INSIGHT

Brought to you by

AEROSPACE TECHNOLOGY INSTITUTE

Introduction

The Aerospace Technology Institute (ATI) aims to secure the full economic potential of the UK civil aerospace sector through strategic investment into differentiating technologies. To support this aim, the Institute has developed market and economic models to project the aerospace sector's future performance.

This paper makes use of the ATI's market and economic models. It estimates the expected potential impact of government investment and industrial strategy initiatives in the aerospace sector, upon future UK market share, value added, employment and wider economic impact, under two different market and competitiveness scenarios. The ATI Economic Model was developed with Fathom Consulting in 2016.

04

The Economics of Aerospace:

THE ECONOMIC IMPACT OF UK AEROSPACE INDUSTRIAL STRATEGY

EXECUTIVE SUMMARY

Government investment in aerospace is making a real difference.

Through the Aerospace Growth Partnership (AGP) and the Aerospace Technology Institute (ATI) investments are taking industry to the forefront of technology, raising supply chain competitiveness, securing future skills, bringing new inward investment and developing international trade opportunities. There are growing examples of how this industrial strategy is beginning to have an impact:

- Accelerated progress in maturing new products and manufacturing technologies
- Growing supply chain capability and competitiveness, leading to new business opportunities[1]
- Increasing levels of research and development (R&D) and establishment of new business capabilities in the UK by global aerospace companies[2]

The long-term government commitment to research and technology (R&T) funding through the ATI has been instrumental. Matched by industry to total £3.9bn between 2013 and 2026, this instils business confidence and crowds in higher private investment. It also leads to social returns that far exceed the commercial returns of the companies undertaking the research.

The ATI analysis summarised in this paper shows that sustaining current levels of support to aerospace industrial strategy could return around £114 billion to the UK economy over the next 20 years and create and secure an additional 95,000 jobs by 2035.

Without today's investments, the country and its aerospace businesses would quickly become uncompetitive. Globally mobile companies would favour investment in overseas capabilities where financial support is strong and consistent. Component suppliers would find their route to market compromised and struggle to develop the level of competitiveness required to compete in modern global supply chains. This would weaken the position of lower tier aerospace supply chain companies.

As the UK negotiates its exit from the European Union, Industrial Strategy must remain a steadfast part of the business environment to ensure business confidence and competitiveness.

Aerospace is a long-term industry. Breakthrough technologies can take decades to achieve market readiness, requiring sustained investment. Major aircraft developments are infrequent, raising the stakes. Suppliers must be ready to demonstrate mature technology and manufacturing capabilities, or they risk losing deals that can determine a decade or more of business.

Aircraft design is expected to shift dramatically to deliver continued efficiency improvements. This will represent a generational change in passenger aircraft, reliant upon design and manufacturing capabilities yet to be fully developed, in addition to maturing nascent technologies. Today's understanding of aircraft design was built over decades through the delivery of iconic projects.

New knowledge and capability will be needed to bring a new breed of aircraft to market. The trajectory and role of UK aerospace will ultimately be shaped by whether the UK's industry and its research base can take a lead in this respect.

Positioning UK aerospace to access opportunities in 2030 and beyond needs today's industrial strategy to go further in terms of support and ambition.

[1] *Examples include Boeing investing in a new UK supply chain site to manufacture wing actuation components (February 2017), Aeromet securing record-breaking orders with Boeing supply air-frame and aero-engine components (April 2017).*
[2] *Examples include Rolls-Royce announcing it will invest £150m in UK aerospace facilities, securing 7,000 UK jobs (June 2017), Dowty Propellers (General Electric), announcing plans to build a new UK headquarters and production facility (July 2017).*

THE ROLE OF INDUSTRIAL STRATEGY IN DRIVING SECTOR PERFORMANCE

In January 2017 the UK government published a Green Paper on Industrial Strategy[3] in which the aerospace sector was referenced as an example to follow. The analysis below illustrates the expected impact of existing commitments in aerospace industrial strategy.

Today, the Aerospace Growth Partnership (AGP) and the Department for Business, Energy and Industrial Strategy (BEIS) influence the course of the sector in several ways:

- **R&T funding:** primarily via the ATI (which now includes the National Aerospace Technology Exploitation Programme – NATEP) and the Industrial Strategy Challenge Fund (ISCF)[4].
- **Capital and infrastructure funding:** primary mechanisms include the ATI (R&D capital), Local Enterprise Partnerships, Devolved Administrations and the UK National Infrastructure Committee.
- **Supply chain competitiveness initiatives and funding:** primary mechanisms include Sharing in Growth (SIG - a comprehensive cross-sector competitiveness programme for high value manufacturing businesses) and SC21 (21st Century Supply Chains).
- **Targeted international trade and investment campaigns:** primarily led through the work of the Department for International Trade (DIT) and BEIS, developed with strategic support of the AGP
- **Skills development initiatives and funding:** graduate and apprentice support, particularly focused on science, technology, engineering and mathematics (STEM) subjects.

These areas all matter to improving the competitiveness of UK aerospace businesses, positioning them for future aircraft platforms and contracts, and growing the size and scope of the UK aerospace sector. The absence of well-functioning capital markets for risky long-term investments in technology, and the existence of technology and supply chain spillovers, create a market failure for R&T and need for government funding to crowd in private investment.

It is too soon to identify significant impacts from these investments. Most technology development supported by the ATI is targeted at exploitation opportunities expected around 2025. However, examples are already emerging of how industrial strategy and technology investment is benefiting UK aerospace:[5,6]

- Growing international reputation and attractiveness affecting long-term business planning and investment decisions - internationally-mobile aerospace companies are choosing to invest in UK capabilities over other global options
- Rising levels of R&D and accelerating progress in maturing major new manufacturing technologies
- Increasing competitiveness among suppliers engaged in capability and technology initiatives

As the UK negotiates its exit from the EU, there is now greater uncertainty surrounding business investments in the UK. Industrial strategy, and the mechanisms described, are important to maintaining a stable business environment and ensuring business confidence. But industrial strategy should not stop at this defensive mindset. As this paper shows, bolder action would be well worth the effort.

THE ATI's APPROACH TO MODELLING ECONOMIC IMPACT IN AEROSPACE

ATI's economic model and projection presented below considers UK civil and defence aerospace together. Historical and present public data, required to analyse economic relationships and create modelling assumptions, does not segment between civil and defence markets.

When projecting the economics of the aerospace sector, it is important to understand the dynamics of the industry. Aerospace is a long-term game. Aircraft are in service and production for several decades. For example, the Boeing 747 first entered service in 1970, and continues to be flown and produced today.

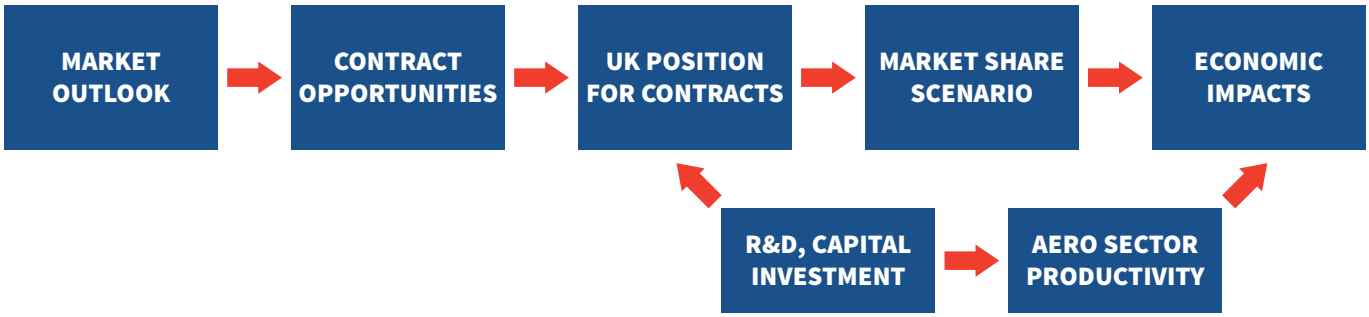
Aerospace technologies take many years to mature. Product development is a five- to ten-year process, and it can take 15 years before the results of research projects are applied in the market. New platform developments are becoming more infrequent too. Suppliers must be ready to demonstrate mature technology, or they risk losing deals that can decide a decade or more of business. It is a high stakes business.

Not all opportunities are like this though. In-service designs will receive periodic enhancements to systems to add performance and new functionality; components will be re-competed and dual-sourcing is an increasingly popular strategy taken by Original Equipment Manufacturers (OEMs) to mitigate risk and drive competitive pressure in their supply chains. These are also important opportunities for UK suppliers to take advantage of.

The dynamics of the aerospace industry call for a particular approach to modelling economic performance. Most economic models are based on long-run past relationships between key economic drivers. Working with Fathom Consulting, the ATI has developed an economic model of this nature, specifically for the UK aerospace sector. However, this can fail to represent the full impact of infrequent yet substantial events, such as the launch of new aircraft programmes. To understand the impact of these, the ATI built a market scenario model specifically for large civil aircraft. This reflects the dynamics and supply chain content of major platform developments, and allows comparison of alternative scenarios and outcomes. These two models allow the ATI to take a hybrid approach to projecting economic impact. Baseline projections for different scenarios are made using the ATI's economic model, and adjustments are then applied to reflect the major anticipated product events predicted by the ATI's market model.

[3] *HM Government (January 2017), Building our Industrial Strategy – Green Paper*
[4] *Still in development at time of publishing this paper, the ISCF is expected to support several cross-cutting R&T opportunities beneficial to multiple sectors including aerospace*
[5] *Examples include Boeing investing in a new UK supply chain site to manufacture wing actuation components (February 2017), Aeromet securing record-breaking orders with Boeing supply air-frame and aero-engine components (April 2017).*
[6] *Examples include Rolls-Royce announcing it will invest £150m in UK aerospace facilities, securing 7,000 UK jobs (June 2017), Dowty Propellers (General Electric), announcing plans to build a new UK headquarters and production facility (July 2017).*

Figure 1: Flow diagram showing the logic of the modelling approach



The key drivers considered in this modelling approach are:

- Factors driving market development – critical events anticipated
- High stakes game – Scale of new aircraft programmes and how this challenges the model
- The sector's interaction with the broader UK economy – spillover
- The UK economy interaction with the global macroeconomy

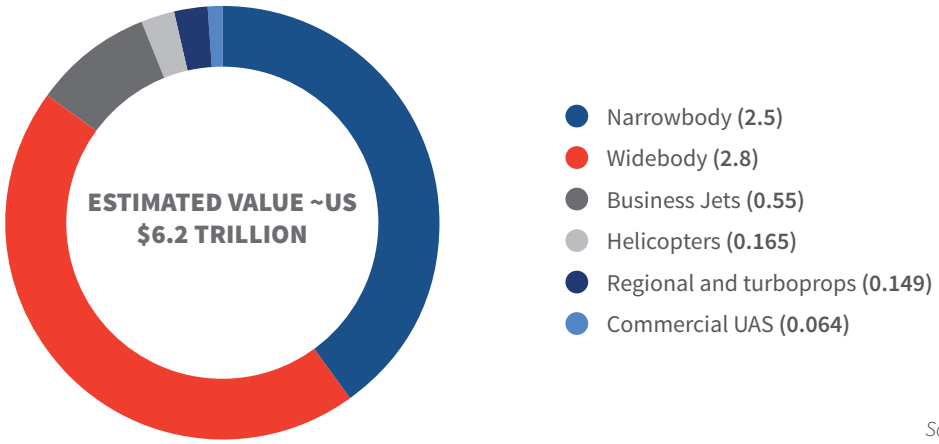
Two scenarios have been explored in this paper to project possible economic outcomes for the sector under different industrial strategy conditions. Assumptions are based on the ATI's understanding of success factors, existing UK capabilities and UK potential. These scenarios are described in detail in the next section of this paper.

GLOBAL AEROSPACE MARKET – FORECAST ASSUMPTIONS

Market outlook

Driven by strong economic growth in emerging markets, demand for air travel is on the rise. There are over 20,000 commercial aircraft and 15,000 business jets currently in operation globally, and this fleet size is expected to double over the next 20 years. Large aircraft (including wide and narrow bodies) is the largest segment, contributing to over 80% of the forecast deliveries, by value, between 2016 and 2035. Business jets, helicopters, and regional and turbo props are also sizeable segments. The through-life-support opportunities associated with the growing number of aircraft are estimated at over US$1.9 trillion.

Figure 2: Value of forecast deliveries (US$ trillions) 2016 - 2034



Source: ATI Market Analysis

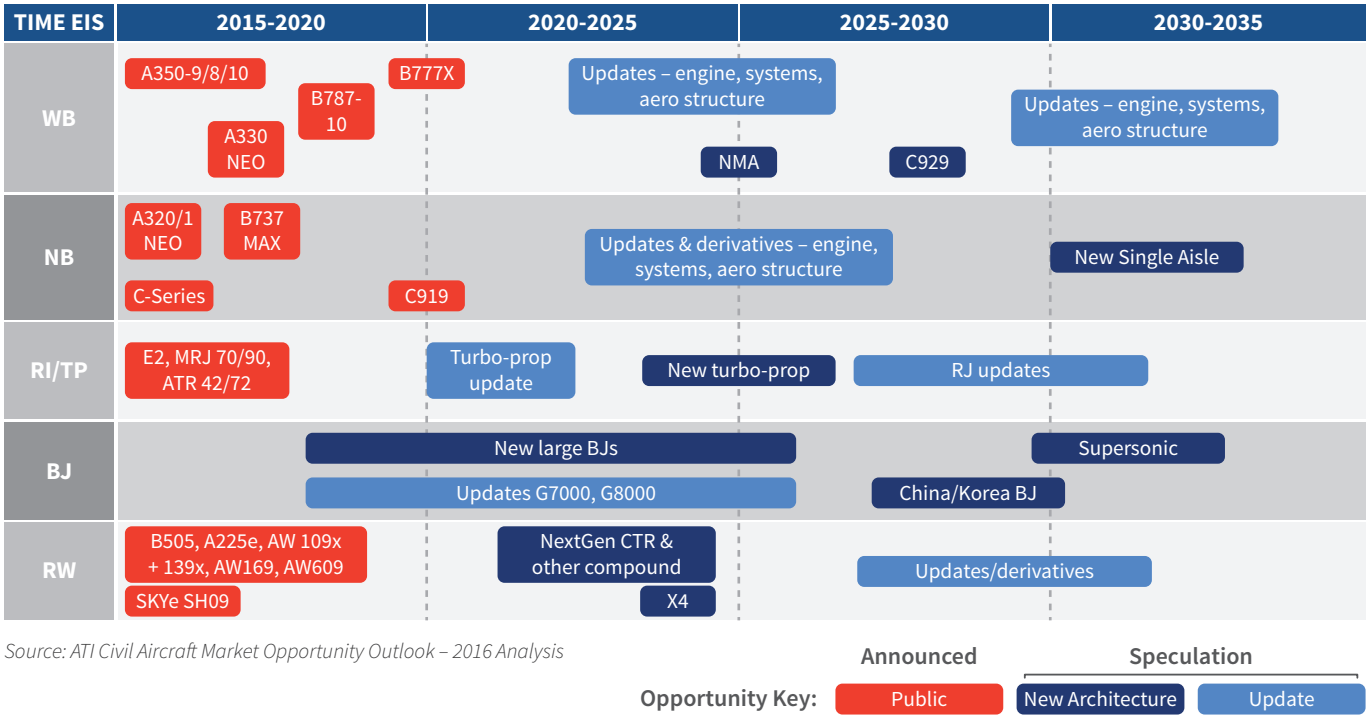
Platform opportunities by segment

The wide body market is exclusively served by Boeing and Airbus – and both have pursued ambitious aircraft investments over the past 15 years. Most design activity in the wide body market is in the 250 to 400 seat class. The ATI's analysis supports an opportunity for a medium-size (200-250), medium-range (3,000-3,500 Nm) aircraft to allow growth on routes operating narrow body aircraft, for entry-into-service in the mid-2020s. There has been much speculation around a Boeing development to compete with the Airbus 321 and 330 in this space. Other opportunities in the segment include the announced COMAC C929 (a collaboration between China and Russia), expected to enter service towards the end of the 2020s, and further opportunities for upgrades to current Airbus and Boeing wide body platforms.

In the fast growing, high-volume narrow body segment, the period through to 2025 will see continued incremental product updates and technology enhancements, like those on the A320 NEO and B737 MAX. However, the market dynamics between the aircraft manufacturers are such that more substantial investments in these products are likely within the next ten years providing new opportunities to the supply chain. The turbo-prop, regional aircraft, business jets and rotatory aircraft segments will continue to provide opportunities for the UK supply chain. Further insight on these opportunities can be found in the ATI's Market Opportunity Outlook Paper last refreshed in December 2016.

Beyond 2030 aircraft design is expected to shift dramatically to deliver continued efficiency improvements. This will represent a generational change in passenger aircraft, reliant upon design and manufacturing capabilities yet to be fully developed, in addition to maturing emerging technologies.

Figure 3: High-Level Future Platform Opportunity Roadmap 2015–2035



Source: ATI Civil Aircraft Market Opportunity Outlook – 2016 Analysis

Aerospace industrial strategy scenarios

The probability of UK suppliers securing business for each platform opportunity and supply activity is influenced by future capabilities, technology, competition and supply chain trends.

These factors will depend on industrial strategy - investments in technology, design and manufacture capabilities, capital, and supply chain competitiveness. A greater level of investment and ambition can enable the UK aerospace sector to address greater opportunities and increase the chance of success.

Two distinct industrial strategy scenarios have been considered in this paper:

- Maintaining direction: Future technology and market scope remains in line with today's activities, with improvements in core areas. This scenario is underpinned by current commitments to aerospace industrial strategy, including R&T investments already planned within the ATI programme and supply chain competitiveness programmes.
- Counterfactual: This would lead to an erosion of UK core capabilities (from sunk investments) and the loss of competitive position or increased offshoring in current areas of strength. The UK is then locked out by its international competitors from key long-term contracts for specific platforms. This scenario is based on there being no aerospace industrial strategy – i.e. stripping out the technology investments through the ATI and supply chain competitiveness programmes already in place. The purpose of the counterfactual is to gauge the economic difference that the current sector support is expected to achieve and therefore the return on government investment.

In addition to the economic advantages accruing directly to the aerospace sector, the spill over impact to the broader UK economy is also calculated. But what are the funding assumption associated with each of these scenarios?

- Counterfactual: This represents no direct government funding for Aerospace R&T since 2013, i.e. no ATI programme, to provide reference from which positive interventions can be valued.
- Maintaining direction: This is based on a continuation of existing support, this scenario assumes £150 million per year of government investment in R&T through the ATI to 2026[7], and sector competitiveness initiatives. This represents a falling UK aerospace R&T budget – both in real terms (i.e. inflation-adjusted) and as a share of the size of the aerospace sector (which will grow).

It is important to emphasise here that the maintaining direction scenario does not represent a ceiling for the sector. The level of support directed at aerospace is a long way off any kind of diminishing return – a look at peer nations is an indication of this, where R&D levels are multiples of that seen in the UK.

In a future paper, the ATI will consider the potential for raising the game on industrial strategy.

SCENARIO RESULTS

Expected impact on the UK aerospace sector

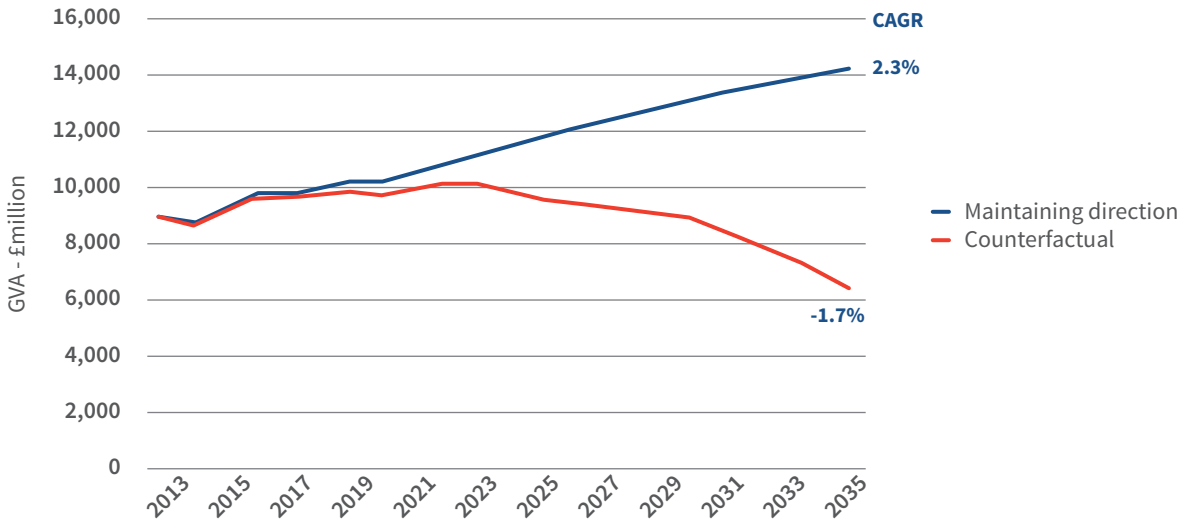
The market scenario described in the previous section shows the next major aircraft programmes entering service in the middle of the next decade, and then again in the early 2030s. These are potential game changer moments for the sector and drive notable inflections in the model. Aircraft system updates and re-competing of component level content for in-service aircraft will provide regular opportunities for the UK aerospace supply chain and is a basis for sustained market capture over the projection period.

By **maintaining direction**, UK aerospace value added is projected to grow by over 2.3% per year in real terms. This takes UK aerospace direct value added to just over £14 billion in 2035, compared to a current value of approximately £9 billion (Figure 4). Based on a 2.5% average inflation rate, this corresponds to a nominal growth rate of 4.8%, just above global aerospace market forecasts, growing UK global market share (of gross value added – GVA) from a current position around 12%, to approximately 13.5%.

This contrasts against the **counterfactual** scenario, where UK aerospace gross value added is projected to decline from £9 billion in 2015 to around £6.5 billion in 2035, despite a growing market. UK market share in this scenario is expected to halve from a current level of 12% to 6% by 2035.

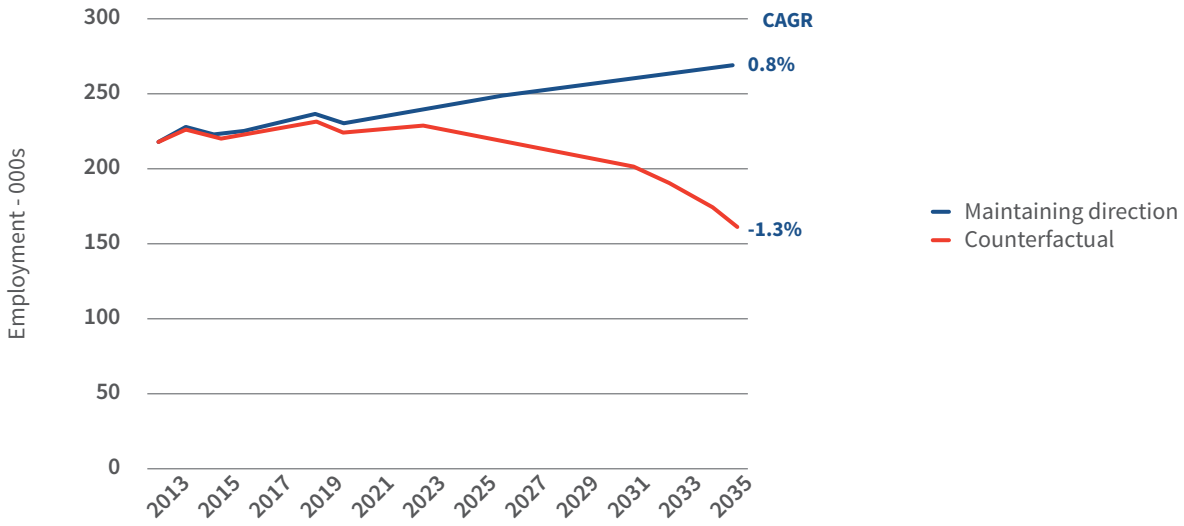
Currently, the UK aerospace sector directly employs around 112,500 people – and each direct job in the aerospace industry creates at least one additional job within the aerospace supply chain. This gives around 225,000 people directly and indirectly employed by the aerospace sector. These are high-value design and high value manufacturing jobs.

Figure 4: ATI Future Scenarios – UK Civil and Defence Aerospace[8] – Real GVA (£m)



Source: ATI Economic and Market Model Analysis

Figure 5: ATI Future Scenarios – UK Civil and Defence Aerospace – Total Jobs



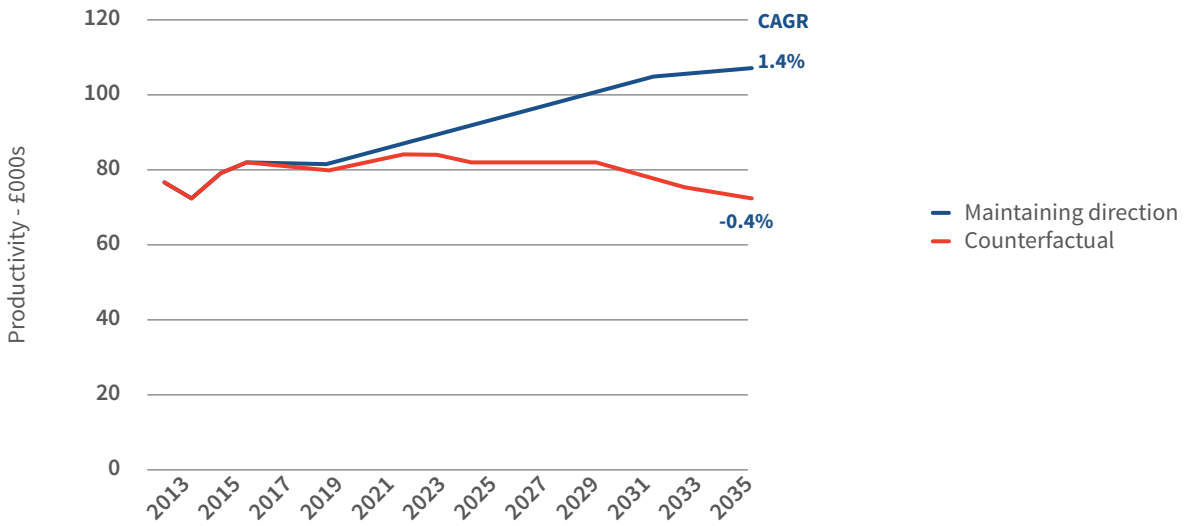
Source: ATI Economic and Market Model Analysis

The majority of the changes in gross value added – around 60% – is expected to come from productivity improvements, realised through increased investment in capital and R&D, rather than increases in sector employment. In the **maintaining direction** scenario aerospace productivity is expected to grow by just over 1.4% per year, in real terms – resulting in an almost 40% increase in sector productivity over the next 20 years. This means that growth in employment trails growth in value added.

[7] *Government's current commitment in ATI R&D runs to March 2026 at a constant £150m per year*
[8] *Note: the chart data is for both civil and defence aerospace, as the majority public data does not segment between them*

In contrast, however, productivity in the **counterfactual** scenario is expected to decline slightly year-on-year, due to a relative lack of investment and declining competitiveness.

Figure 6: ATI Future Scenarios – UK Civil and Defence Aerospace – Productivity (£000s)



Source: ATI Economic and Market Model Analysis

Productivity improvements are vital to UK global competitiveness, to reduce manufacturing cost and achieve ambitious production rates for new aircraft. This will lead to a shift in skills mix. Automation and digital manufacturing technologies, and the skills needed to operate in these environments, will become increasingly important to the aerospace sector.

Nonetheless, UK aerospace sector and supply chain employment is expected to increase from its current level of around 225,000 for the **maintaining direction** scenario. By **maintaining direction**, aerospace employment is expected to reach nearly 270,000 in 2035 – resulting in significant job creation of the order of up to 45,000 positions. In contrast, in the **counterfactual** scenario, it is estimated that nearly 50,000 UK aerospace and supply chain jobs would be lost between 2015 and 2035, as UK employment declines from 225,000 to 175,000. Overall, the difference in employment between the **maintaining direction** scenario and the **counterfactual** is around 95,000 people by 2035.

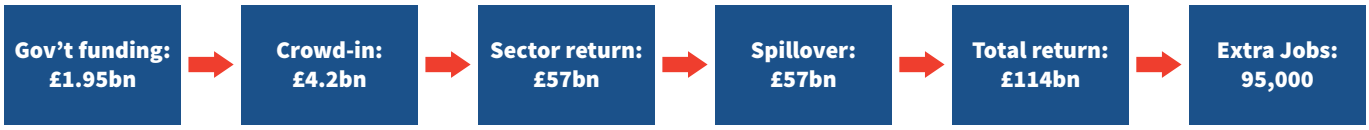
Expected impact upon the wider UK economy

Investment in aerospace research and technology leads to wider impacts beyond the sector. Every £100 million spent on R&T by the government crowds-in around £300 million of additional private sector investment. Furthermore, every £100 million invested benefits not only UK aerospace GVA by £20 million per year, but also the wider economy by £60 million per year through technology spillovers. These include automotive, marine, oil and gas, nuclear, electronics, composites, metals and other UK industrial sectors.

In total, the return on government investment for **maintaining direction** is an additional £57 billion of gross value added for the UK aerospace sector and a further £57 billion to the wider UK economy between 2015 and 2035. For an initial government outlay of £1.95 billion between 2013/4 and 2025/6, there are few better Government investments that provide this sort of return.

Most of these returns are realised by firms beyond those undertaking the original investment (technology spillover) – whether within or beyond the aerospace sector. There are also significant risks attached to these early stage investments. Government funding is therefore essential to reducing these risks and raising levels of R&D investment so that these spillover benefits can be realised.

Figure 7: Maintaining direction scenario – Expected Return on Government Funding – Cumulative to 2035



[3]*HM Government (January 2017), Building our Industrial Strategy – Green Paper*
[4]*Still in development at time of publishing this paper, the ISCF is expected to support several cross-cutting R&T opportunities beneficial to multiple sectors including aerospace*
[5]*Examples include Boeing investing in a new UK supply chain site to manufacture wing actuation components (February 2017), Aeromet securing record-breaking orders with Boeing supply air-frame and aero-engine components (April 2017).*
[6]*Examples include Rolls-Royce announcing it will invest £150m in UK aerospace facilities, securing 7,000 UK jobs (June 2017), Dowty Propellers (General Electric), announcing plans to build a new UK headquarters and production facility (July 2017).*

Could more be achieved?

For certain – but this would rely on another level of ambition and investment. Based on current measures, this paper forecasts UK aerospace sustaining a global market share in the region of 13% by 2035, a slight improvement on today. In a growing market, with growing competition, this is some achievement. But track back 15 years and this was closer to 17%. If the sector could return to these levels, that would represent around an additional £70 billion to the UK economy over the next 20 years.

Reaching those levels would require the sector to exert greater leadership in the development of future aerospace products and services – including new markets and disruptive enterprises - built on world-class design capabilities and industrial competitiveness. Today's understanding of aircraft design was built over decades through the delivery of iconic projects. New knowledge and capability will be needed to bring a new breed of aircraft to market. The trajectory and role of UK aerospace will ultimately be shaped by whether the UK's industry and the research base can take a lead in this respect.

However, the UK's High Value Design capabilities are at risk of falling behind as the digital revolution continues to unfold. The same applies to industrial capabilities, where digitally-enabled manufacturing technologies and supply chains will re-write the rules of manufacturing complex products. An absence of mid-cap companies remains a structural issue in the UK's industrial landscape. The UK's large and diverse landscape of SMEs presents an opportunity to regrow this band of innovative organisations, but will rely on targeted support. Civil and Defence aerospace share many of the same capability needs and challenges.

Positioning UK aerospace for opportunities in 2030 and beyond needs today's industrial strategy to go further in terms of support and ambition. This will depend upon investment from Government and improved coordination between different elements of industrial intervention and the UK landscape.

CONCLUSIONS

The scenario modelling conducted within this paper has highlighted the major platform opportunities that exist for UK aerospace over the next 20 years. It has shown how government investment in research and technology is already making a difference in helping UK aerospace companies position themselves to address these opportunities by improving the performance and competitiveness of their products.

As a result of Government investment in research and technology of £1.95 billion between 2013/4 and 2025/6 through the Aerospace Technology Institute, and in supply chain competitiveness and skills initiatives, the UK is strengthening its position in the global market. This is expected to boost real gross value added to the aerospace sector by over 50% between 2015 and 2035 and generate around 95,000 extra high-value UK jobs in the aerospace sector and its supply chain, as illustrated in the **maintaining direction** scenario in this paper.

The future could be even brighter. Through further investment in technology, high-value-design skills, capabilities and infrastructure, and expansion of supply chain competitiveness initiatives, the UK could gain additional market share, bringing long-lasting benefits to the whole UK economy. This analysis stresses the importance of a targeted and effective industrial strategy for UK aerospace. The alternative leads to a very different future: one from which industry would find it virtually impossible to recover.

The decision to leave the EU adds uncertainty to the business environment. Sectors such as aerospace, which is built on international collaboration, are vulnerable. Now is the time to ratchet up our ambitions and build on today's foundations. There are few other ways of instilling business confidence than committing to support technology and capability development for the long term, specifically in:

- Research and technology
- High value design and manufacturing capability – skills, digital tools and processes, and physical infrastructure – that positions the sector for future aircraft design and production challenges.
- Supply chain competitiveness and growth
- International engagement on trade and inward investment
- Skills development, focused on the demands of a more productive and digitally enabled workplace

DISCLAIMER

Contact us

For further information on digital transformation in the aerospace sector please contact **info@ati.org.uk**