

Typhoon

Delivering Military and
Economic Advantage

Prosperity Report Executive Summary



Introduction

Eurofighter Typhoon is Europe's largest defence collaborative programme bringing together government and industry from Germany, Italy, Spain and the United Kingdom. It is a highly successful programme delivering world leading capability to the UK and its allies, with unparalleled reliability and proven interoperability.

In the UK, BAE Systems leads the overall design, development, production and support to the Royal Air Force fleet, with Leonardo UK leading on development of Typhoon's radar and defensive aid sub-systems.

This report quantifies the economic impact of the programme to the United Kingdom's economy over a five-year period between 2018-2022.

*Quantitative impact estimates of GDP, jobs, and exports presented in this document are produced by Oxford Economics, unless specified otherwise.

- 1 Introduction
- 2 Typhoon's Impact on the UK Economy
- 3 Foreword
- 4 Sustaining and Developing National Sovereign Skills
- 5 Export Success
- 7 Powered by People
- 9 Regional Impact of Typhoon Programme
- 10 Levelling Up
- 11 Delivering the Next Generation Radar for Typhoon
- 13 Powered by People
- 15 Spill Over Benefit
- 17 Supporting Our Customer's Net Zero Ambitions
- 18 A Bridge to Future Capability

Typhoon's Impact on the UK Economy

Typhoon delivers significant economic impact for the UK

£1.6bn GDP Contribution

20,800 Jobs

£1.4bn UK Exports

£1.9 total GDP contribution for every £1 spent

3 total jobs supported for every direct job



Industrial impact of Typhoon supply chain in the UK (based on 2020 procurement data) [Source: BAE Systems]

Foreword

The Combat Air industry sits at the heart of the UK aerospace sector and stretches across the four nations of the UK. It has a proven track record of delivering substantial benefit to the economy; boosting innovation, high value skills and promoting exports.

The Typhoon programme continues to be a hugely successful programme and the best example of the UK's world-leading combat air capability. As a proven combat aircraft, it is a highly sophisticated and advanced 'multi-role' aircraft flown by the Royal Air Force and our allies across Europe and the Middle East. Today it continues to underpin European air defence, providing crucial NATO policing in Eastern Europe as part of the allied response to the invasion of Ukraine.

BAE Systems leads the overall design, development, manufacture, upgrade and support for Typhoon aircraft operated by the Royal Air Force and its allies. When we see one of the aircraft take to the skies we know it's the collective

Drawing on a heritage that stretches back to the Vulcan, the scientists and engineers at our Luton and Edinburgh sites take a huge amount of pride in providing the defence electronics for the RAF Typhoon.

Typhoon is an incredible capability and, with upcoming advances such as the ECRS Mk2, the powerful electronically scanned array radar, will continue to be the mainstay of the UK's combat air fleet for years to come. In addition to the leading edge capability, this report describes that it's not just an impressive aircraft, but also a great economic investment for the UK and an export success story.

achievement of thousands of people across the country, built on a dynamic supply chain led by BAE Systems, Leonardo UK, Rolls-Royce and MBDA working with thousands of small and innovative suppliers across the country.

The link between military advantage and national economic prosperity cannot be overestimated. As this report shows, this contribution of the Typhoon programme to the UK is significant, supporting high-value jobs and driving advanced manufacturing and technology development. The programme supports 20,000 high value jobs covering manufacturing, engineering, integration, logistics and maintenance. As a highly successful UK export, Typhoon contributed £1.4bn to the UK economy in 2020, representing significant return on investment to the UK.

From our manufacturing and integration base in the north of England, the impact of the programme reaches right across the United Kingdom, driving

As we head towards Future Force 2040, we will continue to employ the skills and infrastructure we've developed onshore as we further increase Typhoon capability and move forward into projects such as Tempest, the UK's future sixth generation combat air fighter. As well as building next-generation capabilities, this will continue to create and sustain high-value jobs around the Union.

Investment in defence technologies is an investment in the research base and the skills needed to create a vibrant and advanced engineering sector. Britain's combat air industry is, globally, one of the

prosperity across the nation and supporting the critical 'levelling up' agenda. Planned enhancements designed to extend Typhoon's operational effectiveness well into the middle of the next decade, will stimulate further skills development and will see Typhoon playing an important role in the development of next generation capabilities.

We're proud of the role we play in delivering sovereign combat air capability, as a critical national asset and the broad benefit it delivers back to the United Kingdom.

Andrea Thompson
Managing Director
Europe & International
BAE Systems



best in its class which equips the UK to play a leading role in the international environment. Continued investment will ensure that this remains the case for generations to come.

Mark Hamilton
Managing Director
Electronics UK
Leonardo



Sustaining and Developing National Sovereign Skills

Typhoon strengthens national security and economic prosperity through high value jobs and lifelong learning.

The Typhoon programme has sustained and developed the **critical skills** needed to support the defence and aerospace sector in the UK for the last 20 years.

As Typhoon continues to advance, new technologies will be introduced, sustaining the skills and know-how which are a key part in ensuring there is a smooth transition into Tempest.

Aerodynamics and structures training is now more computer based which means we need to **recruit and train people with a wider digital skillset than ever before**



Modelling has shifted from being paper-based and using static tooling, to using computer simulation so that our people **can test and evaluate their work in real conditions** and bring their designs to life



We have introduced **virtual reality** training into our apprenticeship schemes to allow apprentices to learn faster, reduce risk and boost interaction. Students can experience working on different areas of the Typhoon aircraft from the classroom including parts location and identification, cockpit awareness, assembly and spray painting



Students get to experience **mission planning** as part of their placements to understand how this fits into Typhoon as well as gaining a better understanding of the digital planning and data exploitation tools which will be critical to our future business



Our schemes also introduce apprentices to **robotics, automation, and carbon fibre skills**, all processes which support the production and support of the Typhoon platform



Diagnostic and technical skills are required to support the aircraft and provide **high levels of reliability** for our customers



BAE Systems also created two new Engineering Degree Apprenticeship Schemes (EDAS) in 2015 to reflect the changing needs of the business and which incorporate many of the above areas

EDAS Software	141	starters to date
EDAS Aerospace	179	starters to date



Export Success

Typhoon is key to national security, achieving global influence and supporting relations with key allies

Typhoon is proven successful in the export market. Export sales has seen the UK's investment of £12bn more than double the return to the UK economy, with the potential of more to come.

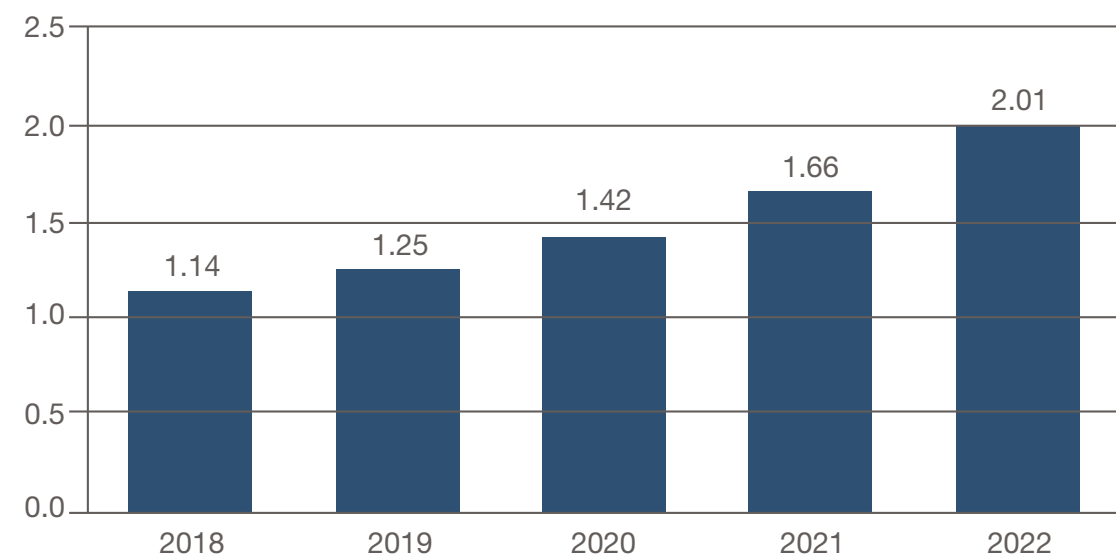
Typhoon further contributes to the UK's economic prosperity by exporting goods and services overseas.

The programme's exports consistently increased over 2018—2022 from £1.1bn to £2.0bn, strengthening international partnerships.

It also contributed more than £980m to the UK's trade balance, the value of its net exports, in 2020.

Exports from the Typhoon programme, 2018—2022

£bn, 2020 prices



Source: Oxford Economics analysis of BAE Systems and Leonardo UK data

Exports increased by over 75% in the last 5 years

£1bn contributed to UK net exports in 2020



BAE Systems and the Government of the State of Qatar have entered into a £5bn contract for the supply of Typhoon and Hawk aircraft to the Qatar Emiri Air Force along with a bespoke support and training package. The contract will provide 24 Typhoon aircraft with first deliveries commencing in Q3 2022.

Image: BAE Systems personnel working alongside their RAF colleagues supporting Typhoon at RAF Coningsby.



Powered by People

Typhoon is developing a new generation of talent

“I chose computing just to fill my Scottish Highers schedule – now I’m coding software for the world’s most capable combat air radar.”

Sarah Small didn’t always know that she was going to be working on Typhoon. In 2013, when she had to choose her Scottish Highers subjects, the future software engineer picked computing out of curiosity rather than as part of a grand career plan. “I had a free slot, I thought I’d just pick it up” she says. But that decision set the course for her career to-date. “It turned out to be something I really enjoyed. I found it was a way to solve problems and think in a different way. I started with making little apps and games. It’s what got me interested in engineering.”

Having earned a first class degree in Computer Science at the University of Dundee, Sarah was inspired by the opportunities presented by a career in combat air. “Leonardo UK was interesting, particularly because of Typhoon and Tempest. It felt like a good area to be in terms of technology with the potential to get involved in machine learning, AI, it’s really up and coming.” Like many of her generation, Sarah was also keen to choose a job with purpose: “The defence industry can make a big difference, a big impact”.

Today, Sarah works as a graduate software engineer at Leonardo UK’s site in Edinburgh, one of around 2,000 highly-skilled people developing defence electronics such as radar, lasers and integrated sensing. She is a key member of the team developing the control software for the RAF Typhoon’s next generation radar system.

It is proving to be a satisfying role. “One of the things I find interesting about the project I’m working on is that we’re trying new things. For example, our team is developing using component-based architecture, so you can reuse useful chunks of code. It makes development a lot quicker and a lot more flexible. There’s loads of interesting stuff going on”.

So what’s next for Sarah? She’s keen to stay involved in the cutting-edge world of combat air, and in software. “I’ve recently been given the opportunity to go and have a secondment on another team for a couple of weeks, to explore and see what’s out there. But I’d like to continue in software, I think it’s really interesting. I think in the future I’d like to look at data analytics and AI, which are definitely going to be part of the UK’s of future combat air systems like Tempest”.

Sarah Small
Leonardo UK



“Being an integrated part of a team at an RAF base has enabled me to see the results of my work first hand and my favourite part of it has been watching the aircraft take off, knowing that I’ve helped get it into the sky.”

“As part of my apprenticeship, I’ve been working with the Royal Air Force to support the Typhoon fleet from RAF Coningsby. This includes Contract Delivery, Resourcing and Project Control, where I’ve had the chance to experience all of the work that goes on behind the scenes to support the customer.

“I’ve really enjoyed Project Control where I was responsible for ensuring that any aircraft servicing and repairs were completed on time and within budget which plays a vital part in keeping the aircraft flying.

Working with so many different stakeholders on the programme has also allowed me to build good communication skills and boosted my confidence and I am really looking forward to working closely with the customer in the future.”

Maddie Jeffrey
BAE Systems



Regional Impact of Typhoon Programme

Typhoon delivers substantial benefit to regional economies, boosting productivity, innovation and safeguarding high value skills

North West

The North West of England is the engineering centre of excellence which powers the Typhoon programme.

BAE Systems directly employs 4,800 workers in the North West, supporting a significant number of jobs in key regions of the UK.

The company's sites in Warton, Samlesbury, Lancashire, provide unique sovereign capabilities for fast jet test and development, including secure aerodrome and wind tunnel testing facilities, advanced manufacturing and final assembly.

Employee wage spending contributed £210m to the region's GDP with just under half of the 3,940 jobs supported by wage spending nationally being based in the North West.

East England

An industry team led by BAE Systems and supported by Leonardo UK avionics specialists forms part of the Whole Force team supporting the Royal Air Force's frontline Typhoon fleet in the East Midlands. It directly employs 670 people at RAF Coningsby, supporting the RAF Typhoon fleet ensuring aircraft are available to respond on Quick Reaction Alert securing the skies over the UK and on operations, as well as providing synthetic training ensuring Typhoon pilots have the skills they require.

Stevenage in Hertfordshire is the site of MBDA UK's head office, as well as many engineering aspects of the missiles and missiles systems that the company manufactures. A large majority of the people employed by MBDA in the UK are based at the site, all playing a role in providing decisive military capabilities, with more than half of them working on Combat Air programmes including many highly-skilled engineering roles.

South West England

At Rolls-Royce Defence headquarters in Bristol, there are around 3,000 people, working across a range of military programmes, including Typhoon and Tempest.

Rolls-Royce plays a vital role in delivering the power and propulsion for the Eurofighter via the EJ200 - a collaborative engine that combines the expertise of Europe's aerospace industry, made up of Rolls-Royce, MTU, AvioAero and ITP under the EUROJET consortium. Across Rolls-Royce, up to 500 direct jobs are associated with work across the Typhoon programme with a further 2,500 jobs amongst 55 suppliers located predominantly in the Midlands, North East and Southwest of England.

Scotland

At RAF Lossiemouth, Moray, north-east Scotland, BAE Systems employs around 40 people providing availability support to the RAF Typhoon fleet which protects the UK's northern airspace alongside military colleagues.

Edinburgh

The single most important sensor on Typhoon is its radar and Leonardo UK in Edinburgh designs and manufactures some of the most advanced in the world. Originally set up in the 1940s to support the war effort, the site now exports radars to dozens of countries including the United States and also controls over 60% of the international market for high energy military lasers. Leonardo UK's scientists and engineers in Edinburgh are currently developing the cutting-edge ECRS Mk2 radar for the RAF Typhoon.

RAF Lossiemouth

One of two RAF Quick Reaction Alert (QRA) stations, RAF Lossiemouth protects the UK's northern airspace. Field Service representatives from Leonardo UK and BAE Systems work alongside their RAF counterparts to ensure Typhoon is ready to scramble into action at a moment's notice.

Supporting significant jobs

Scotland
1,410 Jobs

East England
1,490 Jobs

North West
9,280 Jobs

South West
1,590 Jobs

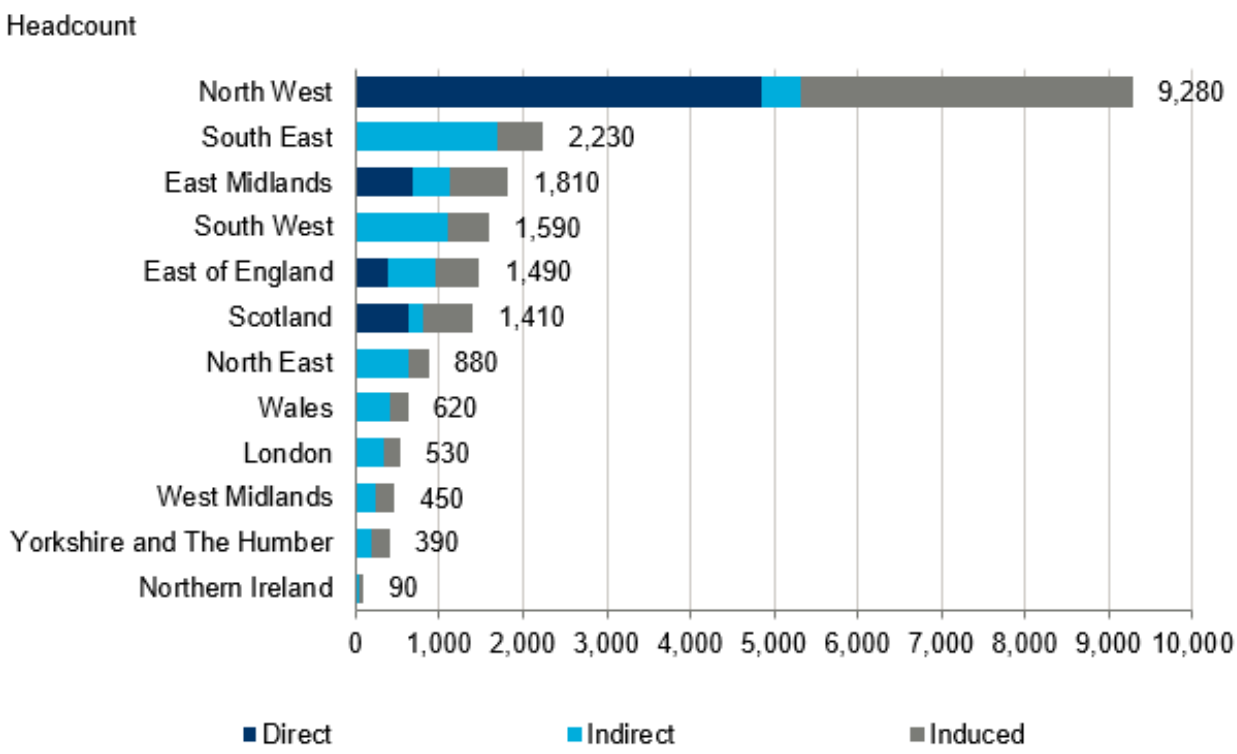
East of England related to the East of England and East Midlands regions

Levelling Up

Typhoon's footprint stretches across all areas of the UK, with a proven track record of delivering substantial economic benefit where it's needed most

The Typhoon programme spreads opportunity around the UK, helping to level up regions that desperately need this economic activity. Typhoon accounts directly for 6,500 workers at BAE Systems and Leonardo UK located in the North West, Scotland, the East Midlands and the East of England and more than half of employment supported by Typhoon's supply chain spending reached around the Union: The North East, the East of England, the North West, the East Midlands and Wales each benefitted from having more than 400 workers indirectly employed through Typhoon. As with employment, over half of Typhoon's supply-chain GDP impact accrued to regions outside of the South East, with £50m of indirect GDP impact in the North of England.

Figure 2. Total number of workers in the UK supported by the Typhoon programme, by region, 2020



Source: Oxford Economics analysis of BAE Systems and Leonardo UK data

Delivering the Next Generation Radar for Typhoon

Typhoon's new radar keeps the UK at the top of the defence electronics premier league

The ECRS (European Common Radar System) Mk2 is the new radar for Typhoon. Expected to be the world's most capable fighter radar when it goes into service later this decade, the ECRS Mk2 will give pilots an incredible boost in combat capabilities and survivability.

It will equip RAF pilots with the ability to locate, identify and suppress enemy air defences using high-powered jamming. They can engage targets whilst beyond the reach of threats - even when they're looking in another direction - and operate inside the range of opposing air defences, remaining fully protected throughout. This game-changing capability will ensure the UK retains the freedom to deliver air power wherever and whenever it is needed.

Behind this effort are some of the UK's brightest engineering minds. The programme is creating interesting and productive work for firmware, hardware, software, systems and microwave engineers at Leonardo UK in Edinburgh and Luton, where the radar is being developed, and BAE Systems in Warton, where the radar is being integrated onto the aircraft.

As well as maintaining and developing skills, the project is providing an opportunity for the firms to innovate operationally and create new processes, as well as further enhancing the state-of-the-art manufacturing facilities at both companies.

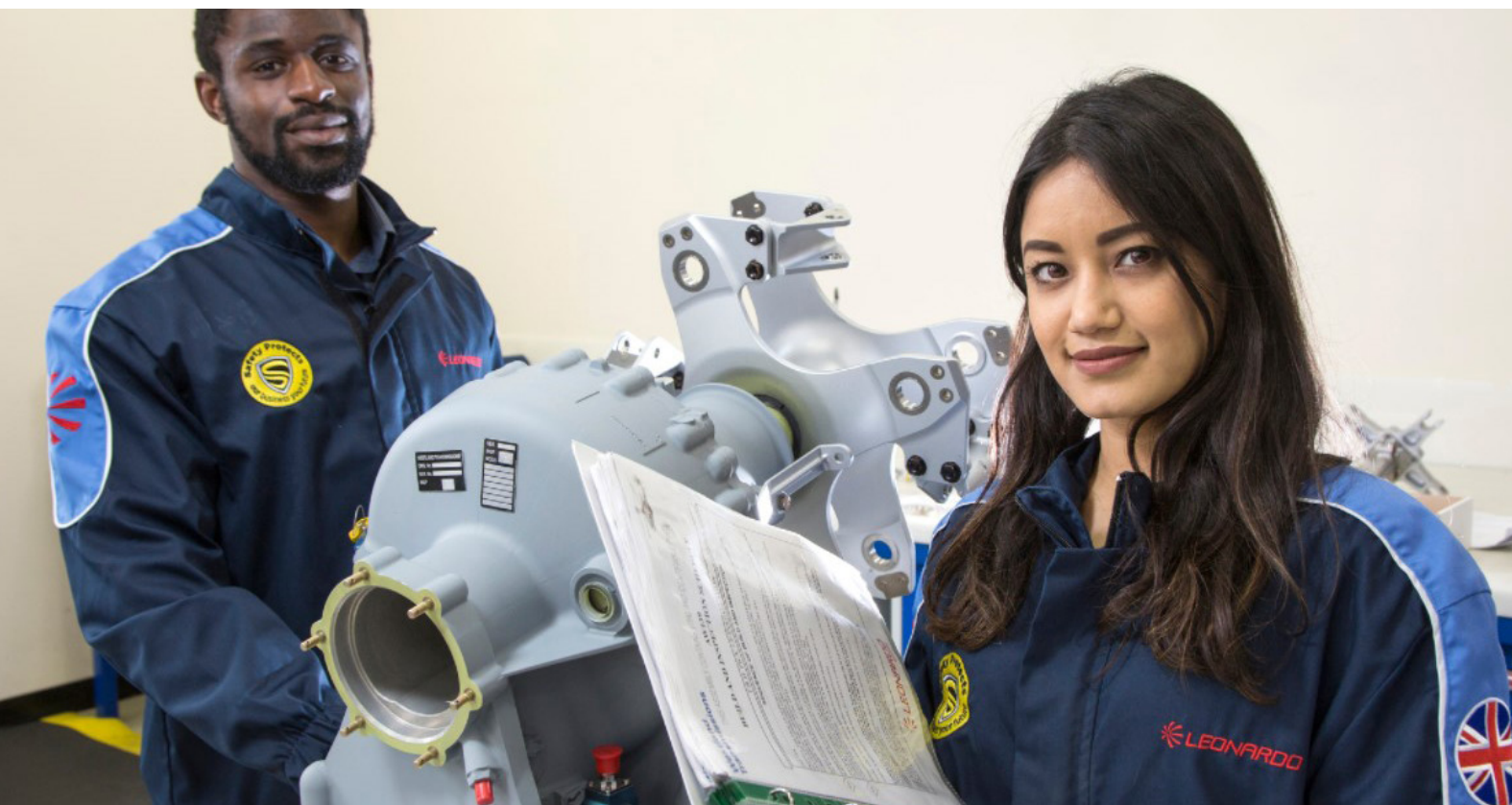
Indeed, having invested for years in specialist skills and infrastructure, the UK can confidently claim to be top of the premier league when it comes to radar and electronic warfare development. The upshot of this is that the new radar, more properly described by the technical experts as a multi-functional Radar System, includes a number of advanced features that the UK will be first to bring to the global market. These include integrated electronic warfare and wideband electronic attack, in addition to traditional radar functions.



To develop these digitally-driven new capabilities, Leonardo UK is drawing on niche skill sets including modellers, architectural engineers and mathematicians as the ECRS Mk2 product takes shape. Of course by employing these skills today, the UK is maintaining them for the future.

Having this knowledge and capability onshore is not just a badge of national pride. It brings a number of tangible benefits for the UK customer over and above the significant national economic benefits. Keeping these skills available means that the UK Armed Forces are able to tailor the capability that is being developed to their specific needs, rather than taking something that was designed for a different nation's military, and will maintain this influence over any future upgrades. It means that they're at the front of the queue for any urgent changes which might be found to be required when the radar goes into service on real operations. Taking a big picture view, having these skills onshore preserves UK sovereignty over its freedom to take military action.

There's a collaborative benefit too, as a confident, international UK looks outwardly to work in partnership with its allies. Here, having the ability to develop world-leading technology onshore gives the UK something to bring to the table when major international programmes are coming together. It enables the country to assume a seat at the top table rather than being a customer. A perfect example is the Tempest programme, a grand international endeavour which the UK is able to lead only because of its established skills, knowledge and capability in the combat air field.



Powered by People

Typhoon is developing a new generation of talent

“Growing up around military airfields, and family visits to air museums, there were often aircraft overhead. So it’s not surprising I ended up working with aircraft after earning a first-class degree in Aerospace Systems Engineering!”

“I began working on Typhoon soon after I graduated. Helping develop its weapons capability with the Eurofighter consortium and the UK Ministry of Defence and RAF. Whether it’s helping ensure existing capabilities still meet the needs of air forces, or helping develop future weapons systems that will keep the aircraft on the cutting edge, I’ve continued to work on Typhoon throughout my career so far. That path has given me a wealth of interesting experiences that I wouldn’t have dreamed of doing when I was younger.

“I’ve planned and witnessed flight trials, worked with various international air forces and travelled around Europe to do this. There are always new challenges, but working with the great teams across the enterprise, I see we are all committed to ensuring Typhoon always delivers. I look forward to seeing what the future holds as Typhoon evolves, and with it, its role in the future of combat air.”

Ben Butters
MBDA



“I started off my career at Rolls-Royce, as a graduate working across the EJ200 programme, the engine that helps to power the Typhoon aircraft. During my placement, which I held for 6 months, I attended to the product safety and quality of the propulsion system to the aircraft by identifying fleet safety concerns and implementing reactive solutions to keep the Typhoon fleet flying.”

“This placement provided me with the skills, capability and enthusiasm to venture into Future Programmes, the part of the business that develops technologies for upcoming programmes like Tempest and the Future Combat Air Strategy.

“This has provided me with the transferable skills such as technical leadership, problem resolution, programme management, stakeholder engagement and systems thinking.

“The knowledge and skill base I developed during my time working on the Typhoon programme helped enormously in allowing me to understand our existing processes, engineering and manufacturing techniques on proven and experience concepts such as this and how we can apply that learning in order to advance our future capabilities.”

Graeme Sutcliffe
FCAS System Design Integrator &
Scrum Master, Future Programmes
Rolls-Royce



Spill Over Benefit

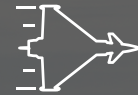
Advanced technologies developed on Typhoon have driven innovation across the aerospace industry and beyond

The Typhoon programme has contributed to research and development in the UK of advanced technologies that have delivered benefit to the aerospace industry and beyond.

Expertise created and perfected on the Typhoon programme has allowed BAE Systems to develop the skills required and sustain the roles required to secure further work for the company and in some instances resulted in technology spinning-out for the benefit of wider industry. This is evident across a range of areas including carbon fibre, heads up displays, sensor fusion and computational fluid dynamics modelling.

Manufacturing Technologies

Significant investment was made in manufacturing technologies as a result of the Typhoon programme including the advancement of carbon fibre composite (CFC) technology to the exacting operational standards required of a fast jet combat aircraft in the most hostile of environments.



Carbon fibre composites in highly loaded environments helped mature a supply chain in the UK that has enabled it to support the use of composites in civil aircraft manufacture.

Work was secured on programmes including the Airbus A320 and the technology has been adopted more widely in the use of road going cars and race cars.



Enhancing the Supply Chain

The Typhoon supply chain benefitted from enhancements in precision manufacturing driven by the demanding tolerances required from the Typhoon programme.



The need to work within a digital environment on highly complex structural items with an extensive footprint in the supply chain in the UK allowed companies to invest in capability that positioned them well to secure work out of the aerospace civil sector and also drove diversification with mixed portfolios into automotive, bio-medical and beyond including Formula 1.

BAE Systems continues to collaborate with many adjacent industry leaders including Williams Advanced Engineering and McLaren.



Supporting Our Customer's Net Zero Ambitions

The Typhoon programme is using synthetic technologies to shape the future of RAF training

BAE Systems' engineers will provide high-fidelity simulators which will allow Typhoon pilots of the future to develop their skills to secure our skies for decades to come.

The synthetic environment we are developing will allow RAF pilots to train together on Typhoon and become the first plug in to Gladiator, a single synthetic environment which will be the digital backbone across air, land, sea and space.

The Future

The RAF Typhoon Force flies around **45,000** hours every year

The RAF wants **80%** of its training to be synthetic by **2040**

Around a third of that is synthetically in the Typhoon Training Facilities at RAF Coningsby and RAF Lossiemouth.

Two high security buildings at RAF Coningsby and RAF Lossiemouth, the Typhoon operating bases from where the RAF provides Quick Reaction Alert.

Ten fully immersive networked full mission simulators - with six at RAF Coningsby and four at RAF Lossiemouth.

Two high fidelity deployable training devices capable of supporting training on the frontline.

What will it bring?

Security - allows Typhoon pilots to train the way they fight with full synthetic mission systems and weapons in a high security environment.

Affordable - a reduction in live flying will reduce the cost of training pilots ready to fly Typhoon on the frontline.

Greener - in 2020 more than 13,000 flying hours took place synthetically in our Typhoon Training Facility saving around 75 million litres of fuel.



A Bridge to Future Capability

Investing today for tomorrow's front line

In 2018 the UK launched its Combat Air Strategy, which provided the foundations for a continuous and evolving combat air capability for the UK Royal Air Force, delivered through upgrades to Typhoon and F-35 and the launch of Tempest. The strategy confirmed the UK's Combat Air sector as a critical national asset, and set out the UK's determination to remain at the leading edge of Combat Air capability to protect our people, project influence and promote our prosperity.

As with Typhoon, the Tempest programme has the potential to deliver significant long-term economic and social benefit to the UK, and is already acting as a magnet for collaboration, innovation, encouraging R&D investment and driving new skills. More than 2,000 people are already working on the early stages of the programme.

Tempest is a highly ambitious programme requiring the design and development of several truly 'world firsts' in aviation. Many of the companies working together on the Typhoon programme are also involved in the design and development of new technologies for the next generation of UK combat air power as well as looking at a wide number of technologies that can start life on Typhoon and evolve onto Tempest.

At BAE Systems' facilities in Lancashire, UK, engineering teams are developing ground breaking capabilities, including working with Leonardo UK on an advanced new radar, ECRS Mk2, equipping Typhoon pilots of the future with electronic warfare and electronic attack capabilities, which will operate as part of a complete new weapons system.

This system will unlock the potential of Typhoon's radar and open the way to explore and exploit new sensors and weapons that be critical in a data-rich, complex battlespace environment. In this way, Typhoon is helping to accelerate capability for the future by feeding into the development of the UK's next generation combat air system, Tempest.

Through this type of long term investment approach, it ensures the UK sovereign combat air industrial sector not only protects national security, but also helps advance the UK's science and technology capability; creating and sustaining skilled jobs that contribute to national prosperity and play a role in improving the UK's global competitiveness.



About BAE Systems

At BAE Systems, our advanced defence technology protects people and national security, and keeps critical information and infrastructure secure. We search for new ways to provide our customers with a competitive edge across the air, maritime, land and cyber domains. We employ a skilled workforce of 85,800 people in more than 40 countries, and work closely with local partners to support economic development by transferring knowledge, skills and technology.

www.baesystems.com

Follow us on Twitter at @BAESystemsAir

About Leonardo in the UK

Leonardo is one of the UK's leading aerospace companies and one of the biggest suppliers of defence and security equipment to the UK Ministry of Defence. The company operates from 7 main sites across the country, employing around 8,000 highly skilled people. Globally, Leonardo is among the top ten world players in Aerospace, Defence and Security, with more than 49,000 employees and a significant industrial presence in Italy, the United Kingdom, Poland and the USA. In 2021, Leonardo recorded consolidated revenues of €14.1 billion.

For more information visit
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@Leonardo_UK



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