Director R&D, ensured Whittle's team retained a stake in engine development when the Rover company muscled in.

The theme that emerges is the need for effective leadership at all levels of both your organisation and those with whom you interact. If you get this right then it might be possible to overcome any bad decisions you made along the way.

And I'll touch on this again in organisational culture, our final piece of the conference framework.

Organisational culture

The key question here is perhaps rather obvious: did the aggregate of the organisational cultures that impacted Whittle's story inspire and actively promote innovation, or stifle it?

In the early days, the prevailing attitude questioned how a mere squadron leader with a simple design could possibly know more than the big, well-established engine manufacturers? But collectively they had rather missed the point – nobody had any real experience in this field! The point is obvious – one has to be prepared to listen and consider new ideas.

Whittle's research was actually funded by two ex-RAF friends, not the RAF; they were effectively venture capitalists. So the role of private investors is perhaps another theme we should consider?

Whittle's company – Power jets Ltd – was essentially a Small and Medium Enterprise. Its challenge was twofold: first, in today's language, how to bring its product across the 'valley of death' into viable production?

And then how to do so without being trampled upon by the big boys, the Primes in today's lexicon. Unfortunately, the culture and bad behaviour Whittle encountered made it very difficult for him to do either. The RAF did encourage him to pursue his ideas at Cambridge, then run a private company whilst in government service and also allowed direct negotiation with an aircraft manufacturer; this was remarkably progressive. So the theme for me is whether we are doing enough of this today?

Contrast Whittle's experience with that of the US who, after studying Whittle's engine³, designed, built, tested and flew their own engine in their first jet aircraft⁴ within 8 months. The theme is how to gain institutional agility in turning ideas into capability.

But surely this historical experience could not happen today? Well, let me briefly draw on 3 pieces of contemporary thinking which suggests that it does.

Thinking the Unthinkable (Unpalatable)

In their report⁵, *Thinking the Unthinkable*, Nik Gowing and Chris Langdon⁶ asked 60 of the highest level executives from business, finance, government, military and the humanitarian sector what challenges they face today.

³ The GE 1A.

⁴ The Bell Airacomet.

The conclusion they drew is stark: 'leadership is overwhelmingly caught off guard and their skills and organisation tested to the limit'.

They suggest there is now a 'new normal', one where a rapid-fire succession of abnormal, disruptive events is their new reality. They conclude that executives face new vulnerabilities that are greater than at any time in recent history - I recognise the picture they are painting.

But why aren't we thinking about the unthinkable, or unpalatable, that might be coming our way? These are the nine reasons why the authors think this is occurring⁷.

The research suggests that mindsets, behaviours and systems are rarely configured to handle the 'new normal'.

War is change; change is war

Chris Donnelly⁸ in *Rapid Reaction Force for Success*⁹ has gone further arguing that because war brings with it rapid social, economic and technological change, and since this is the reality we are experiencing today, then we must configure ourselves for war in order to cope with it¹⁰. In short: war is change, change is war!

He suggests the speed of global change has outpaced all our national and international institutions who have been unable to react and adapt fast enough to remain fit for purpose.

So what? Donnelly argues that leaders need to move the cursor towards the wartime position and away from the peacetime one in a rebalancing of their approach. He cites these 4 key factors to be addressed¹¹.

⁵ <http://thinkunthinkable.org/downloads/Thinking-The-Unthinkable-Report.pdf> accessed 25 Jun 16. See also: [Groupthink is depriving the West of vision | Chatham House](#) accessed 25 Jun 16.

⁶ Nik Gowing is former international news broadcaster at the BBC and ITN. He is now a Visiting Professor at King's College London. Chris Langdon is head of 'Reconciliation through Film', a non-profit start-up. He is the former managing director of the Oxford Research Group.

⁷ The nine reasons are: Group-think / wilful blindness; being overwhelmed by numerous pressures; cognitive overload and dissonance; institutional conformity; risk aversion; fear of making 'career-limiting' moves; reactionary mindsets; and, denial. These were presented on a supporting slide.

⁸ Chris Donnelly is a Director of the Institute for Statecraft and former Special Advisor to the Secretary General of NATO.

⁹ <https://www.chathamhouse.org/system/files/publications/twt/twt-2016-03-success-needs-military-mentality-donnelly.pdf> accessed 25 Jun 16.

¹⁰ The notion that war was characterised by rapid social, economic and technological change was articulated by Karl Marx.

¹¹ These 4 levers are: a changed balance from training (peacetime) towards education (wartime); from control (management) towards command (leadership); risk aversion, from 'error and trial' towards 'trial and error'; and, from efficiency (peacetime) towards effectiveness (wartime).

His conclusion, which seems sensible to me, is that we must be able to think and act very short term but – crucially – be guided by a clearly articulated, long-term vision and clear objective.

And he adds that in wartime – ie, periods of rapid change – institutions must operate differently from how they do in peacetime if they are to flourish. He advises to identify people who can do things best, whatever their age or rank, then listen to what they say.

Reactive innovators

Finally I want to touch on the work of Gijs van Wulfen¹² to highlight the reality of armed forces as reactive innovators.

Van Wulfen sees 2 types of innovators: those who want to, and those who need to. Reactive innovators, the second type, wait until they get hit by a crisis or disrupted by new technologies and must innovate to survive. But once the need to change is recognised there is usually a great urgency at the Operational level of the organisation to do so, even if there is often little time to act.

As military forces are wholly funded by the public purse, driven by the need to maintain a certain level of operational effectiveness, not profit, it is probably an appropriate reality that we are reactive innovators.

On that note let me conclude my remarks by making three points about what this means for UK air power and the Royal Air Force.

Conclusion

Implications for UK air power and the RAF

My first point addresses van Wulfen's 'need to' question. Up to the Second World War, the RAF offered high-level thought-leadership on air power's development. But during the Cold War our contribution stagnated when tactical excellence, not higher-level conceptual thought, became the dominant factor.

¹² Dutchman, Gijs van Wulfen is a leading commentator on innovation. For examples of his work see: [Home FORTH Innovation](#) accessed 25 Jun 16; and, [Innovation Excellence | Gijs van Wulfen](#) accessed 25 Jun 16.

Expeditionary warfare in the early 1990s briefly forced us to think again but circumstance again, almost imperceptibly, drove us to become very experienced in a very narrowly defined discipline of counter-insurgency and irregular warfare.

Now, new circumstances and new challenges require us to think again more broadly at the Operational and Strategic levels about every facet of our business.

My conclusion is that what has stood us in good stead up to this point is no longer enough and we are now at the point where we must innovate, and innovate well, again; our thought sabbatical is over.

My second point concerns a transition between epochs. I now see the period of the early 1990s differently. Beyond stealth technology and precision guided munitions, I now see that as one that marked the apogee of the post-industrial era and the birth of the information era.

At its heart is the battle for information. Military forces have always sought accurate and timely information so they can act decisively; however, in the new information era, it is the quantity, the methodologies and the rapidity that makes it so distinct and dominant.

Space and cyber powers' relationship to this information battle will see their prominence rise, whatever you perceive their impact on air power to be. For air power, our operations at or from the home base and those mounted away from it are blurring to the point where they hardly remain distinct at all; this is driven by information.

Thus I conclude that we have now reached the 'crossover point' where the natural decline of the post-industrial era is surpassed by the rise of the information era. Previously we couldn't see or feel it clearly; now we can and it means something.

As Darwin elucidated, it is not the fittest that survive but those who can adapt the quickest. I therefore assert that the success of the RAF over the next 100 years largely depends on how successful we are in our hard thinking today.

Which leads me to my third and final point - that 'hard thinking'. The RAF's *Thinking To Win* initiative is the tangible manifestation of that hard thinking. I've spoken several times on it over the last 6 months and so I'll just say a few words here.

At its heart, *Thinking To Win* is a cultural transformation programme designed to re-ignite the conceptual innovation of the RAF in order to make it fit for the next 100 years.

I view it as the most important 'fight' that we face today. We are going to think about the unthinkable and the unpalatable. We are going to give the organisation the wartime mentality that better reflects the uninterrupted war fighting activity it has been conducting within a peacetime construct since 1991. It has but a single goal: to make us better at defeating our enemies, violently when necessary.

A final thought. In 1895, Lord Kelvin, the President of the Royal Society - the man whose name adorns this room and whose painting looks down on us¹³ - said: 'Heavier-than-air flying machines are impossible'.

Eight years later, Orville Wight proved him wrong. In a few months' time, an aircraft powered only by the sun should complete its circumnavigation of the planet¹⁴.

Ladies and gentlemen, anything is possible.

Thank you. Enjoy Air Power Conference 2016.

¹³ Viewed from the stage, two paintings of Lord Kelvin are in the left-hand-corner of the Kelvin Lecture Theatre.

¹⁴ The Solar Impulse 2 completed its crossing of the Atlantic in mid-Jun and there remains just the Seville to Abu Dhabi overland legs to be completed.