

EUROFIGHTER

PROGRAMME NEWS & FEATURES
MARCH 2016

WORLD



- A CHANGING WORLD
- COMBAT EDGE
- HOWARD'S WAY



MASSA vs. BOWMAN

WHEN SPLIT SECONDS COUNT

 Eurofighter
Typhoon



Title:
Reflections on speed and
decision making.
Two professionals speak out.
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BAE Systems/Williams F1

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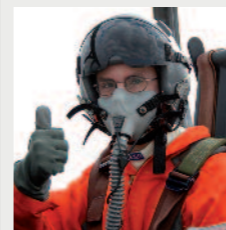
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Austrian Air Force Eurofighters air-air at Zeltweg



WELCOME

I'm delighted to be back at Eurofighter, especially in my new role as Chief Executive Officer (CEO) of a company I know and love. It's a great time to re-join the organisation. This magazine is just one of the many 'shop windows' on our world, and I hope you enjoy reading it.

EDITORIAL

In the Eurofighter Typhoon, we have a world-class combat aircraft, and I'm certain we can look to the future with confidence. Right now, there's much happening on the Programme. Work is going full steam ahead on contracts for Meteor and Storm Shadow integration, for the future E-Scan radar and on Phase 3 Enhancements.

This issue of Eurofighter WORLD should give you a real sense of how the aircraft is taking shape, as well as the pride and expertise of the people who work closely with it.

There are some fascinating articles, not least the feature interview with the F1 driver, Felipe Massa. In it he looks at some of the parallels between F1 drivers and fast jet pilots. We're very grateful to the Williams F1 Team for their help in making that story come to life.

We also speak to NETMA's Brigadier Javier Del Cid De Leon, who led the first Spanish Air Force deployment of Eurofighters on Baltic Air Patrol. He speaks about the crucial role the Eurofighter Typhoon plays in protecting national interests.

Another article I'd recommend is a feature on how Eurofighter's sensors work together to give pilots what we like to call 'Combat Edge' during a mission. It highlights a whole host of intelligent design features that go into making the aircraft so special. Linking into that is a piece by guest author and journalist Tim Robinson from the Royal Aeronautical Society, who talks about Eurofighter's place in the ever-changing battle space.

There's also a look at the specialist equipment that goes into creating a Eurofighter pilot's unique life support system – technology meets life-support clothing in ways few could imagine.

Finally, this issue also offers you a chance to take a look at the work we do to bring advance capability to the aircraft with one of our key partners MBDA. It puts the 'weapons' into our Weapons System and gives insight into a fascinating world.

I hope you enjoy the read as much as I did, and I'd welcome any feedback you may have.

Yours

Volker Paltzo
CEO
Eurofighter Jagdflugzeug GmbH

BETTER AND BETTER

Eurofighter Typhoon is the most advanced new generation swing-role combat aircraft currently available on the world market. And the past 12 months have seen progress across a range of programmes for the aircraft – not least testing on **Phase 2 Enhancements**, a major stepping stone in the continuing capability journey of the aircraft. So what will it bring to the mix and how is it shaping up? >>

The UK Royal Air Force Test and Evaluation Squadron has welcomed the capability upgrades to the Eurofighter Typhoon combat jet after taking the latest enhancements to the skies to test how they will work when in service.

41(Reserve (R)) Sqn TES (Test and Evaluation Squadron), based at RAF Coningsby, has been at BAE Systems' site in Warton, Lancashire, where an early version of the Phase 2 Enhancements (P2Ea) Typhoon, was successfully tested.

41(R) Sqn TES pilots conducted a number of Operational Performance Assessment Tests (OPAT) on the aircraft. These OPAT flights allow the customer to fly an early version of the P2Ea avionics and software upgrades in a way which represents how they

will work when fully in service. This feedback is then assessed and helps directly influence the final design.

Two tests were conducted using Typhoon IPA (Instrumented Production Aircraft) 6 – one a typical air-to-air exercise and the other an air-to-surface exercise targeting simulated targets.

Wing Commander Steven Berry, of 41(R) Sqn, said: "The P2Ea upgrade brings some major capability changes and some welcome tweaks to the existing capabilities. The enhancements mean as an air-to-surface platform, **Typhoon has the simplicity and flexibility in the design to be easily employed in close air support missions or more complex scenarios like convoy over-watch.**

"By 2019, Typhoon will be filling a lot of roles, including air defence of the UK,

offensive and defensive counter-air, stand-off attack and close air support. That's a lot of skills for a frontline squadron to master. Typhoon needs to deliver all of that capability in a simple, reliable cockpit."

There are further OPAT tests planned this year. These tests will seek to determine any changes or improvements that would need to be implemented before the final version of the upgrade commences flight test and roll-out. They are part of a combined testing approach, allowing the customer to fly capability improvements at an early stage and feed into the design process to ensure the upgrades are exactly what the end operator needs.

P2Ea is a major stepping stone along the path of the RAF's Project CENTURION – the project to ensure a seamless transition between Typhoon and Tornado GR4's roles when the latter goes out of service in 2019.

The full P2E upgrade for the RAF will include the integration of the MBDA Meteor Beyond Visual Range Air-to-Air Missile. The next phase of enhancements, P3E, will bring the MBDA Storm Shadow cruise missile and MBDA Brimstone 2 close air support weapon into service on the Typhoon in the UK.

The first release of a Storm Shadow missile from Typhoon IPA2 took place in November 2015.

This continued the series of trials our Eurofighter Partner Company, Finmeccanica - Aircraft Division, is leading to demonstrate the full integration of the Storm Shadow missile with the Typhoon weapons system. Further integration work, including scheduled firing trials on Meteor and Storm Shadow, is ongoing.

Finmeccanica - Aircraft Division, with support from BAE Systems, missile designer and producer MBDA, and specialist trials support from QinetiQ, conducted trials at the Aberporth MoD firing range. Further work on both Storm Shadow and Meteor continues.

Andy Flynn, Head of Capability Delivery Programmes for Combat Air at BAE Systems, said: "Working with the customer test teams

at this stage provides us with invaluable feedback that we can assess and directly feed-back into the design process. This combined testing approach is a fundamental part of how we are improving the way we do business. It allows the customer to fly capability improvements at an early stage and provide feedback to ensure the upgrades are exactly what they need."

The Eurofighter Typhoon is subject to an extensive continuous upgrade programme and the latest Phase 1 Enhancement (P1E) package – delivering true simultaneous swing-role capability to Eurofighter – entered into service with the UK RAF last year.

Upgrades and integration of new weaponry, as part of P2E, further enhances the aircraft's potent multi-role and swing-role capabilities – adding new capability to strike day or night, in all-weather conditions. <<



SPLIT SECOND SUPREMACY

In the world of Fighter Jets & Formula One - winning means survival. Here F1's Felipe Massa and Eurofighter Typhoon's Mark Bowman explain why. >>



FELIPE MASSA

Nationality: Brazilian
Born: 25th April 1981
Job description: F1 Racing Driver
Height: 1.66m
Weight: 60kg

CAREER HIGHLIGHTS

2014
Racing Driver for Williams

2006 - 2013
Racing Driver for Scuderia Ferrari

2004 - 2005
Racing Driver for the Sauber Petronas F1 Team

2003
Test Driver for Scuderia Ferrari

2002
Racing Driver for the Sauber Petronas F1 Team

2001
Euro F3000 Champion. Test with the Sauber Petronas F1 Team

2000
Italy and European Formula Renault Champion

1999
Formula Chevrolet Champion (Brazil)

1998
Debut in single-seater

1990
Debut in karting



Interlagos, Sao Paulo, Brazil. Sunday 15 November 2015.
Felipe Massa, Williams FW37 Mercedes, makes a pit stop.
© LAT Photographic



MARK BOWMAN

Nationality: British

CAREER HIGHLIGHTS

2015 Director Flight Operations

2015 Chief Test Pilot

Joined BAE Systems as Harrier Project Test Pilot and then as Typhoon Project Test Pilot.

Appointed by Ministry of Defence on Operational Requirements area for Typhoon programme.

Flew Harrier GR7 in Middle East and Balkan campaigns

Promoted Squadron Leader - posted to frontline as an executive on 3(F) Squadron

Project Test Pilot, - night electro-optical capability in Harrier Jaguar weapons trials in support of Gulf War

Trained and qualified as test pilot at Boscombe Down Empire Test Pilot's School flying Harrier and Jaguar

Posted to 1(F) and IV(AC) Squadrons - worldwide deployments, flew Harrier VSTOL fighter.

Entered flying training at RAF Cranwell, Valley and Chivenor

Studied Aeronautical Engineering at Imperial College.

Joined the RAF as a cadet

>> SPLIT SECOND SUPREMACY



THE F1 DRIVER

Monte Carlo, Monaco.
Thursday 21 May 2015.
Felipe Massa, Williams F1.
© LAT Photographic

Felipe Massa is one of the best-loved and most experienced racers in the F1 paddock. The Williams driver took time out of his busy schedule to talk to Eurofighter WORLD about the challenges he faces, the parallels between his sport and the world of a fast jet pilot, and his love of speed. >>

Circuit of the Americas, Austin, Texas, United States of America. Friday 31 October 2014. Felipe Massa, Williams FW36 Mercedes. Photograph: Steven Tee © LAT Photographic

How does the F1 driver assimilate information in the cockpit – whether it is coming through the earpiece, steering wheel or any other input – and how does this affect performance? When is it a bad time to be spoken to?

I'm the sort of driver who is quite comfortable receiving information from the team when driving, but you do work with your team to make sure that you are getting information at moments that are the least distracting. The straights are the best time for me and my engineers will try and relay anything I need to know when I'm driving a straight, rather than a corner. You also need to be comfortable with the engineer who is in your ear. That person needs to be organised and give you concise and accurate information. If I have a new engineer I will work with them before the start of the season to practice our radioconversations so that you are in a good rhythm before the season starts.

Beyond driving, what do you consider to be the key skills needed to do the job?

The most important thing is raw talent – you have to be consistently quick. Without that you will never get into F1. Aside from that, you need to also have a good knowledge of engineering to understand what is working in the

car and what isn't – this helps with developing the car over the course of a season. You also have to be able to work well within the team. There are a number of qualities you need to make it to F1, and then stay there, because it's so competitive.

In a race situation, do you ever feel alone or do you feel part of a much larger team reliant on strategic, technical and mechanical inputs?

You never feel alone in the car because you very busy behind the wheel and you're constantly getting information and requests to change things in the car setup, or information on the strategy and when to stop etc. You get a sense that you're driving for many people.

What is the job like from a physical perspective – the biggest challenges – the surprisingly easy bits?

You have to be an athlete to drive an F1 car. We can experience 5G when braking and cornering and that puts a lot of strain through your body and particularly your neck, as we are racing non-stop for nearly two hours. We also have to cope with very high temperatures. At a race like Malaysia the temperature in the cockpit can reach 50°C and it feels like driving in a sauna. You also have to have a lot of concentration and be strong mentally. The car

Circuit of the Americas, Austin, Texas, United States of America. Sunday 25 October 2015. Felipe Massa, Williams F1. © LAT Photographic



▲ Yas Marina Circuit, Abu Dhabi, United Arab Emirates. Sunday 29 November 2015. Felipe Massa, Williams F1.

▼ Autodromo Hermanos Rodríguez, Mexico City, Mexico. Saturday 31 October 2015. Felipe Massa, Williams F1. Photograph: Steven Tee © LAT Photographic

is always on the edge and a small mistake can take you off the track. That's definitely the case on very tight tracks like Monaco.

How much training is done in a simulator and how advanced are they in terms of being able to truly prepare the driver for lights off, race day?

Because we have only a limited number of days where we can test the actual car during a season, simulators are a very big part of the work I do. We have a very sophisticated simulator at Williams and I will drive that before a race to understand the track, but also to help with the setup of the car. The tracks are laser scanned so they are very accurate. That's really what the simulator is for – it's an important piece of equipment for developing and improving your car. Of course nothing will ever compare to the real thing so simulators have their limits, but the technology is improving all of the time.

What are the similarities between F1 drivers and fighter pilots? Do you think F1 drivers and fighter pilots are very much the same breed of people?

It depends really. If you're just flying normally then I imagine it is quite a different job and would probably be easier and more relaxed, but if you're fighting with someone in the air or trying to escape, then there are a lot of parallels. In an F1 car you're always fighting and battling with someone in front or behind and have to be very aware of what is going on around you. A fighter pilot in a combat moment has to be just like this. Of course they are risking more than we are so I have a lot of respect for them. If we make a mistake we will lose lap time or might spin, especially because the safety of the cars has improved so much, but



small number of F1 seats, so the key is to be able to stand out and show that you have something special and different to the rest. Natural talent is one thing, but that needs to be backed up with a lot of hard work. You also need to be humble and to have a desire to always improve and get better, even if you are winning races.

How important do you think technology drivers in the world of aerospace and motor racing are to the average person?

the consequences of a mistake for a fighter pilot can be far more serious. I'd say racing drivers and fighter pilots would have a similar mentality – a love of speed, high technology etc. I imagine a number of F1 drivers would like a career as a pilot if they had not made it as racing drivers.

What attracts you to the sport – the speed, the technology, the competition, the teamwork?

I love cars, and I love speed – I was born like that. When I was a kid I always wanted to go fast and loved cycling and going skateboarding. But I also always wanted to make a race out of anything and challenge my friends. So whilst I certainly love fast cars and the technology, for me it is really the competition side that attracted me to F1. If you're just driving the car and you're not against the clock, it is not anywhere near as fun as when you're racing or trying to beat a time.

What advice would you give to anyone who wants to pursue a career that revolves around speed and split second decision making?

There are a lot of people fighting for a very

There has always been a history of technologies from F1 making their way into the real world, particularly into road cars. I know Williams are doing a lot of work in this area. We have an Advanced Engineering division on the same site as the F1 team and they focus on taking F1 technology and introducing it into other areas. In fact I know they work with aerospace and defence companies.

I've been over to their workshop a number of times and they have some very cool projects on the go – although many of them are secretive and I can't talk about them! In F1 we work with the latest technologies and make things very very quickly, so it's not surprising that other companies would want to learn from that. I remember the Williams Advanced Engineering Team have worked on a project taking F1 aerodynamics ideas and introducing them into supermarket fridges for example!

What's your personal message to the readers of Eurofighter WORLD?

I have a lot of respect for pilots and there are certainly similarities to what we do. A love of speed and technology runs in our blood! >>

>> SPLIT SECOND SUPREMACY



THE FIGHTER PILOT

Director of Flight Operations **Mark Bowman**, heads up BAE Systems' Flight Test group at Warton in the UK. He has worked with a number of F1 teams looking at ways of sharing best practice. Here he looks at the parallels between the worlds of an F1 driver and a Eurofighter Typhoon pilot. >>

How does the combat pilot assimilate information in the cockpit – whether it is coming through the helmet comms or any other source of input – and how does this potentially affect performance? Is there a bad time to be spoken to?

Information comes from all sorts of sources all the time. For example, there are the visual displays and these are now usually enhanced with helmet mounted displays. In addition, pilots also hear through the comms system from various sensors. As a result, a key task for the pilot is to decide how and when to act on the information that's coming at them. A great deal of the training that today's frontline pilot receives is about taking in all this information, mentally processing it and, if we've got the design right, making decisions – most often the right ones.

Given the complexity, speed and volume of information they're processing, the only way they're able to do that is thanks to a cockpit design that allows the pilot to swiftly make sense of what's happening and take time-critical decisions. In combat you need information to be clear, simply presented and supported by a system that allows the pilot to swiftly analyse likely success or failure.

Beyond flying, what do you consider to be the key skills need to do the job?

There are clearly some key mental and physical attributes that every fighter pilot needs

that allow them to operate in what can be a very challenging domain. You need to be a clear communicator, have a high level of technical knowledge of the platform (both its capabilities and limitations), plus a state of mind that allows you to quickly take in information, resolve problems, and act on them. So you need tenacity.

Having said that, you also need to be a good team player, because you're not acting up there on your own. Being a fighter pilot is very much a team effort that involves the clever engineers, ground crew and of course, the other members of the formation; there's simply no 'I' in team.

Can you describe the overall situational awareness a fighter pilot has in the cockpit – what can they see, hear, feel and sense? How do these blend together and how can this affect competitiveness?

Well first you need to understand that you're operating in a hostile environment, certainly environmentally, if not always operationally – whilst outside it can be warm or cold, inside, the air con keeps it just about right, but even the best protection in the world can't prevent you from noticing just how bright the sun is! And the engineers have done wonders in helping eliminate noise from the cockpit. That said, all those kinds of stresses need to be addressed.

But beyond that the fighter pilot needs to have what I'd call, a real sense of connectivity with



GAF Eurofighter Typhoon of JG-74 Neuburg



RAF Coningsby Eurofighter Typhoon, April 2008

the aircraft. That means you need to feel what the potential of the platform is. For example, how quickly is the aircraft turning compared to how much back stick you've put in? Or how you manage tell-tail buffet when it's telling you the aircraft is reaching a limit? Ultimately, to help win or lose, it's a question of how well the pilot is able to identify when the aircraft is reaching the limit or 'she' has more to give. On top of that of course the pilot is constantly receiving information from the aircraft's sensors. They take it in, process it and translate it into where and how they want the aircraft to move. In terms of competitiveness, for a fighter pilot, that means simply who takes the first shot usually wins, and then whether it's a case of fight or flight. In Typhoon the answer is usually fight and win!

In a mission situation, do you ever feel alone or do you feel part of a much larger team reliant on strategic, technical and mechanical inputs?

At the most basic level you could describe it as a pilot being in his 'bubble', but only in the sense that you need to have full concentration on the mission, rather than dealing with distractions. The mission becomes the pilot's all consuming focus. Reinforcing that you need to have full confidence in the performance of your weapons system.

You are also acutely aware of support you may need from other 'players', whether that's as part of the formation or part of supporting assets such as E3-AWACS or ground troops.

How much does the aircraft 'fly' itself?

We are at a point now where flying the aircraft is no longer the all-consuming task that it might have been say 25 years ago. We almost take it as a given that the technology will allow the aircraft to practically fly itself, but it's for a very good reason. Most of the pilot's capacity needs to be focused on the mission, rather than wrestling with the controls and making sure the aircraft is flyable. New levels of automation >>

>> SPLIT SECOND SUPREMACY



are coming along all the time and ultimately the flying task may be taken away from the pilot. That opens up the question of whether we should continue calling them pilots or merely mission systems commanders. I need to check the dictionary!

What is the job like from a physical perspective? What are the biggest challenges and the surprisingly easy bits?

The environment can be quite brutal because of the rotational and pitching forces. An aircraft like Typhoon can operate between +9G and -3G and rotation rates approaching a full revolution a second, and therefore physical fitness and resilience is important. Clearly the aircraft is designed to help the pilot cope well through some cool kit like full cover anti-G suit and by modifying the angle of the ejection seat, but overall strength, both physical and mental, are required in large handfuls. One of the surprisingly easy bits is what we call 'relaxed G' which is the ability for the pilot to sustain relatively high G for long periods of time. Some of the challenges that people don't often think about come from the sometimes longer duration trips. What do you do on long transits when you don't have the ability to get up and stretch your legs? Typhoon has to have the capacity to stay airborne for long periods and it's these that can present the biggest sometimes 'physical and contortional' challenges for pilots, where 'crossed legs' are not an option!

What do you consider the parallels are between being an F1 driver and a fighter pilot?

For my money you need similar personality traits – drive, ambition, talent and also an awful lot of luck. I know from personal experience that both pilots and F1 drivers can get very close to the edge and clearly, the aim is to minimise those occasions. I think the mentality is similar. In fact mutual respect. We also operate in a similar high tech environment. We are asked on occasions to use unfamiliar technology at much earlier stages of development than perhaps the rest of the population and so we have to become very adaptable to change. Of course, in one area we are quite different – we aren't paid the same rock star salaries that the F1 boys are!

Are you both brave?

Brave! I don't know, I'd say we are good at compartmentalisation and very task focused, rather than allowing external factors to interfere with our thoughts too much when airborne. It is fair to say during your career you will experience some great successes, near misses and scrapes but you can't dwell on them for too long. You have to be able to move

on very quickly – put them in their box – and remain focused on the task. Bravery, it's a mental thing!

How much training is done in a simulator and how advanced are they in terms of being able to truly prepare the pilots for mission?

I know there is growing use of simulators in both fields, as technology improves and they become more and more accurate and precise. Where once a pilot may have expected to spend 10 per cent of their time in a simulator, the fighter pilot of today will probably be spending closer to 50 per cent. The role of the simulator has changed too. It used to be where you went once a month to test your emergency procedures, but now the quality and ability to accurately produce sensor performance means you can simulate most missions. It's a great way of learning lessons, allows you to be very productive and doesn't cost as much as using the real thing.

What could pilots learn from F1 and vice versa?

We both deal with a multi-skilled team of people, both use high tech equipment and both operate in high performance teams. From what I've seen of the F1 world I really admire the resilience of F1 drivers. From a testing point of view test pilots go through a 12-month course learning how to analyse and communicate within the team. But there is no F1 test driver school or equivalent that uses a common language within the sport of F1. So from that perspective there is perhaps a future opportunity. Because whether you are testing an aircraft or an F1 car, the ability to communicate words with precision and consistent meaning is essential. What could we learn from the sport? Well, having witnessed at first hand the singular empowerment and responsibility that the engineering teams in F1 are given, there are probably some lessons we could learn here. They are trusted and empowered to react quickly and produce sound results. In both worlds the consequences of getting it wrong are acute and therefore the quality of the team training in F1 has to be something to be admired.

What attracts you to the combat air environment – the speed, the technology, the competition, the teamwork?

Being a fighter pilot or F1 driver is every young person's dream. I was no different. There were two paths I wanted to take – flying or driving. I was looking for excitement, endeavour and something that would give you a rewarding and exciting life. Speed is an obvious attraction. It draws you in. What I've discovered is that a car going fast over a road is every bit as exhilarating as

flying an aircraft at 250ft above the ground. The more you get into it and test yourself in those kinds of environments, where speed is central, the more you want it. It becomes like a drug.

Then it's a case of choosing the jobs that will allow you to do that. You have to possess ambition, drive and self-belief. You also need the mentality that, if at any stage it doesn't work out, you learn to stand up, dust yourself off and move onto the next thing but you don't ever give up or give in, you just find other clever ways to fulfill your ambition. It's all a mental thing.

What advice would you give to anyone who wants to pursue a career that revolves around speed and split second decision making?

First of all, self-belief is important. You need talent, but you can always strengthen your natural skills with training and practice. But you also need ambition and, along the way, you are going to need some luck too. You should never ever believe that you have to give up.

How important do you think technology drivers in the world of aerospace and motor racing are to the average person?

Technology pushes both our worlds at an incredible speed and very often both are used as a test bed for the innovations that filter down into the 'real' world. There are obvious parallels between F1 and aerospace, for example, the use of simulators and wind tunnels. We are in a sense operating in a similar space. To push technology, you need companies working in an agile way and you need to have people who are clever enough to adapt the changes.

How important is the 'human element' in the total performance package?

When you have Typhoon flying with another Typhoon what it highlights is human frailty. The machine's performance is exactly the same – the only variable is the human. The mental state or approach of each pilot can be different and that can effect performance. It demonstrates that some people adapt better to different situations. Under very high levels of stress the human becomes more vulnerable to small changes.

This underscores the importance of getting and training the right people, with the right skillset, the right mental attitude and resilience. This is absolutely key to normalising the chances of things going wrong because of human failure. >>

>> SPLIT SECOND SUPREMACY

WILLIAMS F1 (2015)

POWER UNIT	Mercedes-Benz PU106B, Turbocharged V6 with Hybrid Engine Recovery System
TRANSMISSION	Williams eight speed seamless sequential semi-automatic shift plus reverse gear, gear selection electro-hydraulically actuated
FUEL INJECTION	High-pressure direct injection (max 500 bar, one injector/cylinder), pressure charging single-stage compressor and exhaust turbine on a common shaft. Max rpm exhaust turbine 125,000rpm
MAX RPM	15,000 rpm
BRAKES	AP 6 piston front and 4 piston rear calipers with carbon discs and pads
TEMPERATURE	Maximum operating temperature of brakes is around 1000°C.
CLUTCH	Carbon multi-plate
CHASSIS	Monocoque construction laminated from carbon epoxy and honeycomb
DIMENSIONS	Width: 1800mm, Length: 5000mm, Height: 950mm,
WHEELS	Apptech forged magnesium
TYRES	Fronts: 245/660-13, Rears: 325/660-13
SUSPENSION	Double wishbone, push-rod activated springs and anti-roll bar
ELECTRONIC SYSTEMS	FIA SECU standard electronic control unit
ERS	Mercedes AMG HPP
COOLING SYSTEM	Aluminium oil, water and gearbox radiators
FUEL SYSTEM	ATL, Kevlar-reinforced rubber bladder
STEERING	Williams power assisted rack and pinion
COCKPIT	Six point driver safety harness with 75mm shoulder straps & HANS system, removable anatomically formed carbon fibre seat

EUROFIGHTER TYPHOON

POWER UNITS	90kN from each of the two Eurojet EJ200 Turbojets
MAX SPEED	Mach 2.0 (1,535 mph)
MAX ALTITUDE	above 55,000ft
LENGTH	15.96m
WINGSPAN	10.95m
G-LIMITS	+9 / -3
PASSIVE SENSORS	IRST and LDP
PILOT AIDS	Radar, Sensor Fusion, DASS
WEAPONS	Lethal Air Dominance Stealthy Deep Strike Air-Surface Payload
	6x Meteor and 2x SRAAM 2x Storm Shadow/Taurus 6x smart bombs/12x Brimstone 2
AIRCRAFT STRUCTURE	
Carbon Fibre Composites	70%
Metals	15%
Glass Reinforced Plastics (GRP)	12%
Other Materials	3%
COCKPIT	
	Advanced cockpit design - unique glass cockpit, from the head-up, head-down and head-out systems to all-round vision.



PRECISION ENGINEERING

MBDA
MISSILE SYSTEMS

The Eurofighter Typhoon is currently in the middle of one of the most important periods of its life. Blessed from inception with incredible performance characteristics, it has evolved into a world beating platform thanks to a capability programme that is putting weapons integration centre stage. In this edition of Eurofighter WORLD, we take a closer look at the work of missile specialists MBDA and how their relationship with Eurofighter has developed. >>

The first thing you notice about MBDA is the scale of the operation. It's vast. "MBDA is the first truly integrated defence company in Europe and we provide missiles and missile systems for all branches of the Armed Forces – air, sea and land", says Paul Mead, Group Business Development Director. "We have partnerships with customers throughout the world and are one of three global players in the missile sector, the other two being based in the USA."

To put this in the context of numbers our order intake in 2015 was Euro 5.2 billion and that was split as domestically Euro 1.6 billion and export Euro 3.6 billion, with an order book of Euro 15.1 billion. Although it operates autonomously, the Company has the backing of our three major shareholders – BAE Systems (37.5%), EADS (37.5%) and Finmeccanica (25%). In terms of our industrial sites, it is located in France, Germany, Italy, Spain, the UK and the US, with 10,000 employees, the majority of whom are engineers.

MBDA has longstanding links with the Eurofighter programme, sharing an industrial heritage with the consortium partners that make up Eurofighter through its own industrial

shareholder links, specifically BAE Systems, Airbus and Finmeccanica - Aircraft Division, who are all part of the Eurofighter Jagdflugzeug GmbH Consortium. But in terms of products the story starts with the Royal Air Force.

"The relationship could be considered to have started with ASRAAM as the Royal Air Force's choice for its infra-red air dominance missile, but has extended to a whole range of MBDA weapons that fulfil a variety of mission roles", says Paul.

"The relationship has grown deeper and stronger as the aircraft's capability has evolved and the demands of the global market have placed increasing emphasis on the role of weapons in customers' decision making.

"As a consequence the range of missiles that MBDA offers for Typhoon has grown to cover a wide range of missions that includes air-to-surface weapons such as Brimstone, Storm Shadow, Taurus, Marte ER and SPEAR and air-to-air missiles such as ASRAAM and Meteor. The result is that MBDA's products bring combat capabilities that no other missile company can offer on Typhoon."

The relationship between the Eurofighter programme and MBDA is far closer than

perhaps the classic supplier role of old. Weapons testing programmes are complex by their nature and require a great deal of joined up thinking and working. Paul describes it as a partnership – and one that touches different levels in the respective organisations.

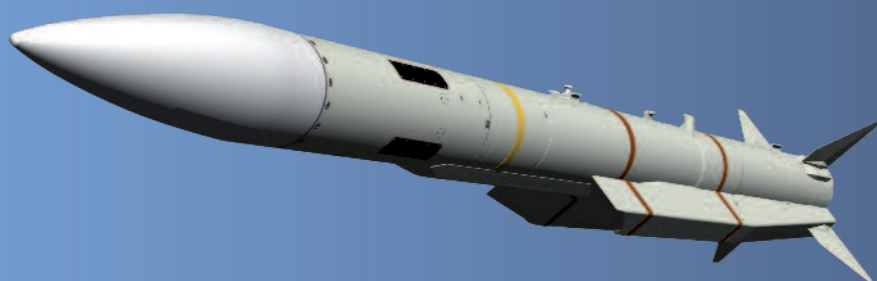
"I believe it's a significant and long-term relationship, with both parties working together to produce a 'total weapon system'. It should be seen as a partnership with the objective of maximising the potential of the whole weapon system (aircraft and weapons). At this stage of the aircraft's life the partnership and relationship has enabled us to keep the aircraft relevant and at the forefront of air combat capability.

"We also need to recognise that there have been significant changes in the nature of air combat in recent years; the fact that the aircraft will need to cover a variety of roles and that the weapon systems integrated onto it must also meet future combat requirements.

"Customers also expect system level solutions to comprise of highly integrated elements in order to meet their training, operation and support needs across the life cycle. Working with Eurofighter has enabled all of us to meet >>

>> PRECISION ENGINEERING

▼ Meteor in flight © MBDA UK Ltd



these challenges. The partnership must therefore operate at various levels; from establishing the capability requirements of the overall weapon system, a combined strategy to support these and the delivery of effective capabilities to time, cost and in line with operator expectations and beyond.

"Only through this partnership are we able to remain at the forefront of global air combat capability for the benefit of both our home, existing and future export customers. Therefore limiting the description and nature of MBDA as a classic supplier would not be appropriate; especially considering the added value that our products give to this outstanding aircraft."

The past few months has seen the Eurofighter programme make progress in a number of different areas, with several testing programmes taking place simultaneously. Not surprisingly MBDA has been playing a prominent role.

"Modern combat aircraft are called upon to fulfil a multitude of missions, increasingly in the one overall mission. This is why the concept of a 'swing-role' capability is so critical", says Paul. "MBDA is best placed with its European footprint, broad product portfolio and strength in export to provide customers with the optimum weapon capability for the increasingly sophisticated threat environment.

"P2E will also provide strategic precision strike capability through the Storm Shadow missile, whilst P3E then introduces Brimstone. Brimstone brings a unique Close Air Support capability with its dual mode seeker able to engage moving and manoeuvring targets with minimal collateral damage. These packages



▲ Brimstone in flight © MBDA



▲ ASRAAM in flight © MBDA UK Ltd

"Many of these weapons have been used in operations with the RAF on Tornado and that service record will only grow as the Typhoon integration process continues.

"We are currently working with Eurofighter on the delivery of the Phase 2 Enhancement (P2E) and Phase 3 Enhancement (P3E) capability upgrades. P2E will introduce Meteor, which will be transformational for the aircraft, providing an unrivalled No Escape Zone to dominate the Beyond Visual Range combat mission.



▲ Taurus © MBDA



also lay the foundations for future growth in both air-to-air and air-to-ground roles."

MBDA is working closely with all of the Eurofighter Partner Companies to help deliver these programmes within a challenging environment and to the timescale required by the customers. On both P2E and P3E, MBDA and the Partner Companies have worked closely to define the technical solution, schedule and cost of integration to secure an eventual contract award from NETMA.

"The route to contract has made demands on all parties. Now that we are actually delivering the integration programmes we have seen a continuation of this close working; the success of which has been evident in the current Storm Shadow and Meteor flight test programmes", says Paul.

"The experience we have gained will now be applied to future programmes such as SPEAR and the anti-ship weapon MARTE ER, for which a specific definition study has already been started."

SPEAR is a medium range, greater than 100km, stand-off precision strike weapon able to exploit the future networked battlespace with high load-out. MARTE ER will equip the aircraft with a maritime strike capability through the proven Marte heritage, but

benefitting from the addition of a turbojet to engage vessels at greater range minimising the threat from naval air defence systems. The intention is that these and other programmes will sustain Typhoon to the middle of this century.

While there is a partnership at a very human level with daily interactions there's another vital relationship at play here too. The one between the aircraft and weapons. Carrying, deploying, interacting all these aspects have to be carefully considered. The considerations are numerous – what difference Typhoon's high kinetic energy and altitude capability make; how will the interaction between the pilot, aircraft and weapon work; how important is an effective HMI to a weapons provider in order to get the best from the weapons.

"When you consider the relationship between missile and aircraft, the aircraft's performance remains a significant factor in the capability of the weapon systems available to the pilot. You can't separate this and in the same way the aircraft needs weapon system solutions to provide the 'fire power' for the aircraft, the weapons it carries rely on the aircraft to provide targeting data and sensor capability to optimise weapon performance.



▲ MBDA's SPEAR in flight © MBDA UK Ltd

"The better the radar and sensor performance is, (and I include Typhoon's FLIR and DASS systems here) the better the potential firing solution becomes. Cockpit display technology, the helmet mounted display and sensor fusion all have critical parts to play.

"For example, using the PIRATE passive identification and targeting system together with the imaging infrared guided ASRAAM; Eurofighter Typhoon can engage air threats without the tell-tale signature of search radar. For longer range engagements where radar targeting is required, the CAPTOR radar combined with Meteor gives Typhoon the ability to engage targets before they are in a position to

fire their own missiles. In turn, the upcoming E-SCAN radar is going to provide a step change in the sensor package that will unlock the full potential of our missiles, especially Meteor.

"Typhoon is also a great 'load carrier' with its powerful engines and big wings. This gives it the added benefit of being able to carry some of the heaviest ordnance such as Storm Shadow and Taurus KEPD 350. Both missiles are capable of attacking and penetrating hardened or heavily defended targets at long ranges that ensure the Typhoon pilot is beyond harm's reach. The missile's flight plan is uploaded before flight and once launched, the Typhoon is free to complete other missions or return to base, leaving the missiles to navigate their way through to the target.

"This combination of overall aircraft performance and sensor capability gives Typhoon significant advantages over threat aircraft with a real edge in delivering combat capability. You can therefore understand how effective and potent a force the combination of Typhoon with MBDA missiles is.

"Together they become a 'total weapon system' that gives our customers the combat capabilities they need in a demanding world." <<



STAGE B TESTING PRODUCTION

HOWARD KERR



In addition to being one of the most capable, Eurofighter is also one of the safest and most reliable fighter aircraft ever built. But consistency and dependability doesn't happen by accident. When each Eurofighter Typhoon aircraft is built, the production testing teams put the aircraft through a series of rigorous tests. This process occurs over a number of weeks in the production hangar, before engine ground runs and the first flight tests can take place. >>

>> STAGE B TESTING PRODUCTION

It's worth noting that, even before they reach this stage, each of the major parts of the aircraft, the wings, fuselage and so on are tested independently.

Test Procedures: There are around 100 different test procedures and in each a number of test points need to be checked off. Such a demanding schedule is agreed and managed by Eurofighter to provide consistency across the fleet. The different tests can be broken down into three distinct phases: mechanical, avionics and final phase.

Mechanical: The first phase of the process is to ensure all the mechanical parts work. They include:

- Hydraulics
- Fuel systems
- Environmental systems
- Under carriage and brake system
- Backlash – a test used for all the primary flying controls. This test checks for movement, slip and play in all the aircraft control surfaces. Applying load individually to the surface, flaperons, foreplane and rudder. It is a final check prior to the aircraft's Flight Resident Software (FRS) taking control.

■ **Harmonisation** - the final task included in this phase is harmonising all fixed points like the Head-Up Display, the pylons, gun and forward looking infra red (FLIR) and weapon stations.

■ **Avionics:** The next test phase concentrates on ensuring the avionics are all working correctly. These include:

- Weapons system
- Communications
- Flight control surfaces
- Defensive aids
- Radar checks

FINAL PHASE CHECKS (PLUS SEAT AND CANOPY INSTALLATION)

- **Symmetry and alignment:** Checks carried out using laser measuring devices to ensure the accuracy in construction of the aircraft, measured within 1000ths of a millimetre.
- **Weighing:** Each aircraft has to be weighed and its centre of gravity (COG) established. This determines the air-

craft's unique mass characteristics. These are an important baseline measure input for the flight control systems.

■ **X-ray:** The final FOD check. The aircraft is X-rayed and examined in the centre fuselage and intake areas for any possible foreign objects that could have been lodged internally during the build phase. A preventative measure carried out to reduce risk prior to engine ground run.

At this stage the final build process also takes place with the installation of the ejector seat and canopy. This takes place last in order to minimise the risks of accidents. The ejector seat once installed is live.

Only once the aircraft is given a clean bill of health does it leave the assembly hangar and go to the next testing phase.

The time taken to test a Typhoon has dramatically reduced over the 15 years of production. This is not down to short cuts, but based on the enhanced integral performance of the aircraft platform, improvement & capability of test equipment, and lean operating principals generated by a highly skilled workforce.

Subtle differences in Final Assembly techniques do vary across Europe, however the performance test element is ultra-consistent. <<





**'I'D SAY RACING DRIVERS AND FIGHTER PILOTS
HAVE A SIMILAR MENTALITY...'**

FELIPE MASSA

Photo by: Photograph: Glenn Dunbar / Williams F1., Felipe Massa at Jerez, Spain with Eurofighter Typhoon "Watermark" in the background.
© LAT Photographic

THE PILOT'S SURVIVAL SUIT

A quick glance at the typical Eurofighter pilot striding to his aircraft doesn't do justice to the hours of research, specialist materials and advanced design that's gone into creating their life support system. The simple truth is that, pilot safety is a number one priority for every air force and a great deal of thought goes into every aspect of keeping them safe and sound. >>

Every detail is carefully considered – right down to their socks! The result is a range of Personal Protective Equipment designed to ensure a pilot can cope with the rigours of flying at high G, as well as surviving in demanding and potentially hostile situations.

WHY AN ANTI-G SUIT:

Without the suits, the pilot's blood would pool into their feet and legs when the aircraft pulls G and the pressure would make it too hard for the heart to pump fresh oxygenated blood up to their brain. This is clearly dangerous. Without enough blood going to the head the pilot would black out. In fact, most untrained people black out if they experience between 4 and 5G. The anti-G suit squeezes the legs, stomach and chest tight, meaning the blood isn't allowed to pool and has more pressure to feed the brain. The squeezing doesn't hurt and pilots say they quickly get used to what's initially a 'strange' feeling.

Anti-G Straining: Pilots are also trained to work their bodies in the same way as the suits and 'squeeze from within.' These are known as

Anti G Straining Manoeuvres. In essence, just as the trousers squeeze the legs, the pilots also tense their thighs, stomach, chest and arm muscles and they also breath in a short explosive way. All this squeezes their veins and raises their blood pressure. To prepare for Anti G Straining Manoeuvres they spend hours in the gym working on their anaerobic and aerobic fitness, as well as their core strength with Pilates techniques.

Material: All the clothing is fire retardant as well as offering nuclear, biological, and chemical (NBC) protection.

The Layers: Underneath the anti-G jacket and trousers the pilots wear an emersion suit which is like a diver's dry suit and protects them from hyperthermia if they land in water. Under that they have thermal wear. Finally, they have cotton underwear which offers both comfort and an extra layer of thermal insulation.

The Ejector Seat: The seat includes a personal survival pack, which has all sorts of survival equipment, including a one man dingy. <<

The Jacket: The jacket offers chest counter-pressure. Under G force, when required, an inner sleeve is filled with air and the garment squeezes the pilot's chest cavity. The jacket also incorporates a life jacket that auto-inflates when it lands in water. The side pockets are packed with the pilot's Combat Survival Kit. Amongst other things, this kit includes items like a radio, a personal weapon, water and local currency. On the jacket there are a number of different life support and oxygen tubes that plug into the aircraft.

Liquid Conditioning Vest: This optional vest is useful for extreme conditions. It works like underfloor heating but in a vest, liquid tubes in the garment keep the pilot warm in the extreme cold and cool in the heat.

Knee Pockets: These can hold emergency cards detailing procedures, as well as providing storage for mission related material.

Boots: Special issue flame retardant boots, offer ankle protection, but also dexterity for flight control. They also feature an anti FOD sole – which means foreign objects, bits of debris and so on, aren't carried into the cockpit.

The Helmet: Clearly this offers skull protection and the dark visor protects the eyes from sunlight. The helmet also allows the pilot to communicate on multiple radio channels and it incorporates the latest Helmet Mounted Symbology System (HMSS), meaning the pilot can interact with the weapons system more efficiently.

Oxygen Mask: Using computer controlled anti-G and breathing support technology, the mask delivers oxygen at greater concentrations and at pressure. This squeezes the pilot's lungs out at the same time as the trousers and jackets are squeezing things in. It sounds strange but it's very natural once you've done it. The only thing that can take some getting used to is talking under 'pressure breathing'. Pilots have to fight against the air coming in and force words out, plus with the mask on their voice sound a little different!

Full-coverage Anti G Trousers:

In Typhoon these differ from traditional anti-G trousers because they offer far more coverage, hence the name. They are worn with special anti-G socks that 'plug' into the trousers. They're made with a bladder that automatically fills with air (bleed air from the engines) when the aircraft pulls G. Tightly fitted in normal conditions, when the bladders inflate, the pilot's legs and stomach are squeezed even tighter. Like the jackets, the anti-G trousers are adjusted to measure, and are bespoke to each pilot. An initial fitting takes around 30 minutes as both the trousers and jackets are adjusted just like a corset. Once they've had that first fitting, experienced pilots can put on their 'suits of armour' with relative ease.



THE EUROFIGHTER TYPHOON COMBAT EDGE

The sun is a glaring ball of heat, the blast of the engines a constant accompaniment, but nothing can shake 'JT', our Eurofighter Typhoon pilot out of the zone. >>

Operating at greater than the speed of sound, every moment brings him closer to the oil refinery that's his target. He's been tasked with making this key enemy site inoperable, while all around him a ground offensive rumbles. Then, within the blink of an eye, JT's mission is turned on its head. His radio has crackled into life and now JT has multiple objectives. There are hostiles in the air looking for him and the primary target getting closer. The ground targets have multiplied too. At Mach 1.6 you're travelling at 16 miles per minute. Seconds equal closure; time taken to process information is critical.

It's now about making the right choices. Assess the threats and work out the priorities. Fast. JT stays calm but the adrenaline is pumping. 'What to do now? What do you know? What's going on out there?' Rapidly he makes sense of the new orders and works out how he's going to achieve them.

The cockpit radio comes to life sporadically – messages are being intermittently jammed – chatter then silence, then a mangled voice again. Half sentences, possible warnings add to the confusion.

But JT remains a picture of calm. His Eurofighter is a highly capable tool when missions get critical. It sniffs out the danger, scanning the skies while simultaneously mapping the ground, seeking out threats and friendlies, targets and decoys. Seven sensors work together and instantly give JT an Ultra 4K view of the battle space. At speeds in excess of 1,000 mph, huge amounts of information come into the aircraft and each piece is registered, distilled, combined and then presented. JT knows where he is, where the threats are and crucially what to do next. He stays ahead of the game.

And by having that advantage he can make it mission accomplished. >>

1. RADAR

Captor-E is the future primary sensor on Eurofighter Typhoon and has a full suite of air-to-air and air-to-surface modes. The Captor-E's optimised array brings with it a Field of Regard that's 50 per cent wider than traditional fixed plate systems. This gives significant benefits in both air-to-air and air-to-surface engagements and combined with the large antenna aperture provides the pilot with much enhanced coverage compared to fixed plate systems. It has a unique combination of repositioner and large antenna; greater power and sensitivity; and can carry out multiple concurrent air and surface tracking tasks.

2. STRIKER II

An incredibly sophisticated digital innovation, Striker II is a Helmet Mounted Display system (HMD) that's believed to be just about the most advanced helmet ever devised. The pilot can use it to cue weapons, it displays HUD-information through 360° and the integrated sensor delivers wide field of view night vision. The digital design of Striker II means it's safer and creates less fatigue than the legacy Night Vision Goggles that it replaces.

3. MIDS

MIDS is an advanced data link – a Multi-functional digital Information Distribution System – that allows the aircraft to securely exchange real-time data between a wide variety of users, including air force and, where appropriate, land and naval forces. It's high speed, high capacity, secure and jam resistant. For the pilot it means the ability to share and receive information from other users in their network.

4. PIRATE

The PIRATE infrared sensor provides air-to-air target detection and tracking performance in the Infra-Red Search and Tracking (IRST) mode for covert tracking. Forward Looking Infrared (FLIR) mode gives hi-res imagery day or night.

5. IFF

Identification Friend or Foe. The interrogator confirms the presence (or absence) of friendly assets, while the transponder ensures the allies know we're I am a friendly. The IFF works to current and future standards – making it effective regardless of the age of the other aircraft.

6. LITENING/DAMOCLES/SNIPER

These are advanced Targeting and Recce pods. Day or night they enable: precision targeting at range, the generation of coordinates, hi-res imagery and advanced reconnaissance features including detection of ground and air targets.

7. DASS

The Defensive Aids Sub-Systems comprises wingtip Electronic Support Measures and Electronic Counter Measures pods (ESM/ECM), missile warners, chaff and flare dispensers and a laser warner. As well as detecting threats, the system gives the pilot manoeuvre cues, coordinated with automatic jamming and optional deployment of decoys to deliver unrivalled survivability.

THE FUSION SUITE**WHAT IS THE COMBAT EDGE?**

- Cutting-edge sensors
- Intelligently fused
- Cutting through the fog of war
- Unique HMI delivering a complete, coherent picture
- This information superiority allows the Typhoon pilot to dominate the battlespace

THE FUSION SUITE

Eurofighter Typhoon is at the forefront of sensor fusion technology and its sensor suite continues to be upgraded to deliver enhanced detection and decision-making. Combining the data from key sensors gives the pilot unrivalled ability to rapidly assess the overall tactical situation and respond effectively to threats.

Sensors are continuously evolving but it's when you combine that in an intelligent way you have a significant advantage. Each sensor provides different pieces of information that are intelligently fused to give the Typhoon pilot a complete, coherent picture of the entire battlespace. To understand what that means it's worth looking at a couple of scenarios where different sensors come to the fore.

SENSING STEALTH

A low radar cross section (or stealthy) air threat will minimise radar returns, reducing the range at which the radar will detect it. However, through the fusion of its other sensors Typhoon can still detect and target low RCS threats at tactically useful ranges. This can be done entirely passively when necessary (ie without any emissions). This may be

an essential aid to survivability in some scenarios. Fusing the most accurate track elements from each sensor ensures that the pilot has complete situational awareness.

RAPID AND PRECISE GROUND TARGETING

The fused output of datalinks, radar and DASS gives the pilot a great overall picture of the tactical scenario. However, this may not be

accurate enough to cue weapons against a specific moving target when accuracy and updates are important. The laser designator pod provides a very detailed picture, but it's also akin to looking through a straw, so the straw needs to be pointed in the right place. In Typhoon, a pilot can instantaneously cue the pod from his fused tactical display or using the Striker Helmet. With that taken care of the

pilot can zoom right in and specifically target a ground feature or moving ground target, rapidly with ease.

SENSOR FUSION IS TRULY SPECIAL

Eurofighter is famed for its performance and handling – combining huge amounts of thrust from its twin EJ200 engines with incredible agility. What it's perhaps less well known is >>

>> COMBAT EDGE

its brain power when things really get interesting. Fusing the information together from its different sensors is crucial when the pilot needs to take mission critical decisions. It's one of the things that makes Typhoon truly special.

This sensor fusion is what gives the aircraft what we call the Combat Edge. And that's why pilots love it. When you're in the heat of battle, every second, every fraction of a second, is absolutely crucial, because it means distance to the enemy. Ultimately it makes the difference between mission success and failure.

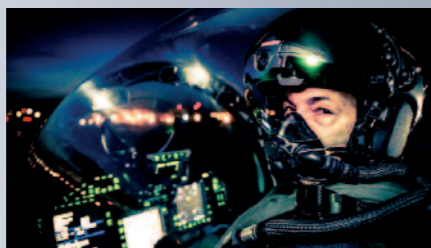
Each of the aircraft's various sensors have unique qualities, but it's difficult to rank them in terms of importance because it depends on the scenario a combat pilot finds himself in. In truth Combat Edge is not about individual parts but how they all come together to serve the pilot.

"At any one time during a mission the pilot receives an awfully large amount of information," says Eurofighter's Paul Smith, himself a former RAF pilot. "In legacy aircraft, a pilot has to pull together each of these threats to assemble a picture of the battlespace in their head. Typhoon presents the pilot with a complete coherent picture - freeing up capacity to make more rapid and effective tactical decisions.

"In one sense it's about reducing the pilot's workload. Taking away some of the things they've previously had to process themselves in the cockpit. For example, the pilot doesn't need to try to work out whether the aircraft out there is friend or foe, because the aircraft is able to do it for them", adds Paul.

"So no matter what scenario - air-to-air, air-to-ground, or complex swing role - Typhoon uses its various sensors to give the pilot a true picture of everything that's going on around them. This awareness is not just down to the cutting edge design of each sensor but the unique way the aircraft displays that fused picture to the pilot."

So that's the Combat Edge. A battlespace that is often chaotic and confused, is given clarity. A Eurofighter pilot knows they can maintain the information superiority that allows domination of the air, land and sea environments. <<



STRIKER II HELMET



PIRATE



CAPTOR-E RADAR

DASS
(in flare dispense mode)

"EUROFIGHTER IS FAMED FOR ITS PERFORMANCE...
...WHAT'S LESS WELL KNOWN IS ITS BRAIN POWER."

ITALIAN TYPHOONS PLAY KEY ROLE IN EXERCISE TRIDENT JUNCTURE



WORDS AND PHOTOS BY
GIOVANNI COLLA

Italian Air Force Typhoon squadrons proved their worth when they took to the skies as part of the largest NATO exercise since 2002.

Considered by many the most important military operation since the fall of the Berlin Wall, there's no doubt that Trident Juncture (TRJE15) was a great test for NATO.

The facts alone are staggering. It mobilised over 36,000 troops – from air, land and maritime forces – from more than 30 allied and partner nations and 12 international, governmental and non-governmental organisations. They came together in 16 locations across Italy, Spain and Portugal to train, exercise and learn from one another.

As part of TRJE15, Eurofighter Typhoon aircraft from the Italian Air Force 4th Wing of Grosseto, 36th Wing of Gioia del Colle and 37th Wing of Trapani provided Defensive Counter Air and Offensive Counter Air capacity.

The Italian Air Force deployed six Eurofighters to Trapani Air Base (two from 4th Wing, two from 36th Wing and two from 37th Wing) plus two additional Typhoons for back up provided by the local 37th Wing. They flew as many as 12 training missions a day (6+6), day and night in a range of scenarios.

The exercise took place from the 3 October to 6 November 2015. Part One (3-16 October) tested the command and control elements of the NATO Response Force (NRF) and showcased NATO's ability to work with external actors. Part Two (21 October-6 November) was a LIVEX – Live Exercise – providing training opportunities that are not found in most national exercises.

The exercise was based on a scenario that involved the use of military capabilities in an

out-of-area crisis response mission. Events in the exercise ranged from the effects of subversion and terrorist attacks to conventional warfare, cyber-attacks, hybrid warfare and humanitarian crisis.

Components from air, maritime, land and Special Forces carried out missions simultaneously, in different areas. This included much of Mediterranean Europe, and involved leadership from several different headquarters.

Through TRJE15, NATO also effectively demonstrated the ability to integrate with non-military structures, such as international organisations, and non-governmental organisations. This demonstrated a willingness to continue to contribute to a comprehensive approach, in the resolution of international crises.

During LIVEX, Italy participated mostly with air components (Command and Control, with the new certificate JFACC National Poggio Renatico, Combat, F2000, Tornado and AMX, Combat Support, C130, KC767, Predator, AB212 and HH139; and Combat Service Support), deploying in the field all the air capabilities available, launching air operations, mainly from the air base of Trapani Birgi.

The Air Power element saw packages of several aircraft, assigned to a single mission aim known as COMAO (Composite Air Operations). Each aircraft brought its own capability to the fore.

The Italian Air Force Eurofighter Typhoon aircraft that took part in the exercise, and – with their partners – had a number of objectives to fulfil. These included: the neutralisa-



tion of enemy air power, with attacks on airports and the destruction of ground air missile systems; the recovery of isolated personnel, for example an ejection in enemy territory; the neutralisation of enemy naval power, attacking military ships or destroying naval missile systems; plus the safe supply of transport aircraft, persons, or property, as in the case of exfiltration of compatriots from a territory which has become hostile.

Throughout the exercise the Italian F2000 provided air superiority with the ability to neutralise enemy air power (aircraft and missiles) making it ineffective for a certain time and location, in order to allow all the 'friend' operations from land, sea and air.

For the entire exercise the Italian Typhoons were able to extend their range

and time on station thanks to the ITAF KC-767 and USAF KC-135 which were deployed in an Air-to-Air Refueling (AAR) role.

TRJE15 was the culmination of a series of dynamic and demanding training events designed to train the troops of the NRF, test the Very High Readiness Joint Task Force (VJTF) and enhance NATO's readiness, flexibility and interoperability in response to a changed security environment and to challenges from the south and the east.

It proved the readiness of the NRF for mobilisation; the exercise also tested the integration of the allied forces, as well as their interoperability. Put simply TRJE15 demonstrated the effectiveness and efficiency of NATO. <<

BATTLESPACE: A CHANGING WORLD

Since coming into service the Eurofighter Typhoon has matured, its capability has been enhanced and its reputation among the air forces that use 'her' has grown. >>



TIM ROBINSON

Editor in Chief of Aerospace

And, just as the aircraft has changed so too has the world in which it operates. So, in this edition of Eurofighter WORLD we speak to Tim Robinson the Editor-in-Chief of *Aerospace*, the magazine of the Royal Aeronautical Society, to see how he assesses Eurofighter's role in this new world order.

The battlespace has changed dramatically over the past decade or so, how important do you think it is to have flexibility in a fighter jet and why is that?

Immeasurably. Who would have thought 20 years ago that in 2016, NATO air arms would be regularly scrambling in the Baltics, undertaking counterinsurgency operations in Africa and fighting a terror-state with unbelievably complex airspace and potentially a high risk of escalation over Syria? So today there is no such luxury as a single-role aircraft for budget-conscious air forces – all assets need to pull their weight. And the extremely long development times of modern combat aircraft means that all conflicts now are 'come as you are'. There is simply no time for any grand WW2 rearmament plan before the next crisis erupts. Having a flexible, adaptable fighter to begin with, before the next crisis starts, is therefore key.

What value do you think a good power-to-weight ratio is and having weapons and sensors that have above average reach?

Well the classic view is you can turn a decent air superiority fighter into a good fighter bomber, but not the other way round. Hence the success of the F-15 Strike Eagle, the F-16 and Su-27/30/25 families. I'll not name names but I guess we can all think of some examples where trying to adapt bombers into fighters have failed.

Excess power-to-weight gets you all the good stuff that jet jockeys love – rapid acceleration, phenomenal climb rates, speed – but also the ability to lift heavier loads if you want to stick air-to-ground weapons on it. Why is this important? The higher and faster you go then the more kinetic 'throw' you can impart weapons, especially in air-to-air missiles, and the better the range you give the 'spear'. Pairing the Eurofighter's superb high-altitude performance, (I've never been able to tempt a pilot to reveal its true ceiling) supercruise abilities and a long-range beyond visual range missile like Meteor will, I think, end up with a phenomenal weapon system.

In fact, even though the US has absolutely giant training areas in Nevada and so on, where they can invite allies to Red Flag, I suspect that supercruising Typhoons and Meteors may end up bumping the edges of the ranges. One final point, and one which is seldom

discussed, is that a good fighter pilot always assesses the battlespace and plays the odds. Sometimes you might want that excess power-to-weight to run away, or disengage, from superior numbers and come back another day with your mates.

What difference do you think it will make for the Eurofighter having AESA onboard, coupled with Brimstone, Paveway IV, Meteor and Storm Shadow? And will this change battlespace engagement?

The in-service Captor radar as it stands is a highly capable piece of kit, but the proliferation of AESA radars mean that recent moves to upgrade it to the coming Captor-E is very welcome from a capability and a sales standpoint. Moreover, the Eurofighter's large nose means when the Captor-E radar does enter service, it should be one of the best fighter radars around. For AESAs, I am told by experts, that the more T/R modules you can fit in the nose, the better the performance (resolution and range) of the radar. So Captor-E should be an outstanding fighter radar.

Second, there is another advantage in AESA too, in that it allows simultaneous 'interleaved' operation in both air and ground modes. This, I believe, will truly justify the 'swing-role' marketing tag and is especially useful for the single-seat pilot to be able to know the sky ahead is clear, while, for example, prosecuting ground targets.

Finally, another underappreciated (and for obvious reasons not discussed too much in open sources) about AESA radars is the possibilities they give you for electronic warfare attack. With the EW environment becoming ever more contested and vital – this AESA jammer function adds another key capability to Eurofighter.

How important do you think having good defensive aids and an intuitive human machine interface are?

You only have to look at recent events in Syria and the loss of a Russian AF Su-24 to see what happens when your defensive aids and situational awareness aren't up to scratch. The cost of combat aircraft today and the political fallout of any lost/captured aircrew mean that we are well past an age where losses could be shrugged off.

The consensus is that the Eurofighter's Defensive Aids Sub System (DASS) – which includes ECM, flares and towed decoy – is extremely good, giving the pilot enhanced survivability and situational awareness. Indeed, in Libya in 2011 (and reportedly over Syria today) the RAF flew 'mixed pairs' of Typhoons and Tornados, with the Tornado crews benefiting from flying with a fighter with high-quality >>

>> BATTLESPACE: A CHANGING WORLD

situational awareness and a power air-to-air radar.

An intuitive HMI or cockpit is also important these days. With 'carefree handling' and FBW, the challenge today is not to fly the aircraft but to fight with it and understand the battlespace around you. The colour MFDs, easy to interpret symbology and helmet mounted display (HMD) are all vital tools.

Though I have only 'flown' the Eurofighter simulator so far – my experience from other fast jet flights is that non-fighter pilots frequently underestimate how physically demanding flying a fast jet is. If you imagine a tough

workout, while talking to a friend on a mobile phone, and perhaps solving an IQ puzzle at the same time – then it's clear how important an intuitive cockpit is.

When you combine HMSS with enhanced weapons capability, do you think this will give Eurofighter distinctive and unique capabilities?

The HMD already allows a Typhoon pilot to 'look and kill' with a short-range missile like ASRAAM or IRIS-T for off-boresight shots. I think the most interesting aspect is that the wide-angle radar scan zone, more than 90 degrees to the sides,

will along with the HMD enable a Eurofighter pilot to target, fire crank (evade) and keep track of the enemy in a phase of the BVR fight where usually the choice is 1) drive straight into the merge (and risk getting shot down yourself) or 2) crank, to put yourself in the 'notch' zone with regard to the enemy's incoming missile, but, in doing so lose track of your missile and bandit. **In short, it will allow Typhoon pilots to 'stand-off', take more lethal shots, at longer range, while reducing the risk to themselves.** It's going to allow the Eurofighter pilot to dominate the engagement. It's also worth noting, that the F-22, the number one air dominance fighter in

the world (an USAF General I believe rated the Typhoon as number two) still lacks an HMD.

How important do you think interoperability is in this environment and do you see advantages in the mixed fleets that both Italy and the UK have opted for?

Interoperability has been a buzzword since at least the 1990s when the Gulf War and Balkans conflicts highlighted the challenges of allies working together. Today, after Afghanistan, Iraq, and Libya, it is expected that everyone should be able to plug into a coalition or alliance. This doesn't just happen by accident; it's about

training, standards and common equipment. In Eurofighter's case the aircraft already has a huge advantage in interoperability terms with six nations already flying it. However, the future could be even more exciting. Though exercise results are naturally classified, it has been an open secret that warfighters, when seeing what the Eurofighter and F-22 can do when teamed together in Red Flag, are positively drooling with anticipation to discover and develop joint Eurofighter/F-35 tactics. For the UK and Italy this is likely to be a massive jump in air warfare to have these support and complement each other. Using Typhoons to clear the

way for F-35s to hit the most heavily defended ground targets, or using them to distract the enemy while the F-35s sneak past, the possibilities are endless and present any adversary with huge challenges: Do I focus on the supercruising high-altitude threat or do I try and hunt the Low Observable (LO) strikers?

For nations that are lucky enough to afford both, like Italy and the UK it will be a real game changer in air warfare tactics; but even if you only have one, the likelihood is you are going to be in coalition with the other in the future and therefore everyone is likely to benefit. >>

“PAIRING THE EUROFIGHTER'S SUPERB HIGH-ALTITUDE PERFORMANCE, SUPERCRUISE ABILITIES AND A LONG-RANGE BEYOND VISUAL RANGE MISSILE LIKE METEOR WILL, I THINK, END UP WITH A PHENOMENAL WEAPON SYSTEM...”



>> BATTLESPACE: A CHANGING WORLD



What other considerations do you think should be taken into account when assessing Eurofighter's future role in a changing battlespace environment?

It's often under-appreciated that Eurofighter Typhoon is now a mature weapons system. I remember first covering it more than a decade ago when it was entering into service. During Case White in 2003 some of the diagnostic systems needed tweaks – all part of the usual bedding-in of a combat aircraft.

It is now a mature weapons system, with characteristics that are well understood and, with six nations operating it, there is a whole load of experience to draw upon. So from a supportability and maintainability aspect it has really begun to prove itself and early teething problems are now behind it. Operation Ellamy over Libya in 2011 proved that – I remember hearing that the UK RAF carried out an engine

change during the campaign but the jet didn't need it. That speaks volumes about the aircraft's robustness. And clearly when you assess the future, having a reliable, dependable asset is crucial – but not something you can take for granted.

Where do you think the biggest areas of ignorance are when people assess the value of the Eurofighter Typhoon as part of the future force mix?

One of my favourite criticisms was 'Ohh it's just a Cold War white elephant' – well if we are in a new Cold War with state vs state tensions – it seems to have arrived at the right time! To be fair, this sort of argument, where people were constantly calculating how many Super Tucanos for COIN you could buy for one Eurofighter has somewhat disappeared – after the shock of Ukraine and Crimea.

I think another misperception is that stealth or LO combat aircraft has made everything else obsolete. As the last pre-stealth gen 4.5 fighter, I think Eurofighter suffers from a kind of neglect of its capabilities. Today we live in an attention-deficit world and the focus is always on 'what's the next shiny thing'. (And I hold my hand up as a member of the media partly responsible). Stealth is obviously important and you wouldn't design a clean sheet fighter today without it – but a balanced approach like Eurofighter, effective training and tactics and regular upgrades will still keep it relevant. Because, for stealth, whether its F-35, PAK-FA or even Chinese J-20s, it could be many years before they appear in large numbers in the battlespace. The high cost means that few nations will be able to afford large numbers of them for the foreseeable future. Even Russia, developing the PAK-FA has reduced its initial

buy to a single squadron. So that seems to tell me that the majority of air threats are likely to come from variants of the Flanker family over the next 20 years – a combat aircraft that the Eurofighter was explicitly designed to beat. As long as no-one decides to starve the Typhoon of upgrades – I don't see why its supremacy can't continue.

For tomorrow's SAM threats I believe the Typhoon will still be relevant by working with allied LO fighters like F-35s, using stand-off weapons (Storm Shadow/SPEAR 3) and eventually even UCAV wingmen.

I also think people tend to forget just how many Eurofighters are in service with partner nations – especially when we get caught up in the 'new and potential orders' game where every sale is a 'must win'. Over 470 aircraft have now been delivered and there are

six current operators. A seventh operator, Oman, has signed up and an eighth is expected to do so soon. That is a huge installed base – far bigger than Rafale (over 140) and F-22 (187). Only the F-35 is going to beat that in the future.

Is there anything else you would like to add?

Only Eurofighter is really still at the beginning of its evolution. If you consider the F-15E Strike Eagle – widely seen as the West's premier fighter-bomber – the prototype F-15A first flew in 1972, some 44 years ago. The multi-role F-15E Strike Eagle meanwhile entered services in 1989. So if we compare the Typhoon with that, it appears to me that the Eurofighter is still only around about 1991 in Strike Eagle development. Given the US now wants the Eagle/Strike Eagle to serve until

2040 – (almost 70 years since first flight!) it may be that the Eurofighter Typhoon eventually remains in service until the 2060s!

Integration of new weapons but also an MLU in the 2020s, which could include cockpit enhancements (augmented reality displays, eye tracking/gesture controls), conformal tanks etc means it still will be potent well into the future. Indeed, one can fully imagine that a 2030-40 Eurofighter pilot might be flying as a battlespace commander role – flying with robotic AI UCAVs – and using them to clear a path to high-value targets or act as airborne reloads. UAVs and drones may be a growing part of the future but the high-stakes air-to-air battle – a combination of chess, boxing, car racing and video games, means the fighter pilot's job is likely to be one of the last to fall. As Chuck Yeager once said "It's the man, not the machine". <<

FIGHTING TALK

A Brigadier, who led the first Spanish Air Force deployment of Eurofighters on Baltic Air Patrol, was a key speaker at a London Fighter Conference, where he told delegates about the crucial role the Eurofighter Typhoon was playing in protecting national interests, the value of simulation training – and the value of pre-deployment exercises. >>

BRIGADIER JAVIER DEL CID DE LEON

NATO Eurofighter and Tornado Management Agency



CV HIGHLIGHTS

- Fighter school as flying instructor
- Operational (Captain) at Albacete AFB flying Mirage F1
- International ops – Bosnia, Kosovo
- NATO tour at Airsouth HQ, Naples (IT)
- First SPAF Baltic Air Patrol Detachment Chief – Siauliai, Lithuania
- Air Base and Wing Commander – 14th Wing, Albacete, during the handover from Mirage F-1 to Eurofighter Sqn

NETMA's Brigadier Javier Del Cid De Leon gave the Conference a unique insight into Eurofighter Typhoon's role in the Baltic Air Patrol (BAP) and in the preparations required. It's a subject he knows much about. He was the Detachment Chief of the first Spanish Air Force deployment in the region and was also the ALBACETE Air Base commander in Spain for the handover from Mirage F-1 to Eurofighter.

It's little wonder the Brigadier could captivate his audience in London as Eurofighter WORLD can now reveal in this personal profile – the love of flying runs in his Spanish blood. And his interest in aviation began when he was just a child...

"I remember building my first model aircraft when I was a 10-year-old. After that I filled my parents' house, and later my own home, with a vast array of radio controlled and static models. I joined the Spanish Air Force when I was 17 (in 1976) and I flew, for the first time in my life, in 1978. Even now, after 40 years and more than 4,000 flying hours, I still love to fly."

Today, as NETMA's Division Leader for Business Management, Javier heads three sections of the organisation, managing around 35 people. He's in charge of HR, security, agency support, IT and business improvement and performance.

While his current role is to support the management of the NETMA business, ensuring that appropriate strategies, policies,



processes, tools and resources are in place to generate the right ways of working to maximise effectiveness and motivation, his has not always been an office job.

Indeed, his active background in the Spanish Air Force, his knowledge of Baltic Air Patrols and his links with Eurofighter and NETMA all mean the Brigadier is now a natural choice as a speaker for a fighter conference.

Asked why anyone would be interested in hearing from NETMA, he said: "NETMA plays an important role sustaining Typhoon as a world class fighter." says the Brigadier. "It is the backbone of air defence across our nations as multirole aircraft which will be in service for decades to come. NETMA provides a management service, delivering through-life support and capability enhancement to satisfy our customer's current and future operational needs. In short, the work of NETMA contributes to a reliable and safe Eurofighter Weapons System."

It's exactly that reliability and built-in safety that has led to the Eurofighter Typhoon being seen as the system of choice for those requiring a robust and capable deterrent. And it is this that the Brigadier sees as its key value supporting NATO's Air Policing in Europe.

"NATO Air Policing is important because it demonstrates a common commitment and mutual cooperation among the different nation states involved.

"The NATO definition of the role is clear. NATO Air Policing is a peacetime mission which requires an Air Surveillance and Control System (ASACS), an Air Command and Control (Air C2) structure and Quick Reaction Alert (Interceptor) aircraft to be available on a 24/7 basis.

"This enables the Alliance to detect, track and identify to the greatest extent possible all aerial objects approaching or operating within NATO airspace so that violations and infringements can be recognised and appropriate action taken.

"The Spanish Air Force fully understands the need to collaborate in all NATO missions. The first time it took part in the Baltic Air Patrol with Eurofighter was from ALA 11-Morón Air Base. It was a logistic challenge more than an operational one.

How suitable does he think Eurofighter Typhoon is for the BAP role?

"There is no doubt that the Eurofighter is the best aircraft out there today for Air Policing missions like this. What you need is reliability, simplicity in the pre-take off procedures; high performance to reach operational ceiling and speed; good and reliable communication with the C2 system; and sensors that provide the >>

>> FIGHTING TALK

pilot with a clear situation awareness for the purpose of identification. And, if the situation requires, reliable and efficient air-to-air weapons.

"It's also worth making a special mention of the Eurofighter's EJ200 engines. They provide the combination of low maintenance, high reliability and easy handling that's essential in this work."

"Working in the Baltic means we have been able to operate in extreme weather conditions in winter time. This is a challenge not only for the aircraft but for the entire team involved in the detachment. We are far away from our home base which is why a good logistic plan is vital.

"The Eurofighter and the crews involved have the experience. The aircraft is on duty 24/7 with our four nations covering almost all NATO area of responsibility."

Asked what NATO and the Spanish Air Force have learned about the threats and activities during their patrol time in the Baltics, the Brigadier said: "It's a combination of things – responsibility, interoperability, the ability to maintain high readiness status, strong Air Command and control chain. These patrols bring the same rules of engagement but in a different scenario. Of course the Baltic Patrol also means learning to work in winter weather conditions."

And, like other air forces before them, prior to the deployment of the Spanish Air Force to the Baltics, they made use of The Aircrew Synthetic Training Aids (ASTA) programme to help prepare.

"In my view ASTA proved itself as an essential tool for complex training exercises," says the Brigadier, "because it allowed training situations and missions to be carried out that

in the real aircraft would be impossible to reproduce before deployment.

"In total 50 missions were developed for the pilots involved in the Spanish Air Force deployment. These missions, in total hours represent a time of flight of approximately 75 per cent of the actual hours flown. This is a huge saving on real flying time costs. There's no doubt that ASTA was needed for this and will be needed for future missions.

"It really helped us. Pre-deployment simulator flying means the pilots can focus on the domestic aspects: local procedures, communications sequence, instrument approaches, familiarity with the work area, and so on.

"It also allows the deployments to arrive with much more preparation and knowledge, as crews have undergone a process of planning and implementation (documentation, calculations of time / fuel tactical assessment,

data processing mission for aircraft detection doubts / errors / shortcomings, etc.), allowing them to prepare any missions in the exercise faster and more effectively."

As the Brigadier explained when he spoke in London, it is not just the simulator training that helps pilots prepare for real-life deployment, it is major exercises like 'Vulcanex 15'.

The aim of Vulcanex 15 was to strengthen Eurofighter/Typhoon interoperability and standardisation between the *European Air Group (EAG) nations through the use of common Standard Operating Procedures (SOP). It was also to familiarise ground crews with other nation's Aircraft Ground Equipment, with their "turn around" procedures and their different approaches to Quick Reaction Alert work.

*The European Air Group (EAG) is a seven nation (Belgium, France, Germany, Italy,

Netherlands, Spain & UK) organisation which develops suitable ideas and initiatives into projects with the aim of producing useable end-products that promote interoperability between the Group and partner air forces (Norway & Sweden). It may also assist other organisations.

So how proud is the Brigadier of what NETMA, the Spanish Air Force and the Eurofighter Typhoon have done with regard to Baltic Air Patrols?

"It is mission accomplished," he said. "We now have common goals and we are continuing to demonstrate that we have a value. In fact, in January this year, another Spanish Air Force Eurofighter detachment, this time from the ALBACETE Air Base, 14th WING will be on deployment. I wish them the best."

Finally, we asked the Brigadier what he honestly thought the future will hold for the Eurofighter Typhoon?

"Our nations are betting on Eurofighter as the main air weapon system for the next decades. There are technical and financial solutions that will give us a fleet of Eurofighters with the operational capabilities required by the four nations.

"The Meteor, Storm Shadow, Brimstone and new radar will equip the Eurofighter with the swing role capability necessary for the future. NETMA and Eurofighter are continuing to work together to ensure we deliver the best operational aircraft both now and in the future. Of course challenges will occur, but we are committed to solving them day by day, and I am confident we will meet those challenges." <<



...AND NOW HE HAS BUILT THIS!

How long did it take you to build it?

Start 10 October 2007 / Airworthiness certification 27 March 2012 / First flight 02 June 2012. All day-to-day works recorded in a book with more than 2800 photos.

Where do you keep it?

Last August 2014 I flew with my wife from Albacete (SP) to LANDSHUT (EDML) north of Munich (5 flying hours). Now it is hangered in Landshut.

What do you do with it?

I fly all weekends when weather permits, cross-country in Germany and Austria and of course AEROBATICS all the time; last summer holiday trip from Landshut-Portoroz (Slovenia)- Croatia-Venice (IT)- Verona (IT)- Landshut.

Why does it gives you pleasure?

Building an aeroplane is the most interesting activity I've done in my life. It is a constant challenge where quality control is up to you. I had the constant support of my wife who is also one of the few women expert with the Rivet gun and bucking bar (aircraft has more than 10.000 rivets). She also flies with me, acro included. After flying over 4000 hours in fighters, the RV8 is the closest aircraft I've found to enjoy the flight and allows me to travel fast and do aerobatics without limits.

"I REMEMBER BUILDING MY FIRST MODEL AIRCRAFT WHEN I WAS 10..."

MATERIAL WORLD



Creating an aircraft that can achieve world-class levels of performance means getting the right balance between three, sometimes competing, characteristics: lightness, strength and flexibility. >>

Originally designed to produce an aircraft with incredible performance in the air to air domain, the Eurofighter Typhoon is put together using advanced composite materials.

In fact, the airframe delivers both superior manoeuvrability at subsonic speeds and efficient supersonic capability and can support the widest range of combat scenarios.

1 LIGHTNESS: In order to be fast and agile it is important the aircraft's weight is kept to a minimum. Why? Well the lighter it is the better the power-to-weight ratio, the better the performance. Eurofighter is light and its EJ200 engines deliver huge amounts of thrust and that combination gives it great performance.

2 STRENGTH: If you are pulling high and flying at supersonic speed, you are putting massive aerodynamic force on the airframe. Imagine putting your hand out of a car window while travelling at speed and you'll get some idea of what that's like, then multiply the speed. So, yes, the airframe has to be light enough to deliver outstanding performance but it also has to be capable of coping with astonishing aerodynamic loads. Without sufficient strength, the airframe, pushed to high speeds and G-forces, would simply disintegrate.

3 FLEXIBILITY: In addition to lightness and strength, the airframe also has to be able to flex, otherwise it would snap. You may be able to see how the wings bend slightly in flight. Flexibility allows it to cope with the forces placed on it.

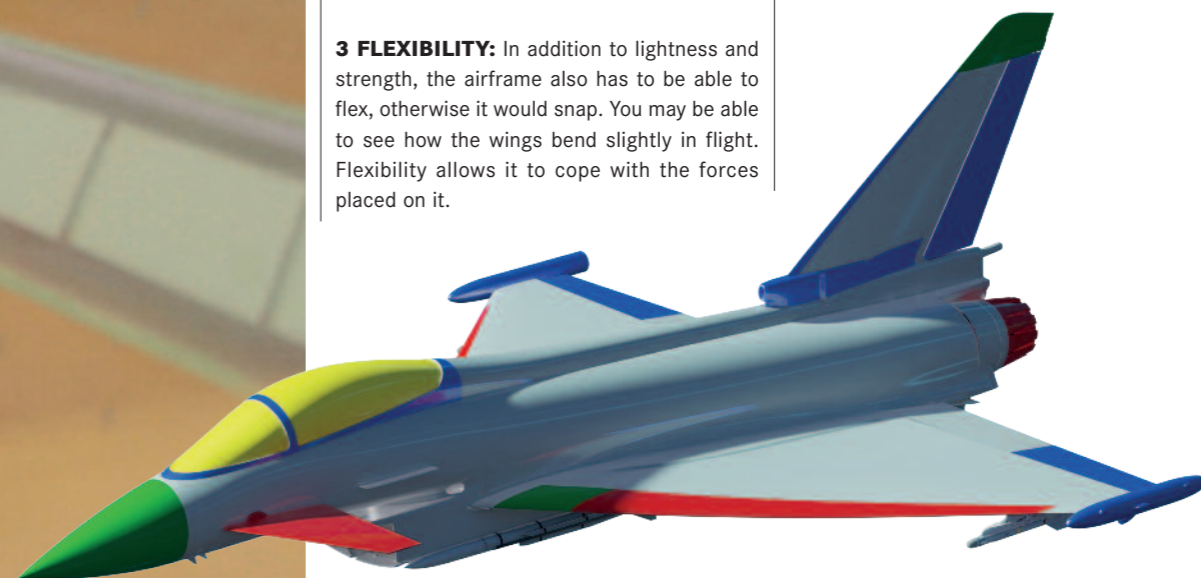
MATERIAL CHOICE

Eurofighter Typhoon is made up of advanced materials. Chiefly these are:

- Carbon Fibre Composites 70%
- Metals 15%
- Glass Reinforced Plastics (GRP) 12%
- Other Materials 3%

Carbon Fibre Composites: Given the need for lightness, strength and flexibility, carbon fibre composite materials are an ideal choice. They tick each box. Indeed Eurofighter Typhoon led the way in making use of carbon fibre in its design. It means the weight of the airframe is 30 per cent less than for traditional materials, boosting the range and performance, as well as reducing the radar signature.

Titanium: Carbon fibre is excellent, but where it suffers is with heat. During flight some parts of the aircraft – the leading edges on the wings, nose cones and the back end near the engine – all experience extremely high temperatures. So here the aircraft needs to be made of a material that has good heat resistant qualities and that's why a metal is chosen. The metal of choice is titanium because, as well as being able to cope when the heat is on, it's also light. In effect it's the carbon fibre



- Carbon Fibre Composites (CFC)
- Glass Reinforced Plastic (GRP)
- Aluminium Alloy
- Titanium Alloy
- Acrylic (Röhm 249)

of the metal world, but you wouldn't build the whole aircraft out of titanium as it would be too heavy and performance would be hit.

Weapons: When flying with most bombs there are limits to how fast and how much G the aircraft can pull. This is not because of the weight but rather the limitations on the bombs themselves. Unlike the aircraft, most have not been designed to cope with the aerodynamic forces that would be acting on them at high speeds. Missiles are different in that they have been engineered to go supersonic and pull lots of G. Some can travel up to Mach 5 and pull an eye-watering 30G! <<

PRACTICE MAKES PERFECT

Two Austrian Eurofighter Typhoons are seen here escorting an Austrian Airlines Boeing 767-300ER to a 'coerced' simulated landing in Zeltweg. The Boeing (OE-LAZ) was coming home after being freshly liveried in a Paint Shop in Shannon, Ireland.

This is one of many exercises carried out by Eurofighter pilots to ensure that, in a real emergency, manoeuvres such as forced landings can be carried out effectively and safely. <<

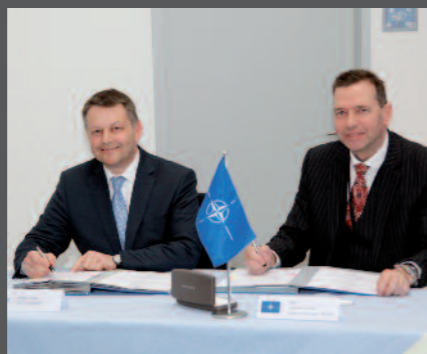


EUROFIGHTER AND NETMA SIGN AGREEMENT TO STREAMLINE PROCESSES

Eurofighter Jagdflugzeug GmbH and NETMA, the NATO Eurofighter and Tornado Management Agency, have signed an Agreement to streamline the Type and Airworthiness Certification process and reduce the workload on Nations and their Military Aviation Authorities.

The Agreement will allow the attribution of privileges to industry to carry out certification work previously done by the customer.

▶ Left to right: Volker Paltzo, CEO Eurofighter and Graham Farnell, General Manager NETMA



It follows the signing of 'Mutual Recognition' certificates by senior officials after agreement to adopt the European Military Airworthiness Requirement 21 (EMAR21), recently approved by the European Defence Agency (EDA).

Eurofighter's CEO, Volker Paltzo, said: "Sharing and delegating a common standard of approval will bring new efficiencies into the programme. This is a significant step forward for a Programme that is already delivering a world-class product." <<



▲ Left to right: GenMaj. Dr. Ansgar Rieke, Head of GE MAA, Gen. Isp. Capo Francesco Langelle, Head of IT MAA, LtGral Juan Manuel Garcia Montano, Head of SP MAA, AVM Martin Clark, Head of UK MAA

GAME OVER – IN LESS THAN A BLINK OF AN EYE...

On average, it takes a human around 180 milliseconds to press a button when signalled to do so by a light-source. But it takes only 140 milliseconds when alerted by sound.

For a fighter pilot those 40 milliseconds could mean life or death. And, given that the blink of an eye last around 300 milliseconds, it's clear that, on both counts, sound has the advantage when it comes to reaction time.



Now, a team of Eurofighter specialists from Airbus Defence & Space, working with the Danish firm Terma, are taking this knowledge and using '3D Audio' technology to engineer the tactical advantage it brings into the high-tech helmets that will help protect and 'inform' their pilots every time they take to the skies.

If you've sat and watched an action movie with surround-sound, you'll know that the explosions and action seem to fill your head from all directions giving you a very real feel of what's where – and what you need to look at.

In a Eurofighter Typhoon, travelling at over Mach 1, at 40,000ft plus, knowing what's coming from where has its uses. If a missile's coming in, and you can hear news of it before seeing news of it – that matters. And, if you have two radio channels giving you information at the same time, and you weren't sure which was which, wouldn't it help if one was always in your left ear and one in your right?

Painting pictures with sound is, in fact, a highly effective way of communicating with pilots, and Airbus Defence & Space is well advanced with trials to introduce the technology into the Eurofighter.

And you can do more with sound too – you can eliminate it when it's not wanted.

Terma is working with Airbus Defence & Space to introduce an Active Noise Reduction (ANR) system into the helmets of Eurofighter pilots making one of the best working environments for any fighter pilot, even better.

ANR works by sampling the sounds that are not wanted, and reproduces sound-waves that cancel them out. It's a technology that can already be found in high-end consumer headphones and in top-of-the-range cars. Now it will play a role in some of the fastest machines on the planet helping pilots concentrate – and delivering combat edge.

Trials of the ANR system are due to take place with the Austrian Air Force's Eurofighter Typhoons at Zeltweg early this year and work on 3D Audio technology integration continues at Manching. Listen to this space! <<

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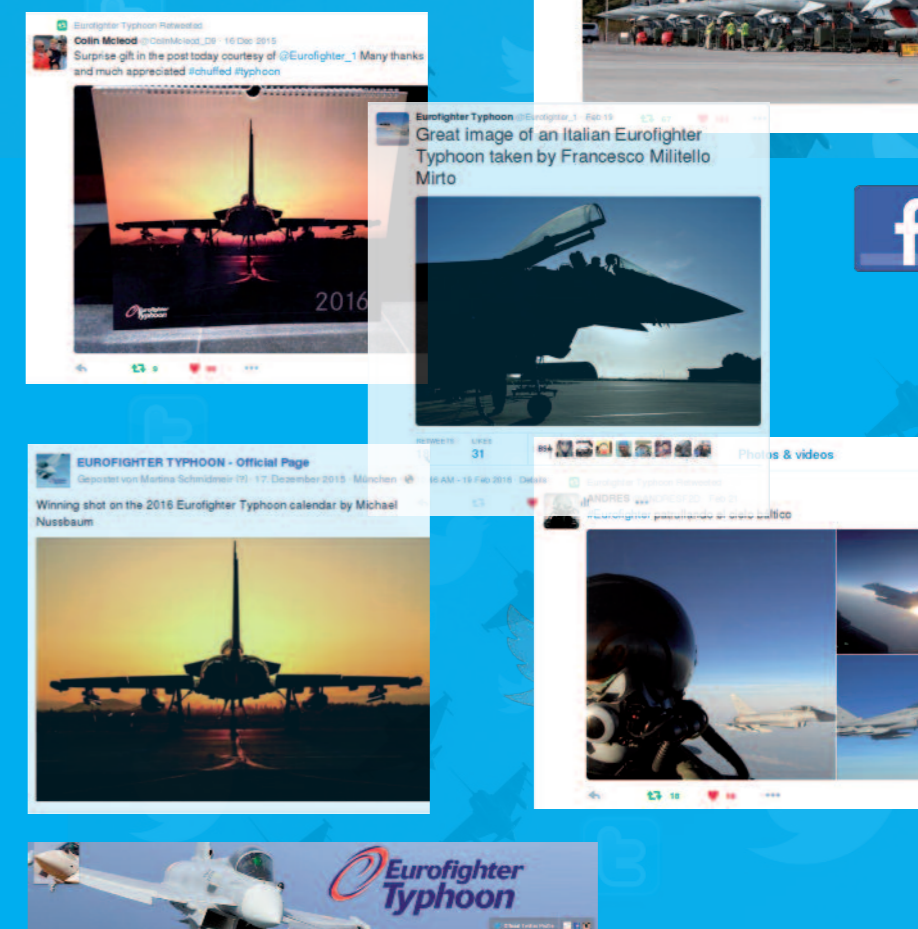


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Visit us online @ www.eurofighter.com



IN OUR NEXT ISSUE...

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

- We report on the major Air Shows 2016
- Special report from Red Flag in Nellis, Nevada
- Latest updates on capability progress

**Eurofighter
Typhoon**

