

EUROFIGHTER

PROGRAMME NEWS & FEATURES  
NOVEMBER 2015

# WORLD



- MISSION POSSIBLE
- LIFE IN THE FAST LANE
- ARCTIC CHALLENGE

**ON PATROL**  
EUROFIGHTER ABOVE THE REST



**Eurofighter  
Typhoon**





Title:  
Eurofighter Typhoon over the  
Arabian Gulf Region

Photo: Jamie Hunter

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PR & Communications  
Am Söldnermoos 17, 85399 Hallbergmoos  
Tel: +49 (0) 811-80 1587  
communications@eurofighter.com

**Editorial Team**  
Theodor Benien  
Simon Shrouder  
Martina Schmidmeir

**Contributors**  
Alenia Aermacchi  
BAE Systems  
Airbus Defence & Space  
EUROJET Turbo GmbH  
Royal Air Force  
Viva PR

**Photography**  
Eurofighter Jagdflugzeug GmbH  
Eurofighter Partner Companies  
Cpl Dave Blackburn, Crown Copyright  
Luigino Caliaro  
Hptm Toni Dahmen/PIZ Luftwaffe  
Dietmar Fenners  
Jamie Hunter  
Geoffrey Lee  
Filip Modrzejewski/Foto Poork  
Stefan Petersen  
Katsuhiko Tokunaga  
Dr. Andreas Zeitler

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PR & Communications Department at Eurofighter GmbH  
communications@eurofighter.com

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## WELCOME



Welcome to the latest edition of Eurofighter WORLD. The first thing that struck me when I read through the content for this edition was the sheer amount of activity.

In the past we have often talked about the aircraft's Paradigm Shift in capability – well now it's very clear that this has moved on to a whole new phase. The focus now is on Delivery Into Service.

In this issue of Eurofighter WORLD, we hear all about how the aircraft is shaping up for the future, with an array of weapons integration tests. We speak to members of the teams who are advancing the capabilities of the aircraft by bringing forward the likes of Meteor, Brimstone and Storm Shadow. These people all play different roles but reading their words it's clear they all share the same characteristics. They are all passionate, knowledgeable and committed to the Eurofighter Typhoon.

There's also a fascinating insight into the world of Test Pilot Raffaele Beltrame, who shows a cultured side to his personality which is a world away from fast jets – but I won't spoil it for you!

We also take a look at how the Eurofighter Typhoon continues to play a vital policing role in the Baltic through the eyes of UK RAF pilot Flt Lt Oli Fleming. You can find out more later in the magazine.

Another feature I enjoyed takes an in-depth look at the core of the aircraft – the Flight Control System. It really highlighted what a clever design the Eurofighter Typhoon is.

Of course, that intelligent engineering comes from people. And at our core that's what Eurofighter is all about. That shines through in the profile of our chief engineer Mark Greenhalgh.

Finally, I'd recommend taking a look at the interviews with three of the next generation. These are clearly bright, young people who have had their first taste of the workplace at Eurofighter. Reading their words gives me great hope for the future.

As always, I hope you enjoy the read and I'd welcome any feedback you may have.

**Alberto Gutierrez**  
CEO Eurofighter Jagdflugzeug GmbH

# MISSION POSSIBLE

**ROB PHILLIPS**  
FLIGHT TEST MANAGER  
BAE SYSTEMS



“The first job is to accept the task and, working with flight operations, award a Trials Risk Categorisation – low, medium or high . . .”

The sun streams through his office window and **Rob Phillips** checks his watch. Outside, the runway at Warton airfield is a picture of calm. Even the wind that regularly batters this stretch of the Lancashire coast seems to be holding its breath. >>

In the skies above the Irish Sea, two Eurofighter Typhoon jets are heading north. Their mission: to fire a missile.

“They’ve just refuelled,” says Rob. “Next stop: the range.”

The focus there, on the Outer Hebrides in Scotland, is an unmanned aircraft, a £600,000 Mirach target drone. It’s a four-hour round trip to it, but once he gets within range, the pilot only has a 10 second window of opportunity to take a shot. Hours and hours of planning, key decisions and the status of future contracts could all boil down to those 10 seconds.

#### WELCOME TO ROB’S WORLD

Rob is BAE Systems’ Flight Test Manager for Typhoon and his role is to oversee and deliver both production and development test flights.

He leads a team of 25 engineers and their collective job role can be summed up in three main elements: planning, executing and reporting.

The individuals in the team have their respective areas of specialist knowledge from handling, through to avionics and missile systems.

“It’s all about ensuring we meet the customer’s specifications in the required timescales and that we do these things safely,” Rob says.

The work starts when they receive a Request for Flight Data. It can be anything from a new avionics software update to the integration of a weapon, but while the demands are different, the approach is always the same: detailed and methodical. Every aspect is considered, with safety at the top of the list.

“The first job is to accept the task and, working with flight operations, award a Trials Risk Categorisation – low, medium or high,”

explains Rob. “Then a flight test plan is developed based on meeting the objectives of the customer. Next we have to work out what we need to measure and how we are going to capture the data that’s required.”

They decide what strain gauges, measuring equipment and other Flight Test Instrumentation will be needed. All this planning documentation can run to more than 60 pages for the more complex test flights. They also develop a detailed flight test schedule. This gives the pilot a very detailed checklist of requirements that need to be ‘ticked off’ during the flight.

On some tests – like weapon releases – two aircraft may take to the air, but the focus of attention is the lead aircraft: it’s the only one armed with the missile. It is a specially modified Typhoon, known as an Instrumented Production Aircraft, and is bristling with an array of recording devices measuring each moment of the test. The second is known >>

## &gt;&gt; MISSION POSSIBLE



“The job does have its pressures. There are an awful lot of eyes on what happens on a test...”

as a chase aircraft and is there primarily to capture video footage of the moment of release that will be useful for public relations activity in the future.

“The chase aircraft provides a picture for PR purposes – it’s what we dub as a ‘Highly Desirable’ element of the test but not essential. But having it can also provide images that are useful for later analysis, as well as for PR. If you’re an engineer, the more information you have, the better.”

Clearly the activity during the flight – be it the release of a missile or a simpler test of a new software drop – is important but just as relevant to Rob is data capture. Each flight is preceded by hours of testing and modelling on computers and ground rigs. Engineers have

predictions on what should happen. The test flight is thus their moment of truth. “The flight gives us the opportunity to look at the actual performance and compare it to how it was modelled. For example, when we fire a missile at a drone we capture the data to see how it released and we can determine how accurate the radar is compared to the modelling probability. The aircraft is also fitted with cameras capturing high-speed video at 400 frames per second so we can see every aspect of the release frame by frame.

“On a job like a missile firing, we would usually have a telemetry team of three engineers up at the range and another three back at Warton, though there can be anything up to 10 engineers supporting particular trials. The

telemetry team look at live data coming from the aircraft and are in contact with the pilot, though only the ‘Boffin’ can communicate directly with the pilot throughout the flight.”

Though an engineer, Rob has a unique perspective on the task because for five years he was a Flight Test Observer, which meant he flew in the back seat of the Eurofighter during test flights, notching up over 120 flying hours.

“I was very lucky. I took part in a wide variety of development flight trials over that period, from Paveway IV drops; Air-to-Air and Air-to-Surface avionic testing; and Air-to-Air refuelling – to name but a few. It gave me a real appreciation of the role and the workload of the pilots during flights.”

If capturing data is essentially what the test

flights are all about then the hard work starts when the aircraft returns to base and the number-crunching starts. Every aspect of the flight is poured over, from take off to landing – you name it, every piece of data is scrutinised and compared to the lab tests. In particular, those crucial few seconds of release are looked at every which way: every measure, every frame, every computer readout analysed, checked and triple-checked.

“The pilots also offer their own end user opinion and it is very valuable input because we want to look at every aspect of the flight,” says Rob. “How accurate was the radar against the computer prediction? How did the missile release? Did it release as modelled? An awful lot of analysis and reporting is carried out.”

The test team works as a closely-knit unit with the customer very much in their focus, explains Rob. “It’s all about satisfying the original request from the customer and giving them the information they need at the right level of detail. At the same time, other parties who may have an interest, say MBDA who make the missile or SELEX who make the radar, will also evaluate their data and report back, too.

“We operate as an independent agency on behalf of the customer. When we write our report, we offer a conclusion or recommendations based on the analysis of the data. Then we either look at a particular test point again or move on to the next test point until we reach a conclusion.

“The job does have its pressures. There are an awful lot of eyes on what happens on a test – from inside the business and from the customer, too. And there are a lot of things that are out of your control, like the weather or the sea state. There’s always an awful lot to consider. But it’s important for the business because adding new capability like a new weapon is key to our chances of winning export business. So we are really under the spotlight.

“But we have the very best guys on the job. It is a very close team. And, as far as I am concerned, we are in a privileged position because we get to work with the end product and see it in action day after day. Not many people in the business can say that.” <<



# PASSING THE TEST

With work advancing at a pace to integrate the **Meteor**, **Storm Shadow** and **Brimstone** weapons on the Eurofighter Typhoon, it's an exciting time for the programme. It's also an incredibly demanding one for the Flight Test team who are at the sharp end of bringing all these projects together. >>

▲ IPA1 takes off on full reheat

Josh Harries' phone buzzes. He has a new text message: "AIRBORNE." This simple word means a lot to Josh. Nearly a thousand miles away from his Munich office, a specially configured Eurofighter Typhoon has taken off. It is carrying a new Meteor missile. The text means several things: the poor weather that had threatened to scupper everything hasn't materialised, there were no last minute technical hitches and the test is on. Relief, for now. Over the next few hours

▲ Above: IPA5 on a test flight with Paveway IV and below, returning from a METEOR test flight

Josh and his team will be monitoring progress from the Eurofighter "Head Office" in Hallbergmoos. The next time the phone buzzes the message states: "MISSILE AWAY." "This kind of real time text messaging can be quite nail-biting, particularly when you are talking about something like a Meteor test firing," says Josh, who as Eurofighter's Head of Flight Test has overall responsibility for coordinating a whole series of flight tests across a number of aircraft in four countries. >>



▲ IPA7 demonstrating Eurofighter Typhoon's power with a full weapons load

## &gt;&gt; PASSING THE TEST



▲▼ IPA1 - one of the key test and development platforms responsible for the evolution of the Eurofighter Typhoon.



...“Weapon Integration flight testing is normally required to demonstrate that the aircraft can carry its intended stores safely”...

### TESTING TESTING...

Test flying can be very labour intensive, particularly weapon integration work.

#### In P2E and P3E:

- Integration of **Storm Shadow**:  
Over 80 flights, using 5 test aircraft
- Integration of **Meteor**:  
Over 40 flights, using 4 test aircraft
- Integration of **Brimstone**:  
Around 70 flights, using 2 test aircraft

▲ IPA1 flying in anger - humid conditions help demonstrate the aerodynamic characteristics of this potent and powerful aircraft.

“Some of the flights, particularly when you are integrating a new weapon, bring a whole new dimension to the aircraft and before we even think about a test flight there is a lot of work required. The text message tennis comes right at the end of the process; it represents the culmination of weeks and months of planning and effort from a lot of people.”

Through the aircraft’s current capability updates, known as P2E and P3E, there are a number of new weapons that are being integrated: Meteor, Storm Shadow and Brimstone. For Josh and his team, these upgrades also require a wide range of flight test requirements, embracing most of the aircraft systems.

“You have to remember that when you add a new store you are bringing in a new element. A Storm Shadow for example, weighs the equivalent of a VW Golf, at around 1,300 kg, so you need to know how adding that affects the handling of the aircraft. Does it give you restrictions on the flying envelope? Do the Flight Control System people need to make changes to the control laws that they use as their basis for flight? What happens when you release one?”

Not surprisingly, long before a flight is ever contemplated, the changes required to accommodate a new weapon will have been comprehensively tested on special system

rigs. Engineers will also carry out lots of computer modelling and simulations.

“Weapon Integration flight testing is normally required to demonstrate that the aircraft can carry its intended stores safely and achieve the required levels of manoeuvrability and performance for each store configuration. They must be capable of withstanding the flight, separate cleanly, and then follow a predictable trajectory to the target.”

The early Air Vehicle testing phase is known in the business as WIF testing, meaning Weapon Integration Flexibility, and this includes flutter (the effect of aerodynamics vibration), performance, aero data gathering, loads (looking at

the structural integrity of the aircraft), vibration and early store safe separation testing.

All of the data is collected by the dedicated Flight Test Instrumentation on the test aircraft. Strain gauges and other sensors are fitted to the stores and aircraft to measure the resulting effects. Once the flight is completed, the data goes to the System Design areas who are responsible for qualifying and certifying (Q&C) their respective Systems once modified. They can then carry out detailed analysis and compare the results with the earlier predictions, and use this flight test data and formal Flight Test Reports as part of their Q&C evidence. This WIF testing phase can be very labour

intensive and may run to dozens of flights to test different weapon configurations at various parts of the flight envelope. For example, during the P2E Storm Shadow aero data gathering testing, there were more than 40 flights on two aircraft, IPA4 and IPA7.

Josh adds: “Safe Separation trials are another very arduous element. Stores are usually released under operationally representative conditions, such as singles, pairs, jettison of launchers and so on and at various weapon delivery manoeuvres. Brimstone, for example, has launchers with three missiles fitted to each, and separation trials will be carried out with all, some and none of the missiles fitted.

“Of course, there’s a lot of data collected but there is also ‘pilot in the loop’ testing. Handling Qualities testing is related to the basic stability and control characteristics of the aircraft with the stores fitted. These series of tests look at how the aircraft responds to the pilot’s inputs, so naturally pilot feedback is important. The pilots summarise how well the aircraft flies and provide information that goes into the flight manual. Generally, two or more pilots will fly handling quality tests with new stores fitted through a series of operationally representative flights. They then assess the handling against a standardised scale which is known as The Cooper Harper rating.” >>

## &gt;&gt; PASSING THE TEST

**THE TEST AIRCRAFT**

**The IPAs:** In order to carry out such a comprehensive test programme, Eurofighter operates a series of Instrumented Test Aircraft (IPA). These are dedicated test aircraft and are usually created during the build phase. At this point the Flight Test Instrumentation (FTI) fit is carried out and this includes the installation of kilometres of orange Flight Test Wiring, as an integrated part of the aircraft and its systems. The FTI fit is very comprehensive and includes real time data availability via encrypted telemetry systems.

**The ISPA:** Eurofighter also operates Instrumented Series Production Aircraft or ISPA. The main difference is usually a reduced FTI installation, which is less intrusive and is normally added during Final Assembly. The idea is that the FTI could be later stripped out in order to return the aircraft to a customer as a standard production aircraft for normal operational use.

**The FTI:** Flight Test Instrumentation (FTI) is used to acquire data about the operation or environment of a test object and record and/or transmit that data for future use. The sources include: various aircraft data buses; aircraft system tappings like power supply voltages; FTI sensors (pressure, temperature, accelerometers, vibration, position etc.); navigation data; audio (crew speech, system, warnings, missile tones). There is also telemetry, which gives real time access to data, though that's encrypted for security reasons. As tests and requirements grow, so too does FTI.

**THE EUROFIGHTER TYPHOON TEST FLEET**

- IPA1 Tranche 1 at Warton
- IPA2 Tranche 2 at Turin
- IPA4 Tranche 2 at Getafe
- IPA5 ESCAN at Warton
- IPA6 Tranche 2 at Warton
- IPA7 Tranche 2 at Manching
- IPA8 ESCAN at Manching
- ISPA3 Tranche 3 at Getafe
- ISPA4 Tranche 3 at Turin

In addition, access can be gained for: IPA3 – Tranche 1 – owned by MoD GE at Manching and ISPA5 (BT017) – owned by the RAF and usually flown out of Warton.

The MoD UK is currently planning to “instrument” other RAF aircraft, primarily for their own use, but these could also be made available to support Flight Test programmes.

“It might sound counter-intuitive but, although we work in Flight Test, we always try to do as little flying as necessary!” says Josh. “We recognise that this is the most expensive and most time consuming part of the testing process so if we don’t need to do it we won’t. I always challenge flight test requirements. So whenever we actually fly, we do so for a reason. There’s no padding.”

With weapons integration reaching a climax, there are multiple tests and programmes at different stages. Eurofighter, through Josh’s office, co-ordinates the whole process. He works with four EPC (Eurofighter Partner Companies) Flight Test managers whose teams carry out the detailed flight planning and execute the flight trials. At Eurofighter, Josh has a highly motivated team that deals with cross-EPC coordination and long term planning over the various programmes.

“The combined EF and EPC FT community provides a thorough knowledge of all the various disciplines used in Flight Test, such that a coherent and balanced flight test programme can be planned and executed. We all work well together. There’s a level of cooperation, camaraderie and willingness in “Flight Test” that I have not seen matched in my career.”

“As soon as the requirements come out and are established, my team at EF ensure the flight test centre is given an outline idea of what they will need to test. We start the detailed planning about six to nine months ahead of the actual flying programme. We come up with an initial order of flight and produce a shopping list of items that forms the beginnings of a basic plan. We go on to define exactly what the customer really wants to do: which configurations to fly in, what the software standard needs to be and so on. We also have to make sure that the aircraft we choose is, or will be, fitted with the right instrumentation.”

Where possible the Flight Test teams try to ensure the end user – the customer – is involved, too, by discussing their needs. “Together we look at the test points we have planned and from that try to come up with an integrated approach. The customer may have included a contractual requirement for an operational assessment and we will accommodate that. With Meteor, for example, we planned nine firings intended to deliver a qualification but three of them are also dovetailed into a customer requirement. Each test programme is different but around 10 per cent of the test points we fly usually tie into a customer requirement.”



Trying to keep the tests on track and contend with issues like clearances, range availability, fuel tanker support, targets, all means the work can be incredibly challenging and frustrating, but Josh and the FTMs are not ones for letting a few snags cloud their day. The flight trials team involved will often work into the night after a flight to ensure that FT data is downloaded, distributed and the aircraft ‘turned around’ for another flight next day.

“All flight tests are the highly visible end game – the bit that everyone sees and the bit that brings everything together. And weapons

▲▼ IPA2 carrying Storm Shadow - each missile weighing the same as a small family car

integration sits right at the pinnacle of the test flying range. If you are the guy rearranging the 0 and 1s in a software programme or you’re doing model predictions at the early part of the process, as vital as this work is, you will never get this close.

“It’s a great job – challenging, exciting and a job I really enjoy. As a former RAF Chief Test Pilot once told me, ‘Flight Testing is all about operating in God’s wind tunnel!’” <<



IPA7 carrying TAURUS - another of many long-range missile test flights





# LIFE IN THE FAST LANE

**RAFFAELE BELTRAME**  
EUROFIGHTER PROJECT PILOT

As a four-year-old, Raffaele Beltrame went through a life-changing experience. His father took him to an air show and there he witnessed a Tornado display: loud, proud and magnificent. In that instant the die was cast. Fast forward a few years and it was the Italian from the northern city of Udine who was wowing the crowds but this time from the cockpit of a Eurofighter Typhoon. Today, as a Eurofighter Project Pilot, it's Raffaele's job to push the aircraft to new limits. >>

It's a life lived in the fast lane but not exclusively. He doesn't just weave patterns in the sky, he creates pictures on canvas, too. For Raffaele's passions also extend to the arts. He's also the first pilot I've heard liken air displays to orchestral arrangements. After an hour in his company it's clear that Raffaele Beltrame is not your archetypal test pilot.

His journey started as a young man in the Italian Air Force where he saw action in Bosnia and Kosovo. Then in 2002 his career path changed when he was selected for the air force's Test Centre.

"I was a little bit anxious in the beginning in the sense that you know what you're leaving but don't really know what you're facing. For example, I didn't know what programme I would be working on – it could have been helicopters for example. I also wondered how I was going to learn everything about each different aircraft."

As it turned out, his timing was little short of perfect. His first assignment was on Eurofighter and he was there for its initial introduction in country. Two years later the aircraft was officially handed over to the air

force and Raffaele was part of the team who provided support for the operational pilots.

"I was lucky. It was an amazing time to be part of all that. Since then I have seen the Eurofighter growing from an air-to-air to swing role. I've been fortunate to be involved in every stage of its development from P1E up till now with P2E, P3E and E-Scan."

In a sense he was part of the backroom team during this period but his profile was raised when Raffaele was selected as a Eurofighter display pilot during the 2010 and 2011 seasons. In India, supporting the

campaign, he performed twice a day notching up 13 flights in just over a week, which even the unflappable Italian describes as a 'really intense period.' Even so, he recalls this phase of his work life – and the sense of freedom it gave him – with genuine fondness.

"Flying a display is amazing. It's a very small portion of the job, and it's both fun and demanding in equal parts. It gives you the chance to enjoy the performance of the aircraft. A display pilot's job is to try to highlight all the good qualities of the aircraft and so you devise your own programme and put in some new manoeuvres.

"Throughout my time as a display pilot I was tense before each flight. You have a level of stress but as soon as you release the brakes you just switch on. You're not nervous because of the crowds – in fact, you don't see many people. The pressure is more internal because it is a very disciplined way of flying. I was always looking for perfection. An onlooker might not notice any faults but being honest there was not one display where I was

truly 100 per cent happy," says Raffaele. Anyone who had the pleasure of witnessing him in action would say it's an admission that says more about his high standards than his aeronautical abilities.

"For me a good display should be like an orchestra. Everything in harmony. >>



Raffaele's artwork showcases his creative side away from the cockpit





## >> LIFE IN THE FAST LANE

I like clean and smooth manoeuvres. Of course, you can show the power but my personal view is that I hate rough manoeuvres. Make it smooth, know when to relax, have confidence in the machine. In some ways it's like creating a painting," he says before breaking out into a big grin at the memory. "It was a blast!"

Like all the best test pilots, Raffaele is an excellent communicator – it's something he says comes naturally and it's a fundamental part of his role.

"I like talking to people and socialising and fortunately that's part of the job. In the test centre you have to be very close to the operational guys – to interact with them and understand their needs. Your job is to constantly help develop their requirements and look at any issues they may be facing. So communication is key. If I am able to fully understand the requirements we can deliver a good product – they're happy and we're happy."

He joined the Eurofighter family as a Project Pilot with Airbus Defence & Space in 2013, and is now based at Manching in Germany where the skills and knowledge he's picked up along the way are now being put to good use.

"It is challenging in a different way. You need a good awareness of the programme and the management dynamics but communication and teamwork are still key because you are interacting with a group of people. I work alongside a team of engineers and I really enjoy it. It's fascinating talking to an aerodynamicist and translating from numbers on a spreadsheet to the mechanics of flight. And, of course, we are in an interesting phase of the programme. There are a lot of challenges and milestones on the near horizon.

"Pilots will always say they never fly enough, and I suppose I'm no different, but we all know that flying hours are very costly. So when we do go out we fly high quality sorties. With each test flight you have to come back with results."

Raffaele has recently completed flight-testing a package of aerodynamic upgrades that promises to enhance further the aircraft's agility and weapons-carrying ability. The Aerodynamic Modification Kit\* (AMK) is part of a wider Eurofighter Enhanced Manoeuvrability (EFEM) programme developed by Airbus Defence and Space that has the potential to help ensure the aircraft's continuing superiority for many years to come. It primarily entails the addition of fuselage strakes and leading-edge root extensions, which increase the maximum lift created by the wing by 25 per cent resulting in an increased turn rate, tighter turning radius and improved nose-pointing

ability at low speed – all critical fighter capabilities in air-to-air combat.

It also serves as a classic case study in how Rafaele 'the project pilot' interacts with the wider team. There's hours of work before he even steps into the cockpit. "That programme started off with a flight test plan where we identified the objectives. Next we had the sim phase. This gives you a chance to see if what you have planned is going to be feasible and allows the pilots to train for specific manoeuvres. This was very important because we knew fuel consumption would be high on this particular test since we were always using reheat.

"In the sim the idea is to get the dance going. You plan each and every manoeuvre then you perform them with a rhythm – the mind-set is the same as display. If everything goes perfect, you move on. In this instance the sim work was a key to defining the entry conditions."



▲ Eurofighter Typhoon makes a statement in Bangalore

All the work on the ground saved time and reduced risk during the subsequent flights. As the simulator was configured with the new software, the team were given an early indication of the results and they were all excited by what they saw.

"You could see the numbers and the improved performance envelope but you have to get into the aircraft to really appreciate the difference. While flying you have such positive feedback. During the debrief you could see the engineers were all the same. They were

just looking at numbers and smiling because the result was a surprise for them as well. That's the point of this job. It's not just you and aircraft but there are 20 people on the ground working with you and constantly monitoring the data. There's always a discussion going on about the best way forward."

Living in such a high pressure world does have its stresses so to relax Raffaele turns to art.

"I enjoy painting and photography and it's something I've done for quite a few years. I have had a few exhibitions in Italy," he says.

"I like to listen to music when I paint – all sorts of music, from classical music to terrible rock. It just depends on the mood.

"It's a great escape. Saying that, I am really lucky. Every day I wake up and I look forward to coming to work. We have a great team and even if there are no flights there is always

interesting stuff to do. The variety is very stimulating.

"I still remember being at an air show as a four-year-old – and I can't believe I'm here sometimes." <<

\*) see page 47



# THE NUMBERS ADD UP

**MARK  
GREENHALGH**  
EUROFIGHTER CHIEF  
ENGINEER

The Eurofighter Typhoon is an engineering marvel. It can climb higher and faster than any of its rivals. It packs a punch too. It has greater persistence and delivers effects faster than anybody. >>



▲ Safety first - a preflight walk around is a crucial part of any flight.

All true, but when Eurofighter Chief Engineer Mark Greenhalgh makes a list of his important priorities, safety is always at the top.

"Safety is paramount. If we were to lose that, the reputation of the aircraft would be impacted. We have to make sure we maintain that.

"It's one of the key roles Eurofighter plays because within the organisation in Munich, we have representatives from all the Customers in

one place. So we can pull those together within an hour's notice and brief them on a particular point. They can quickly get back to their air forces with a common message.

"If we have an incident where it's really important to get that common message to the customers or if we need additional feedback, in terms of data, we can do so expeditiously."

The importance of the aircraft's safety and reliability record was brought into focus

earlier this year when the Eurofighter notched up 300,000 flying hours. It's a memorable milestone but it's worth putting that figure into some sort of context.

That service has been characterised by a level of reliability that's frankly unheard of and that's testament to the engineers who designed and built the aircraft. So here are some more numbers worth considering: The first time the Eurofighter Typhoon went into service in Libya in 2011 the fleet was >>



## >> THE NUMBERS ADD UP

available 97 per cent of the time. They were away for six months, flew more than 3000 hours and clocked up over 600 missions. Little wonder that Mark is proud of the aircraft's reputation for reliability and safety.

But there's another reason why it figures top of his list. Because it's part of Mark's job description that he can recommend the fleet to be grounded if ever he feels there are sufficient grounds.

"We try to get the balance in maintaining a safe platform, but also maintaining flight operations," he explains. "But naturally it's one of the most difficult aspects of the job."

Making those kind of calls demands knowledge and experience and he has both in his favour. Mark started his career at BAE Systems in 1981 working on the Jaguar's wings. It was an era rich in possibilities and he was able to acquire knowledge across a range of assignments.

"I benefited from working on lots of projects. I was able to move about, to carry out different roles, develop different skills and move on to different things. For example, I was involved in the Airbus 320.

"I was fortunate because at the time there were a host of opportunities. There are plenty of people who have probably been in one department all their lives and are very happy doing that. But that certainly wasn't for me; I motivate myself by taking on different challenges and experiences."

Part of that early journey included work on the Experimental Aircraft Programme, which became better known as the EAP, a technology demonstrator that led the way for Eurofighter. A key feature of EAP was its carbon fibre wings – advanced manufacturing technology that was in its infancy back then.

"We've all moved to carbon fibre wings now, but in those days it was something new. It gave the aircraft stiffness and strength. But we also learned some big lessons from that, which is exactly what the EAP project was created for. Some things didn't work out and we had to understand what had happened and why, then build on them in Eurofighter."

From EAP it was a natural step for Mark to work on the early designs for Eurofighter Typhoon. "I originally was involved in the design of the wing. I was the section leader looking after the structural design within BAE Systems at Watton."

His impressive CV also includes five years in the international business of BAE Systems Customer Solutions & Support (CS&S), where he was involved in the agreement with the Saudi Arabian Customer for the Salam project. He joined Eurofighter in 2008 and is a passionate advocate for its role in ensuring the aircraft's development continues on the right path.

"Until I arrived here I have to admit I didn't truly understand the role of Eurofighter but it doesn't take long for you to appreciate the

need for it and the benefits it gives the whole project. The Eurofighter Typhoon platform is such a complex system that no one person can understand the whole thing and therefore you need to know where to bring different people in and that's the key role of Eurofighter. It brings the right people together, at the right time."

"Its role is very important. It has an impartial viewpoint that's focused on getting the best result for everybody. And that's the key – it's all about getting the best results at the end of the day."

"There's a very human benefit too because individual engineers gain from the experience of working in Eurofighter. They have their horizons broadened. It's quite remarkable to see what skills you can gain here from being exposed to different ways of thinking and people. Personally I believe that this helps to create much broader engineers. We are developing engineers who have got wider knowledge and a greater capability of managing complex programmes."

Mark heads a team of 25 people, which includes engineers looking at disciplines like Airworthiness, Configuration Control and Weapon Qualification. He also has a number of people on project delivery teams.

"They act as my eyes and ears in the teams that are trying to integrate the product. The impact the whole team has is greater than the sum of its parts. It's a real co-ordinated effort."

So as Chief Engineer what elements of Typhoon's engineering give him the most satisfaction?

"Well, my background is on the structures side, so I have to say the airframe.

It's the bedrock. After that you rely on the avionics and everything else to give you the mission capabilities.

"The difficulties come when you don't have that (quality) airframe. You can always change the wiring, the software or equipment. That's relatively straightforward. But if you don't have the basics of the airframe and aerodynamic capability and the engine to go with it you really struggle to maximise the opportunities.

"And I do think Eurofighter has a very good structural design. The structural tests that are ongoing have revealed relatively few problems despite the fact we are testing it to 18,000 test hours against a requirement of 6,000 flying hours! That says a lot about the design."

All these excellent numbers are all down to good engineering principles – principles which Mark has made his life's work.





# THE MAGIC BOX

Steve Hunt



Michael Rössler



Rob Wells



**Eurofighter Typhoon is a truly majestic aircraft with incredible power and manoeuvrability. But how does it think? What makes it tick? What is the essence of the machine and what gives it such majesty in flight? At its heart sits the Flight Control System (FCS) – consisting of highly sophisticated sensors and computing power capable of translating the pilot's commands into action, providing outstanding agility. In this edition of Eurofighter WORLD, we talk to Steve Hunt, Michael Rössler and Rob Wells to discover more about the box of tricks.**

## So what is the Flight Control System?

The Flight Control System is a state of the art, digital fly-by-wire control system which optimises the performance and agility of the aircraft.

At its core are four flight control computers, which together control the pitch, roll and yaw of the aircraft. These computers drive the primary control surfaces: foreplanes and flaperons control pitch, differential flaperons roll and the rudder provides yaw control. Signals to the Flight Control System – speed, pressure, rates, accelerations and so on – are calculated within the sensors. These include Air Data Transducers and the Inertial Measurement Unit. 95 per cent of all flight control computing is performed in the flight control computers.

## What is the Eurofighter FCS designed to do?

Eurofighter Typhoon is an inherently aerodynamically unstable platform. That means a significant challenge for the engineers during its development and testing phases. The FCS is the answer to that challenge.

The fundamental requirement of the FCS is to provide a stable yet highly agile platform. The FCS provides stability by using appropriate feedback signals supplied by the Airdata Transducers and the Inertial Measurement Unit.

The pilot commands the aircraft to manoeuvre via the pitch/roll stick and pedals, and these signals are conditioned through control law algorithms to calculate the control surface demands. These demands are converted to electronic signals transmitted by wires (hence the fly-by-wire term) to drive the control surfaces.

The key feature of the FCS is Carefree Handling. Carefree Handling allows the pilot to aggressively manoeuvre the aircraft without concern of exceeding the aircraft limitations and stalling the aircraft or over-stressing the airframe. This capability is available for all weapon configurations.

Other major features supporting the Carefree concept include: low speed automatic recovery to protect against low speed departure; high speed warning to warn against envelope exceedances; G-onset limitation to protect the pilot against sudden loss of consciousness.

## So is the FCS all about computing power?

It's true, the FCS consists of high-speed computing and data buses, complex sensors, control algorithms and state of the art fly-by-wire technology, but the key word is SAFETY. Loss of the flight control system means loss of the aircraft. As simple as that. Therefore safety is paramount.

In this safety context, the FCS design caters for degraded system performance providing graceful degradation in the event of one or more failures. This may lead to loss of capability and therefore mission but it shall not lead to loss of the aircraft.

## Given its importance, how do you guard against things going wrong?

The short answer is quadruplex architecture: There are four Flight Control Computers all monitoring each other, providing redundancy designed to detect, absorb and automatically isolate failures within the system. If one computer is misbehaving, the other three computers kick it out.

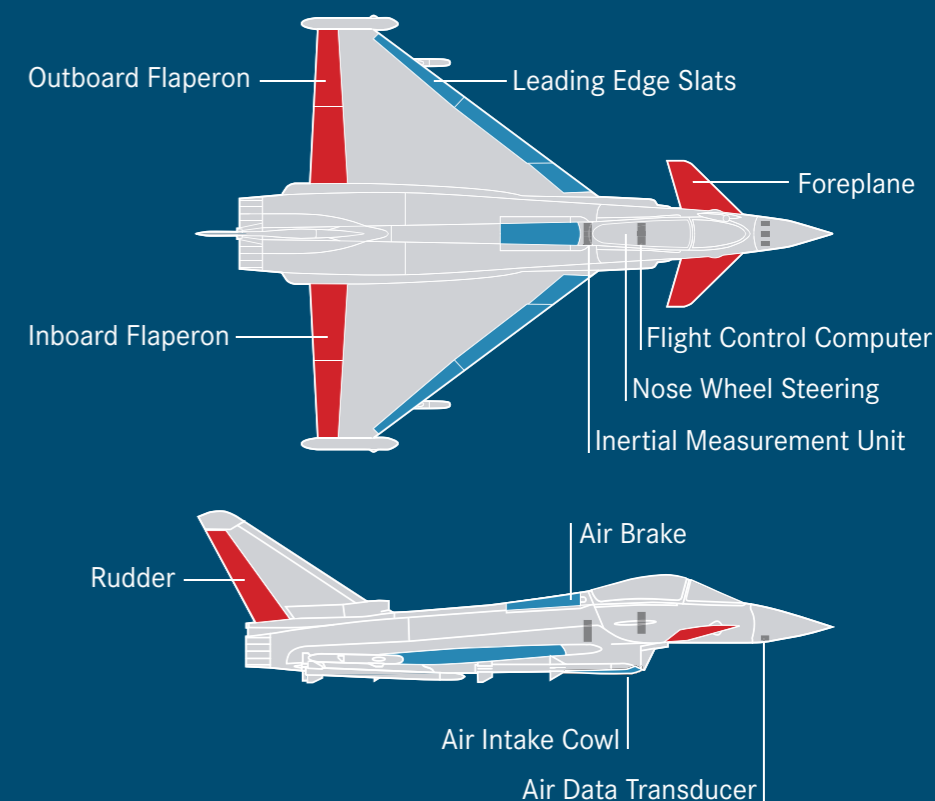
The quadruplex redundancy concept extends to all critical FCS equipment and data transfer to ensure system and ultimately aircraft safety.

## EUROFIGHTER TYPHOON

### Performance Parameters::

- G-limits: +9g / -3g
- Max speed: Mach 2.0
- Ceiling: >55,000ft
- Brakes off to 35,000ft / Mach 1.5: <2.5 minutes
- Brakes off to lift-off: <8 seconds
- Operational runway length: <700m
- Max payload: 7,500kg
- Max unrefuelled range: >2,500km

- ◆ Primary control surfaces
- ◆ Secondary control surfaces



## OK. Given that, what other features does the FCS provide to support the Pilot?

The FCS engineers have designed into the Flight Control System leading capabilities which further enhance the aircraft performance. For example, the aircraft exhibits truly excellent handling qualities in all phases of flight including take-off, approach and landing, aircraft tracking, aggressive manoeuvring and inflight refueling.

The FCS also provides autopilot, auto-throttle and flight director modes, reducing pilot workload at critical times of the mission.

Background tasks taken care of by the FCS also include automatic aircraft trimming. This ensures the aircraft does not drift off as is traditionally the case.

The FCS features an aptly named Disorientation Recovery Function, which when selected by a disoriented pilot, places the aircraft into a defined safe attitude and speed.

## Does this emphasis on safety mean that the aircraft is compromised?

No. Although safety clearly comes first and is paramount to the integrity of the flight control system, aircraft performance is not unduly limited.

The aircraft was originally designed for climbing to 36,000ft, going supersonic, firing four AMRAAMs and turning at 7G to go home (It can, of course, exceed these parameters).

Those are the cardinal points on the specifications of the aircraft – the absolute must do requirements for the FCS. It does this better than anything else in the world.

## Who was involved in the development of the FCS?

The FCS is the responsibility of the FCS Joint Team, known as the FJT. The team was created in 1986 with engineers from the four partner companies based in Munich. This was and remains a truly international set-up represented primarily by German, Spanish, Italian and British engineers working side-by-side. A cultural mix which has evolved into a very effective and skilled team.

The current team is responsible for the full development lifecycle from requirements capture, design, development, demonstration, qualification and In-service support – all performed on one floor within the Engineering Building at Airbus, Manching. This is unique on the Eurofighter programme.

## So when you reflect on the team's achievements, what are you most proud of?

The performance of the aircraft, the robustness, the reliability and the reputation of the Flight Control System are truly magnificent achievements. But above all, the safety record of the aircraft, which is second to none, is something we can be really proud of.

To put it another way, when we get 'Requests for Information' from potential customers they always ask about attrition requirements over the lifetime of the contract (how many aircraft you'd expect to lose). Most aircraft in the history of manned flight have lost about a third of the fleet by the end of their lifetime. However, the attrition requirements



▲ An RAF engineer carries out pre-flight system checks

on this aircraft are negligible. It is so much less than the other manufacturers, the customers will always come back to us and say, 'Are you sure about that?'

But this record of reliability has not compromised the aircraft's performance and that's where Eurofighter Typhoon is unique. It has been fine-tuned to the point where you get optimum performance and maximum reliability.



Photo by: Filip Modrzejewski/Foto Poork - RADOM Air Show 2015

# EUROFIGHTER TYPHOON: A NEW REALITY

This year the highly respected defence think tank RUSI produced a report on the Eurofighter Typhoon. In 'Maximising European Combat Air Power', author Justin Bronk argued that it's time the future of European air power was re-evaluated.

In this edition of Eurofighter World, we speak to Justin, a Research Analyst with the Military Sciences programme at RUSI. >>



Welcome to Nellis - No. 6 Squadron Typhoons prepare for a night flight

If Justin Bronk wanted his RUSI report Maximising European Combat Air Power to achieve anything, it was to address 'a perceived lack of understanding, in political, media and some military circles, of the Typhoon, its capabilities and its level of maturity.' Speaking following its official launch he says: "It seemed to me not only that there was a lack of understanding of just how capable the jet now is but also a lack of understanding of how crucial it is that the upgrade programme continues so that we can get the most out of it. That's particularly important given the fact that Europe already has a very serious combat mass problem in the air domain."

But how has this lack of understanding come about? "For me it is essentially a consequence of the aircraft taking a long time to

mature. It wasn't helped by the fact that during much of its maturation phase there wasn't really much of an obvious role for it in terms of threats.

"Consequently Typhoon suffered with a lot of negative press during the 2000s but now the aircraft is maturing very successfully and coming into its own. At the same time it is deterring the Russians on the Eastern flank of NATO, which is precisely what it was designed to do. History has a nice way with irony.

"The press, and in some cases military, haven't really caught up with that fact. Instead they are looking back or looking out for the next big thing."

His report pointed to the fact that 'significant parts of the political, media and, in some cases, military circles see the stealthy US F-35 >>

## >> TYPHOON: A NEW REALITY

as the future of Europe's combat air fleets. If the common political and media narrative is to be believed, the F-35 has already made all previous fighter aircraft designs obsolete and will soon revolutionise Western air power.'

So an essential aim for Justin was to park the perceptions, start with a blank sheet and use careful and considered analysis of facts to consider what the future of European air power really looks like now and will do in the next 10-15 years.

"I was looking at the force mix that's likely to be around, particularly for the RAF, but also for all the other Eurofighter customers too, up until the 2030s at least. So yes, you have 5th Gen F-35 coming on stream but only in very low numbers and seemingly taking a long time to reach genuine combat usefulness. Looking at it, however well you think the F-35 may go, Eurofighter is destined to be the backbone for four of the five biggest air forces.

His report argued that the likelihood is for relatively small European F-35 fleet sizes and even smaller numbers of aircraft actually available. As a consequence, working out how Eurofighter is able to work alongside these assets is going to be far more important than many appear to grasp.

These aren't the only perception issues Bronk has tackled. "People don't often understand how long combat aircraft are around

now. For example, few people will appreciate that some of the Strike Eagles flying operations over Syria and Iraq today were built in the late 1980s early 1990s. There's a lack of understanding that with a very good airframe and engine combination at a basic level, which Eurofighter undoubtedly has as one of its great strengths, how much you can upgrade that over time to keep it relevant and effective."

If the perceptions are wrong, then what is reality? For a start, Typhoon is a far more capable baseline aircraft than it has been given credit for. In fact Bronk goes further. His report states that Typhoon is already 'formidably capable', but that with relatively modest capability upgrades, it will only become even more so.

He writes: "In the Eurofighter, European states have the most formidable non-stealth air-superiority platform in the world. Once the CAPTOR-E AESA radar and Meteor BVRAAM are integrated, European air forces will have a fighter capable of deterring and, if necessary, defeating any opposing air threats they may meet until the mid-2020s and any non-peer threats substantially beyond that."

Indeed the whole thrust of the report is that it's an aircraft that with continued investment will reap dividends in terms of increasing the longevity of the aircraft.

"The fundamental strong point that should be put forward wherever possible is that Eurofighter embodies the sort of basic airframe and engine strength that allows for huge flexibility in terms of upgrades in the future."

### THOROUGH RESEARCH

While researching material for the report, Bronk met with frontline pilots and air staff from air forces in the UK, Germany and Italy.

"I got a view from across the European operators and heard about what the pilots actually wanted. It was important for me to get the operators' views on the aircraft's

strengths and where they thought improvement was needed. It was interesting that the various nations were candid about the programme in different measures. So getting three national view points was very useful.

"The report has been well received from the feedback I have had. There was the odd comment from manufacturers of other aircraft suggesting it was deeply unfair and too complimentary to Eurofighter. I invited them to point out flaws in the analysis – they didn't.

"Overall I have put out a balanced picture. The beauty of working for RUSI is that you can maintain your independence and, for me, as long as you can stand by your own conclusions that's the important thing.

"The reason why Eurofighter were willing to sponsor the report, despite knowing they wouldn't be able to influence the end result, was they felt that a 'warts and all' look at the aircraft would be in their best interest. What they don't get from us is a sounding board. If they just wanted to paint a positive picture they could get their PR department to do it."

So what did the pilots and their bosses tell him? "The thing that stuck out for me particularly was how enthusiastic the pilots are about the aircraft. I suppose that's not too surprising as pilots are usually pretty enthusiastic about their jet – jet first, wife second that sort of attitude – but there really was genuine enthusiasm.

"What surprised me most was how upbeat they were about the changes that had come upstream in the last couple of years and the issues that have been solved but also the effect small subset deficiencies can have on overall capability.

"It was also interesting to note the extent to which the three different operators had diverged in where they were going with the jet. Priorities, roles and even specifications had been quite markedly different. But now, with the impending drawdown of Tornado in all three countries looming large, their priorities are actually coming back together again and with that the prospects for P3E and P4E are much rosier than they appeared in the past."

### THE FUTURE'S TYPHOON

Bronk states what seems obvious to him but is not fully realised elsewhere that Typhoon is going to be the backbone for all four major European operators out to at least 2030.

"The fact is the number of 5th Gen or UCAVs or whatever starts to come along in the mid 2020s, they are going to be in such

small numbers that the core is going to have to be Typhoon and the good news is that with upgrades, full weapons integration, a new radar, upgraded DASS and better electronic warfare capabilities it is certainly capable of being relevant and formidable out to the late 2020s.

"Don't just take my word for it, look at the RAF. They clearly have great faith in its ability to perform in the air superiority role as Russian and Chinese Low Observable designs start to come in or they wouldn't be spending as much money as they are on Meteor and new radar.

"There is so much capability there in the fleet that is on the cusp of being unlocked with the full multi role capability.

"It is a very reliable asset, where the costs are coming down considerably for operation and maintenance. The aircraft is just a good story for the air forces operating it. It hasn't always been but it is now.

"The other thing to take away is that F-35 and Typhoon shouldn't be seen as a mutually exclusive choice. There is a huge amount of potential benefit for both aircraft to interoperate with each other because they each have strengths where the other is weak.

"The bottom line is Europe isn't going to have that many jets to go round so we are going to have to make the best use out of all of them. It will be interesting to see what all the air forces do." <<

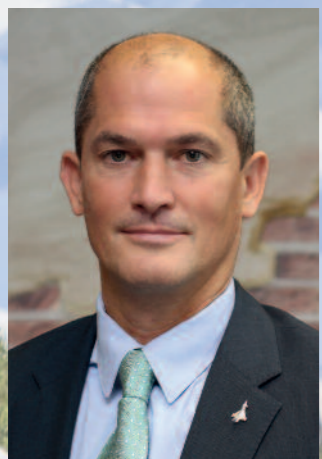


Eurofighter Typhoons - the 'Force Multiplier'

# ARCTIC CHALLENGE 2015

## EXERCISING SECURITY OPERATIONS IN THE POLAR REGION

Earlier this year in the skies above the polar region of northern Scandinavia, Eurofighter Typhoon aircraft were among a host of fighter jets that took part in a large scale exercise: the Arctic Challenge Exercise 2015 (ACE 2015). >>



by Joey Borkenstein



The exercise airspace was a massive 450 by 250 nautical miles above parts of Norway, Sweden and Finland, which allowed the aircraft an extensive and realistic training environment, with very few restrictions. During the 12 days of ACE 2015, up to 90 jets were in the air at once.

The participants included F-16s from Norway and the United States, F-18s from Finland and Switzerland, Gripen from Sweden, Tornados from the UK, Mirage 2000 from France and Eurofighters from Germany. In addition, there were a number of support assets used for the exercise like E-3 AWACS from

NATO, used for airborne early warning and control, DA-20 Jammers for electronic warfare and several tankers from Germany, the UK, Sweden, the US and Netherlands.

The Eurofighter crews came from all fighter wings of the German Air Force (Fighter Wing 74, Neuburg; Fighter Wing 73, Laage >>



## >> ARCTIC CHALLENGE 2015

Fighter Wing 31, Nörvenich) who explored how to best employ their weapon system.

Throughout ACE 2015, Norway, Sweden and Finland were able to make use of their respective military fighter bases at Bodø (Norway), Kallax (Sweden) and Rovaniemi (Finland). These were ideal for enabling short transits to and from the airspace and also for hosting the large number of aircraft that took part in ACE 2015. All the participants were distributed among the three air bases.

The staff at Bodø air base had overall responsibility for the exercise but were supported by their counterparts in Sweden and Finland. One of the main challenges they faced was establishing good communications across the different air bases to ease coordination among all the various participants. This was managed through a computer network and live video links which meant everyone was kept up-to-date.

A key aim of the exercise was to improve orchestration in complex air operations among different NATO partners. It was also devised to ensure the different forces were able to develop their skills in all aspects of an air campaign and to enhance interoperability across different areas. Air crews also had the opportunity to work with other platforms.

A fixed planning cycle was established to enable a thorough coordination and briefing phase. Tasks ranged across the air warfare spectrum and included defensive counter air (DCA), offensive counter air (OCA), close air support (CAS), air interdiction (AI) to high value airborne asset (HVAA) protection.

Aside from missions to train large force employment (LFE), the participants also had the chance to organise individual training sessions amongst one another. The Eurofighter crews used the opportunity to train against legacy platforms like the F-16, F-18 and

Mirage2000 and also more modern jets like the JAS-39 Gripen, who were equipped with a helmet mounted sight system.

A vital part of the learning experience were the debriefing sessions which took place after each mission, when each of the participants reviewed the mission data. During these debriefs, mission commanders and flight leads assessed their plans and the execution, and at the end of the exercise, 'lessons learned' were shared.

The whole exercise was a tremendous success with European and US personnel able to build up a lot of confidence operating with a variety of different platforms across multiple bases. The Eurofighter crews were able to use the aircraft's advanced capabilities to substantially contribute to the success of each mission. <<



“A key aim of the exercise was to improve orchestration in complex air operations among different NATO partners ...”



# HAPPY LANDINGS

As a world leader in aircraft landing and braking systems, Messier-Bugatti-Dowty can boast some impressive numbers. It delivers solutions to 30 leading commercial, military, business and regional airframers. It supports more than 25,000 aircraft. These make over 40,000 landings every single day. But if you were to ask Andrew Roberts, Programme Manager for UK Military and Commuter, to list all the different aircraft he works with, the chances are he'd start with Eurofighter Typhoon. >>



"In my department we look after a huge range of aircraft programmes, but when we tell people what we work on, we always say Eurofighter – it's top of the list every time. It's that bit different and it's great to have your name attached to it," Andrew says.

"I think there is a definite sense of pride to be part of the Eurofighter supply chain. Taken as a whole, Eurofighter is a relatively small programme when you compare it with the commercial aircraft programmes we also work on. But for me it is certainly the most prestigious.

"I guess you could compare it to Formula One cars against trains or buses. At air shows the Typhoon is always the one that everyone is waiting for – the highlight. And we all feel a bit of pride when we see it go through its paces

"We always work on the premise that nobody really wants the landing gear – it's only on there for take-off and landing, albeit at that time quite useful! At every other time it is in the way, taking up space for payload or passengers and this programme is no different."

The biggest challenges are weight, dimensions and how to fit in everything that needs to >>



... and lands. The sad ones amongst us go to the likes of Farnborough and, instead of looking at the aircraft, we look at the landing gear! It shows how keen we are."

Messier-Bugatti-Dowty delivered its 500th Eurofighter landing gear set this year, underlining its commitment to the programme. The original Tranche 1 landing gear was modified for Tranche 2 onwards in order to support enhancements that would allow the aircraft to operate with higher mass configurations.

The engineering involved represents a triumph of both form and function but Andrew knows that outside of his world few people cast admiring glances Typhoon's way for the products he produces.



▲ Testing brake temperatures...  
A vital part of 'post-flight' procedure

## >> HAPPY LANDINGS

be there in very a tight space. In fact it's a classic conflict. The landing gear needs to be light and small but at the same time very strong and robust. That's the exam question the Messier-Bugatti-Dowty team has had to find an answer to.

"The Eurofighter goal was to create an extremely agile and effective combat aircraft," explains Andrew. "This led to many technological step-changes in the air frame and how it operates requiring it to be as light as possible, as well as maximising the number of hard points for an array of payloads – weapons, surveillance and fuel tanks.

"The landing gear, although absolutely essential to operate the aircraft, is by nature a second priority. It was designed around two primary parameters – weight and bay envelope. These presented significant challenges and we had to come up with a very specific design solution to meet them.

"In Eurofighter the main landing gear is designed with a mechanism that significantly shortens the main gear as it retracts, which means it can fit into a much smaller envelope. It actually shortens it by quite a considerable amount. This is not necessarily typical for landing gear but we had to do that with Typhoon in order to fit into the envelope that we were afforded."

Solving the bay envelope conundrum wasn't the only factor at play for Andrew and his team. Another consideration was the material.

"Compared to the aircraft we work on in the commercial market, the Typhoon has different testing parameters. The solution has to be able to cope with ballistics and so on but we are not able to use exotic (or expensive) materials because long term we need to ensure that costs are kept down. We use materials that are widely procurable across the aerospace industry.

"Also, with a military aircraft like Typhoon, there are more onerous tests around the landing gear because the aircraft often has to operate in less than ideal environments. For example, we go through extra design considerations for different runway types. Typically an A320 will take off from a runway that is perfectly smooth. With Typhoon by contrast we can't be sure what the state of the runway is going to be like and we factor different standards into the design. Plus military jets tend to have heavier landings and of course the urgency around military take off compared to commercial puts more stresses and strains on the equipment."

Other things the team has to consider include corrosion protection, impact and even coping with chemical and biological agents in a war zone.

The Eurofighter programme is unique for Messier-Bugatti-Dowty in another way because they are the lead partners in a consortium along with Liebherr-Aerospace from Germany, Compania Espanola de Sistemas Aeronauticos (CESA) from Spain and Magnaghi Aeronautica SpA from Italy. As leader Messier-Bugatti-Dowty has two clear responsibilities: namely engineering and production schedule.

"It is the only kind of consortium-based programme we work on, which is interesting," says Andrew. "Working with the various work share partners in their respective countries

means different approaches both in terms of the engineering and operationally.

"Some of the partners are not our traditional suppliers; in fact, in some instances they are our competitors. Of course we all have different ways of working and we have adapted to work well together.

"A lot of people don't realise what the consortium model has been set up to achieve. It has put a good robust supply chain across the European partner nations and means they can develop and sustain expertise in-country. You spread out capabilities in the different nations and long term it's better."

As a platform, Typhoon is going to be around for decades to come, and with more and more aircraft entered into service across air forces, Messier-Bugatti-Dowty has been under no illusion as to the challenge still to come.

"We've worked hard with Eurofighter Consortium members (Airbus Defence & Space, BAE Systems and Alenia) to understand very well the needs and requirements of the platform today and way into the future to ensure that we have mature 'In-service' support systems well in advance of end of Series Production," says Andrew. <<



"The Eurofighter goal was to create an extremely agile and effective combat aircraft ..."



# ON PATROL IN THE BALTICS

As the UK RAF's term of policing Baltic airspace for NATO approached its midway point, Eurofighter WORLD spoke to Typhoon pilot **Flt Lt Oli Fleming** about life on base, working with the latest version of the P1EB, and chasing down some Russian MIG 31 Foxhounds. >>

## &gt;&gt; ON PATROL IN THE BALTICS



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▲ No. 6 Squadron Typhoons on a exercise

Strreaking across the clear blue Baltic sky, Typhoon pilot Flt Lt Oli Fleming hit Mach 1.5 after scrambling to identify two planes heading into international airspace near Kaliningrad. All he knew was that they were there without a filed flight plan.

As he pulled alongside, he realised they were aircraft he'd never come across before: Russian MiG31s.

Flt Lt Fleming didn't know it then, but that day in June was fast becoming the busiest RAF Typhoons had faced since their deployment to the Amari Air Base in Estonia.

In the space of 24 hours the Quick Reaction Alert (QRA) teams were scrambled four times to intercept Russian planes – two Tu-22M3 Backfire C bombers, two An-26 Curl surveillance aircraft, an A-50 Mainstay and, for the first time, Six MiG-31BM Foxhound fighters.

Some of the UK press called the event the 'biggest act of provocation since the Cold War',

but for Eurofighter pilot Flt Lt Fleming the scramble was a typical day at the office.

"The first thing we'll know about a launch is the scramble siren sounding," says Flt Lt Fleming, "and at that point the two pilots on duty will run to their separate jets as the engineers do the same thing.

"The reason we launch is to visually identify it, so we're not actually sure what we're going to go up against. There is definitely a large adrenalin rush as you run to the jet and get airborne as quickly as possible. Then it's a case of what you're going to be up against, how many aircraft you may see.

"The MiG31s were a bit of a surprise because they were something we'd not experienced before on a QRA and never expected to see. But the procedure remains the same: we get alongside and take some pictures of the aircraft for intelligence gathering, report it back to ground control and then stay alongside until we're ordered to haul off.

"The way the Russians are flying the aircraft is not aggressive, and we are just there to get confirmation of who they are and where they're going. Also they are operating outside the rules of the air so there is a flight safety role in us escorting them to ensure they are clear of civilian traffic. Obviously there's always the possibility any aircraft we're launched against could react, but that's not the reason they're out there and we're just showing our commitment to the NATO policing by escorting them through the Baltic airspace."

Flt Lt Fleming is a member of 6 Squadron, RAF Lossiemouth, who were sent out to Estonia at the beginning of May as part of the UK's commitment to Baltic Air Policing.

With no air defence fighters of their own, Latvia, Estonia and Lithuania are covered by NATO Assurance Measures, which keep the region's airspace secure. The UK is one of several nations which plays a part policing this airspace, working on a four-monthly

rotation basis with NATO members, such as Spain, Italy and Germany.

For Flt Lt Fleming, this commitment to policing Baltic airspace means he and his fellow pilots are constantly on standby for the next scramble.

"The pilots operate on a one-week-on, one-week-off basis for QRA," says Flt Lt Fleming. "We'll do three or four 24-hour shifts in a week, so basically we are in a waiting room – what we call the ready room – at the base for that whole period, in our kit and ready to go."

When the pilots aren't on alert, they operate a normal flying programme, training with Baltic forces and other nations based in the region.

"We've been carrying out air combat training with some of the Italian Typhoons and Norwegian F16s, so we do get a lot of practice," says Flt Lt Fleming. "We are fortunate enough to be operating the latest version of the Typhoon called P1EB (Phase 1

Enhancement Bravo); this allows us to complete lots of air-to-surface training with the Litening pod."

And when it comes to performance, he's got no doubt about the suitability of the Typhoon for the role of Baltic Air Policing: "It's pretty much unbeatable. If we're in a scramble we can get airborne very quickly. The Typhoon has the power to get up to height and speed rapidly; this is far superior to anything we are used to.

"When I was chasing the MiG31s, I needed to maintain 1.5 times the speed of sound just to chase them down, which in another aircraft would be a huge ask. The Typhoon allows us to get within visual range in an incredibly fast time frame.

"And then there's the aircraft's operational capability – it hardly uses any fuel, and the on-board systems can really help us out. The fact we can use an imaging pod to look at aircraft on the radar as well is a huge benefit."

▲ A RAF Typhoon accompanying a Russian Coot electronic intelligence gathering aircraft over the Baltic

▲ Interception work is part of the daily routine on Baltic Patrol

Flt Lt Fleming is typically cautious when talking about his mission, but says life on the Amari base is good: "It's a conscripts' base so fairly basic, but they've built extra accommodation for NATO countries on Baltic Air Policing, which allows us to have the whole team on base and work much more effectively.

"Obviously they know there's a new NATO team coming in there every four months or so, and they're very friendly to us and go out of their way to help us to ensure we are comfortable and can complete the mission.

"It's quite a remote base – we're an hour or so from the nearest town. We actually did a fly past over the city of Tallinn, which was pretty incredible. It just brings home to you why you're out here and you get a real feeling of pride to know you're playing a part in keeping the region safe and secure." <<

# THE YOUNG GUNS

In this edition of Eurofighter WORLD, we turn the spotlight on three young Eurofighter interns and trainees: **Greg Burnett**, **Carlos Garcia** and **Virginia Novarese**.

We discuss their hopes, ambitions and what they have learned during their stint in Eurofighter. >>

**GREG BURNETT, 21**  
Working with the Weapons Systems Integration Team on Future Requirements Capture



*How did you gain the opportunity?*

I was looking for something and heard about Eurofighter. So I made some enquiries and as soon as I got the chance I said yes.

*What attracted you to working at Eurofighter?*

I have always wanted to be a pilot with the RAF and as they use the Eurofighter Typhoon I thought it would be really good if I could go to Munich. Then in the years to come I will be able to say I've worked with Eurofighter. The job is really interesting because it is all about the aircraft and it gives you a good understanding of working behind the scenes. When I go back I'll be going into my fourth year of aero mechanical engineering at university. I looked to go into the RAF when I left high school but was advised to take up a degree. I have always wanted to fly, it has always fascinated me and so aero mechanical engineering was the closest I could do.

*What has surprised you most?*

The variety of people who work here which creates a unique cultural mix. On my first day

I was walking down the corridor with someone and I heard her speak in four different languages in the space of five minutes. It was amazing to see her do that with such ease. It's a place that really brings people from different places and different cultures together.

*How have you found living away from home?*

I settled in fine. Munich is such a beautiful city and I haven't had any problem finding things to do. The public transport system makes it very easy to get around. Here at Eurofighter everyone has been really friendly.

*What have been your biggest challenges?*

Understanding all the documents. There are a lot of industry specific acronyms and jargon that you have to get used to. But it gets easier and more familiar with each day.

*What does your day to day work look like?*

It varies - which is a plus. I have done lots of 'concept of operations' work and the first thing I was asked to do was reformat something. Recently I turned a report into a 10 page Powerpoint presentation and then presented it to 15 people. It was quite daunting at first but very rewarding.

*How are you treated?*

I was told right from the start that I wasn't just here to make the coffee. I get treated well, just like anyone else in the team. It shows they think I am capable.

*What have you learned?*

I have never worked in a professional office environment before. There is a lot more teamwork required. Working here has made me realise you have to work with everyone else and communicate - it's so different to university.

*How do you think this internship will help you?*

It has let me see what a future career might look like. I think working at Eurofighter will stand out on my CV. It is not just about working here but getting to work with so many talented and experienced people. I have been

keen to learn as much as I can and I have asked as many questions as I can. To be able to say that I went off to a different country, on my own and worked in an environment like this and made a contribution will only stand me in good stead and make me stand out from the crowd.

*Has it broadened your horizons?*

Definitely. Seeing different people from different cultures has been great.

*What would your advice be to a student reading this?*

Go for it!

**CARLOS GARCIA, 25**  
Working in the International Weapons System Support Centre - IWSSC



*How did you gain the opportunity?*

I am here for seven months. I knew the Company was looking for a graduate trainee and I wanted to give it a go.

*What attracted you to Eurofighter?*

I'm from Spain and I wanted to come to a multicultural international company. I was also keen to have the chance to gain experience in the aviation sector. My father worked in the aviation world and it's something I've always

been interested in. The first time I went into the cockpit of an aircraft was when I was 10 years old.

*What has surprised you most?*

I like working here because there are a lot of people from different countries and in the IWSSC you get to work directly with customers. We work as a team group and we make a difference for customers. It is good to build the relationships.

*How have you found living away from home?*

When I first came here it was hard but I like Germany and I like Munich. Of course it is different from Spain: the people are more serious and it can be difficult to make friends. But the opportunity to speak and get to know new people and listen to different points of views has been good. The other big difference is the food. It's not a Mediterranean diet - there's a lot of meat!

*What does your day to day work look like?*

I have been looking at a project plan to carry out improvement for the partners and tactical changes. The aim is to improve the department and make processes leaner and that will save costs for our industry partners and customers. Working on the plan means I have to speak with everyone in the department.

*How are you treated?*

I am treated as part of the team. I am not seen as 'the trainee', I am just another member of the team. The team has really helped me and they quickly gave me valuable feedback.

*What have you learned?*

It is very different from university where you are working on your own. Here it is valuable to work in a team.

*How do you think this traineeship will help you?*

I like the aviation world. Eurofighter is not typical of the whole industry but I will be aiming to apply for something in aviation.

*Has it broadened your horizons?*

Definitely. Seeing and working with different people from different cultures on a day to day basis has been a valuable experience.

*What would your advice be to a student reading this?*

Apply. They would gain experience of a truly mixed cultural environment and I highly recommend it.

**VIRGINIA NOVARESE, 24**  
Intern/Trainee in the E-Marketing Department



*How did you gain the opportunity?*

I was about to get my Bachelor Degree in Logistic and Production Engineering and I wanted to have a prestigious training experience like this. Amazingly enough I received news that my application was successful on my graduation day. It was one of the best graduation presents I could have wished for.

I started my Internship in PR & Comms and have since moved into the E-Marketing department which has given me the opportunity to learn about another branch of the business.

*What attracted you to working at Eurofighter?*

I had a little background in civil aviation thanks to an internship in Sagat S.p.A., the Management Company of Turin Airport. From the office windows I could see Eurofighter Typhoons taking off and landing every day and was fascinated by the aircraft!

*What has surprised you most?*

I'd say the consortium nature of the business and how people from different mother companies, different countries and who speak different languages all come together. It's fascinating having so many cultures working harmoniously on such a complex project.

*How have you found living away from home?*

It's second nature to me now. When I was 16 I went as an exchange student to Alaska for a year. Even the Bavarian winter was nothing compared to Alaska! Munich is a fabulous place to live. It's a very dynamic city with a lot of opportunities.

*What does your day to day work look like?*

When I was training in PR & Comms I had a daily routine of preparing the Press Clippings every morning and looking after the gift shop or fulfilling other communication projects in the afternoons. In E-Marketing I've had a more flexible job carrying out various projects - some jobs can last from a couple of hours, others entire weeks.

*How are you treated?*

I feel very well treated in the company. Everyone has always been extremely kind and patient with me. People have been very friendly and I truly feel part of the teams I've worked in. I have made many real friendships.

*What have you learned?*

In the PR & Communications department I learnt a lot about the importance of media, the differences between different publications and about how social media activity can be used to promote Eurofighter. In E-Marketing, I have learned about the many different levels sales campaigns are approached and how crucial industrial support can be in influencing a political decision. I have also learned a little bit of German!

*How do you think this internship will help you?*

I hope an internship in such a prestigious international company will have a very positive impact on my CV and will help me find an interesting and satisfying job in the future.

*Has it broadened your horizons?*

Absolutely! It's my first experience of the working world and I've realised how much more interesting dealing with something concrete is compared to theoretical university studies. I know I still have a lot to learn but I feel much more ready and look forward to new working experiences.

*What would your advice be to a student reading this?*

I would encourage every student to take the challenge of leaving the safety of their homes and stepping into the unknown by moving to a new country and learning a new job. It really is a wonderful opportunity and a life changing experience!

*Since this article was written Virginia moved on to the Eurofighter Production department.*

# NEW NIGHT VISION FIGHTER PILOT HELMET TAKES TO THE SKIES

*\*This article updates the Striker II 'Bring on the Night' feature which you can read in the last issue of Eurofighter WORLD*

Eurofighter Partner Company, BAE Systems has begun night trials on the Striker® II helmet-mounted display (HMD), its' most advanced fighter pilot helmet yet, to evaluate its digital night vision capability.

Successful trials will lead the way to a fully integrated digital night vision helmet replacing the need for traditional analogue night vision goggles.

Developed and tested by BAE Systems, Striker II is a fully digital solution that provides today's combat pilot with exceptional night vision and target tracking technology. The Eurofighter EPC has begun evaluating the digital night vision capability through a series of night flight trials from its Military Air & Information business in Warton, Lancashire.

"Striker II has a high-definition, lightweight night vision camera which translates information and displays it on the helmet's visor. This removes the need for heavy night vision goggles which increase g-force pressures on the head and neck, limiting the pilot's manoeuvrability in the cockpit," said Peter Kosogorin,



test pilot at BAE Systems' Warton site. "The helmet provides a clear and accurate visual display and a seamless transition from day to night, eliminating the need to manually configure and adjust night vision goggles."

The Company will continue to evaluate the helmet's integration with Eurofighter Typhoon aircraft in another series of flight trials later this year.

"The second set of trials is the next step in the flight test program to prove Striker II offers true 'plug and play' compatibility with the Typhoon and builds upon the initial trials to further evaluate the digital night vision capability," said Chris Colston, Business Development Director.

Striker II also includes a cutting-edge tracking system that ensures the pilot's exact head position and the aircraft computer system are continuously in sync, reducing problems common to other HMD's. The tracking system in Striker II eliminates any delay in determining where the pilot is looking and can therefore perfectly position symbology onto the visor.

The results are high-precision target tracking and engagement as well as superior situational awareness and mission effectiveness.

# MORE AGILE THAN EVER...

Eurofighter Partner Company Airbus Defence and Space has recently completed flight-testing of a package of aerodynamic upgrades to the Eurofighter Typhoon known as the Aerodynamic Modification Kit. The modifications comprise of additional fuselage strakes and leading-edge root extensions designed to increase the maximum lift created by the wing. Now, over 30 flight trials on IPA7 have produced better than expected results in improving the aircraft's agility, which in turn has the potential to enhance the Eurofighter's capability in close quarter aerial combat or 'dogfighting'.



In reality, the Eurofighter Typhoon is already incredibly agile, and there is little more manoeuvrability that can be added without the aircraft going beyond the levels of g-force that a pilot can stand. However, the new approach could enable the aircraft to carry much heavier and larger air-to-ground weapons whilst maintaining its current air-to-air performance.

The modification could be offered to current and potential future customers of the Eurofighter Typhoon. It's one of a number of developments geared at enhancing the fighter's performance and swing-role capability in order to secure further export orders. These include the E-scan radar and a number of weapon trials, including Meteor, Brimstone, Storm Shadow and Paveway IV.

# FURTHER SUCCESSFUL METEOR TRIALS FOR EUROFIGHTER TYPHOON

BAE Systems, one of the Eurofighter Partner Companies, has successfully completed guided firing trials with the Meteor Beyond Visual Range Air-to-Air missile launched from a Eurofighter Typhoon aircraft.

The trials took place at the MoD's Hebrides range in the UK in August and saw the aircraft conduct guided Meteor firings against real air targets in preplanned scenarios. The trials are part of the Phase 2 Enhancements flight test campaign, delivering a range of new and improved capabilities to the aircraft including Meteor and Storm Shadow.

Typhoon aircraft IPA6, a Tranche 2 standard aircraft equipped with the latest P2E software, was used for the trials. Test Pilot Nat Makepeace flew the aircraft and said, "The aircraft and missile performed as expected, locating the target accurately and maintaining a datalink communication between the weapon and the aircraft. This year is undoubtedly one of the most exciting years I have experienced in the development of Typhoon. We are taking to the skies with upgraded software, trailing new night vision helmet technologies, developing and expanding weapons capabilities and looking forward to flying the E-scan radar all in the space of a year."

The integration of the Meteor weapon adds another layer to Eurofighter Typhoon's multi-role capabilities, ensuring the pilot is able to engage hostile air threats at long range at the same time as identifying and engaging targets on the ground.

The flight trials were conducted with integrated support from QinetiQ, MBDA and Selex and form part of a contract to fully integrate the Meteor missile onto Typhoon in 2017.

Read more on how weapons such as Meteor are integrated into the Eurofighter Typhoon on page 8.



### KEY FACTS:

- Produced by MBDA, Meteor is an active radar guided missile designed to provide a multi-shot capability against long-range manoeuvring targets, such as fast jets, small unmanned aerial vehicles and cruise missiles in a heavy electronic countermeasures environment.
- Capable of engaging air targets during day and night, and in all-weather conditions, the Meteor will complement Typhoon's existing missile systems, providing pilots with a greater choice of weapons during combat.
- These trials take place in a year that has seen progress across a range of programmes for the Eurofighter Typhoon. The UK RAF is now operating the most advanced Typhoon to date with the latest Phase 1 Enhancement package now in operation. This upgrade delivers true simultaneous swing-role capability to Typhoon.
- Progress is also being made across a number of weapons programmes including Storm Shadow and Brimstone.

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### IN OUR NEXT ISSUE...

Don't miss the latest news and features on Eurofighter Typhoon:

- Insider reports on the latest capability upgrades;
- Get to the heart of the aircraft with our expert guides;
- Find out more about the people and personalities that make Eurofighter Typhoon so special.



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