Combat AIRCRAFT
SUPERFIGHTER PROFILE No. 1
EUROFIGHTER TYPHOON

by Jon Lake

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When US analysts studied the new generation of West European advanced fighters (the so-called Gray Threat), the Eurofighter was rated more highly than its competitors and was viewed as being a lethal opponent to any US fighter short of the F-22. But such comments were viewed by some as a deliberate attempt at scare-mongering intended to justify the need for the F-22. Their inference was that the Eurofighter, Rafale and Gripen represented no real threat to late Mark F-15s or F-16s. The Eurofighter's credibility was further dented as the program experienced minor technical problems and very major delays, most of them caused by German "politicking." It became customary for journalists to use the prefix "troubled" when describing the Eurofighter program, and in the absence of evidence to the contrary, it became too easy to underrate the aircraft.

Some critics claimed the aircraft's origins in Cold War requirements automatically meant that it was somehow conceptually obsolete and irrelevant in the post Cold War world. Superficially, this may have seemed a compelling argument, though all it really meant was that the aircraft was designed to meet the very worst-case threats, and was thus perhaps over specified for some low-intensity conflicts. RAF demands ensured that the Eurofighter was well suited for out-of-area and deployed operations, and that it will be able to cope with any post Cold War threat. Accusations that the Eurofighter is a "Cold War design" are still heard however, and continue to sway the ill informed. More serious were worries about the Eurofighter's performance and agility, or perceived lack of it. Early appearances by the aircraft, flying with its flight control system in the reversionary, "emergency" mode were indeed relatively unimpressive—and this was at the very time that successive Farnborough and Paris shows were dominated by dazzling displays of slow-speed agility by new Russian superfighters. Although the F-22 was not flying at all, its reputation was saved because it promised to rely on the fashionable chimera of "low observables," otherwise known as stealth. By contrast, the Eurofighter did appear to be lacking.

Today, all that has changed. The German government is now firmly on board and the aircraft has been ordered into production. Convincingly, the Eurofighter has also begun to demonstrate its extraordinary capabilities, and its reputation has entirely turned around. Until the beginning of 1998, it was still fashionable to run down the Eurofighter

front cover, top: **Eurofighter GmbH is a consortium of four national partners that comprise primary contractors from Germany (DaimlerChrysler Aerospace), Great Britain (British Aerospace), Italy (Alenia) and Spain (CASA). Between them, they have built seven prototypes referred to as Development Aircraft, designated DA1 through DA7.** *(Rick Brewell/DPR RAF)*

front cover, bottom: **In June 1998, DA5 headed to Rygge AFB in Norway, for in-depth evaluation by the Royal Norwegian Air Force.** *(Eurofighter GmbH)*

opposite page, top: **The first British-built prototype, DA2, was also the first Eurofighter to exceed Mach 2. Royal Air Force requirements are for 232 aircraft out of an initial 620-aircraft production run, and work share between the national partners is based on the order commitment from each. Britain's share is 37 percent.** *(British Aerospace)*

opposite page, middle: **DA5, the second German Development Aircraft, prepares for a test flight in May 1998.** *(Eurofighter GmbH)*

opposite page, bottom: **Assembled by CASA in Spain, DA6 was the first two-seat Eurofighter built and made its initial flight on 31 August 1996.** *(Eurofighter GmbH)*

right: **As the tail logo of the DA4 indicates, this two-seater is fitted with the Eurofighter's intended powerplants, Eurojet EJ200 engines. Of modular design and comprising far fewer parts than the RB.199 fitted to other examples, the EJ200 provides a much longer lifecycle, reduced maintenance and significantly more thrust.** *(British Aerospace)*

below: **At the 1998 Farnborough Air Show it was announced the Eurofighter had been re-christened the "Typhoon" by the partners. For Britain, the name has a strong fighter pedigree.** *(via author)*

coordinate and manage the engine program. The first flight was then expected in 1990. It was a difficult and troubled time, marked by squabbles over price, technology, work share and European politics. The first flight date slipped, first by months, and then by years.

Interestingly, Eurofighter GmbH press material today makes little reference to Eurofighter "prehistory," stating simply that "operational requirements for today's Eurofighter Typhoon ... were agreed by the [respective] Chiefs of the Air Staff ... in January 1994." In fact, 1994's agreement marked little more than a confirmation of agreements made 10 years before, in the wake of high-profile but largely meaningless attempts by German politicians to seek alternatives to the Eurofighter and reduce its cost. In the end, Germany decided to withdraw from

but, today, most impartial observers find it hard to argue with the builder's own confident assessment. As one senior program manager told *Combat Aircraft*, "We believe this is the world's most advanced multirole fighter—it is truly world-beating."

Anglo-Italian-German cooperation on an advanced fighter began in 1982 following implementation of national studies, and a five-nation Outline Staff Target was issued in 1984 that included Spain and France. France dropped out in 1985 but the other nations issued a Staff Requirement in December 1985 and launched full-scale development in 1988. The respective industrial partners (BAe, DASA, Alenia and CASA) formed Eurofighter GmbH to manage the development program in 1986, and a separate consortium, called Eurojet, was set up to the aircraft's Defensive Aids Subsystem (but is now on the verge of rejoining), and insisted on a change of name to that of Eurofighter 2000. It was an attempt to signify Germany had forced major changes although, in reality, it had not.

Britain committed to the production investment phase in September 1996, followed by Spain two months later and by Italy and Germany in late 1997. Production and support Memorandums of Understanding (MoUs) were accordingly signed on 22 December 1997, and contracts followed on 30 January 1998.

Essentially, the Eurofighter remains an extremely agile air dominance fighter designed to meet perceived needs for the first half of the 21st century. It is optimized for all-weather beyond visual range (BVR) and close combat but with

significant ground attack capability. The aircraft will be able to fly close air support (CAS), suppression of enemy air defenses (SEAD) and maritime attack missions, in addition to interdiction sorties. Survivability, reliability, availability and low-life-cycle cost were priorities in its development, as was a high degree of growth potential. In fact, many of these aspects are contractual obligations. Eurofighter GmbH will be forced to pay compensation if certain "maintenance man-hour per flying hour" (MMH/FH) and mean time between failure (MTBF) criteria are not achieved in service. In addition, 15 percent growth potential was built into the engines, the mission computer and other key systems. This means Eurofighter will undergo no midlife upgrade, but instead will be subjected to a continuous technology insertion program (CTIP).

The Eurofighter was always specified as a single-seater that demanded a state-of-the-art, electronic, glass cockpit and a "human-machine interface" superior to that of any fighter before. High-tech avionics systems are linked via an integrated network of digital data buses, while maximum performance and agility are ensured through the use of powerful, modern engines. In addition, its structure ensures low weight and an advanced, unstable configuration.

above: **Together for the 1997 Paris Air Show, Italy's DA7 took part daily in the air demonstrations while Spain's two-seat DA6 remained on static display.** *(British Aerospace)*

right: **DA7 reveals the relative size of the large intakes that utilize radar-absorbent materials to help reduce the fighter's radar signature.** *(Eurofighter GmbH)*

The aircraft is exceptionally unstable in pitch and, without constant inputs from the full-authority, quadruplex, digital flight control computers, would rapidly diverge in pitch and break up within seconds. This allows the highest possible pitch rates for deliberate maneuvers. Additionally, at supersonic speeds the aircraft is also unstable in yaw. The digital flight control system allows the size of control surfaces to be kept to a minimum, thus reducing airframe weight and drag.

Initial Production

Although there are Eurofighter plants in all four partner countries, there is surprisingly little duplication of effort except for the four separate final assembly lines and four separate flight-test facilities. However, the latter have different responsibilities. All manufacturing is single sourced, with BAe producing the forward fuselage, canards, windscreen, canopy, dorsal spine, vertical fin, inboard flaperons and part of the rear fuselage. DASA builds the center fuselage, while Alenia handles the left wing and outboard flaperons, and CASA the right wing and leading edge flaps. The fighter will be produced in some of the most modern manufacturing facilities in the world, taking advantage of the latest "lean manufacturing" techniques.

Planned Eurofighter production for the partner nations now stands at 620 aircraft. Britain will take 232 aircraft (37.5 percent of the anticipated production total) and gets 37 percent of the total work share. Germany will take 180 aircraft (29 percent of the anticipated production total), gaining 30 percent of the work share. Italy's total is 121 aircraft (19.5 percent of production, against 19 percent of the work share), while Spain will take 87 aircraft (14 percent of production against a similar percentage of the work). Subassembly of components for the first production aircraft began in December 1998 with initial flights anticipated in 2001. This scale of production puts the Eurofighter ahead of the F-22 (339 aircraft on order) and the F/A-18E/F (548 orders) in terms of numbers, which, perhaps, is a first for a European aircraft program. In this respect, the Eurofighter is also ahead of the Dassault Rafale, which will be built slowly and in relatively small numbers. Although the Eurofighter will be built in relatively large numbers, the four assembly lines will ensure there is sufficient flexibility to expand production for export, should that become necessary. Hitherto, US manufacturers have been able to take advantage of massive domestic orders to guarantee economies of scale and low unit prices for export customers, and the certainty of "top-up" and attrition buys have allowed production lines to stay open when it would otherwise have been hard to justify. Today, only the JSF (Joint Strike Fighter) looks set to be procured in really large numbers. However, export success for the JSF will depend on the aircraft gaining more credibility as a genuinely multirole, tactical airplane. Both JSF contenders are suffering cost overruns (some $100 million on the Lockheed Martin aircraft), and there are doubts about some program areas. For the first time, possibly, the advantage might be with the Europeans.

With all seven Eurofighter prototypes now having flown and

right: **Returning from its maiden flight, DA6 taxies back to CASA's facility in Getafe, Spain. Currently, the Spanish company ITP is working on development of a thrust vectoring engine for hte Eurofighter in close collaboration with DaimlerChrysler Aerospace.**

middle and bottom: **Among the test programs with which DA2 has been tasked are: flight "envelope" expansion, "carefree" handling, spin recovery, air-to-air refueling and testing of the Defensive Aids Subsystem.**

(photos British Aerospace)

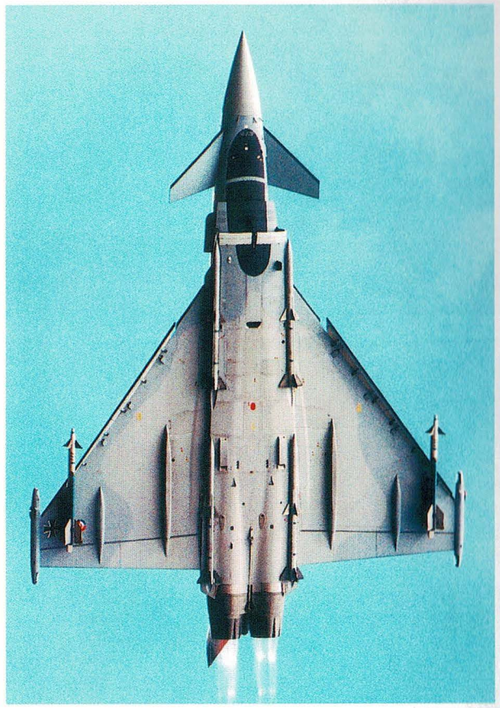
with growing interest from countries outside the four nation consortium, as well as a lower price tag than any equivalent or realistic competitor, the Eurofighter Typhoon looks strong. The aircraft seems to have emerged from the turbulent and troubled days in which German procrastination was casting a shadow over its very future. Indeed, when an air force now considers the superfighter it might procure, the Eurofighter Typhoon seems like the logical choice.

Cheaper than an F-15E and export model F-15s, and probably marginally cheaper than a new-build F/A-18C, the Eurofighter promises to be a better and more versatile fighter. It has superior radar, greater combat persistence (more missiles) and better performance where it counts (supersonic acceleration, agility and "carefree" handling at high-Alpha and lower speeds). Even before the first tranche production contract was signed, Britain's fiscal watchdog, the National Audit Office, revealed the estimated cost of the RAF's Eurofighters to be £40.2 million ($66 million) each, or £61 million ($100 million) including research and development costs. The contract price was actually lower, and the unit price is understood to have dropped to something closer to £33 million ($54 million). Significantly cheaper, only the Lockheed Martin F-16 and Saab Gripen can compete on price. However, even in its Block 50N or Block 60 form, the F-16 cannot match the Eurofighter as a long-range, all-weather BVR fighter. Fine aircraft as they are, neither the F-16 nor the Gripen can compete in terms of capability either.

Purchase price is not the only factor to be considered since through-life costs (the actual costs of ownership) are massive. Such costs for the Eurofighter are contractually guaranteed to be significantly lower than those of any rival, including the types now regarded as being "cheap lightweights." With respect to the latter, a cheap fighter aircraft always tends to be a false economy when it is pitted against more capable types. If the Eurofighter's full capabilities are not available in the first aircraft off the line, even a degraded aircraft will mark an improvement over all of today's best fighters. In any case, it is believed that any deficiencies or delays affecting the initial operational standard Eurofighter will relate to its air-to-ground, not to its air-to-air capabilities.

With its advanced helmet-mounted sighting and display system, and with DVI (direct voice input), the full-standard Eurofighter promises to have a better environment and a better man-machine interface for its pilot than the F-22 Raptor when it eventually enters service. It may be that the F-22 will "supercruise" faster and will almost certainly be stealthier. However, head-on the Eurofighter enjoys a very low radar cross-section signature (RCS), and the F-22's stealth "edge" may be less than is often assumed. In any case, a low RCS is only one aspect of the stealth equation. Low-emission sensors and

this page and opposite page: **Clearly evident in three of these photos is the Eurofighter's sleek delta canard design. The wing has a constant leading-edge sweep and the drag-reducing swept foreplanes increase lift. Construction has taken advantage of new-generation composite materials, titanium and advanced alloys that have resulted in an aircraft that is remarkably light for its size.**
(this page top: via author, bottom: British Aerospace, opposite page top: Gary Bihary, bottom: British Aerospace)



targeting devices may be even more important. Even if an F-22 is invisible to radar, as soon as it starts transmitting with its radar it becomes detectable by the enemy. Interestingly, the F-22 does not have a passive (emission-free) target detection sensor, unlike the Eurofighter, which carries a very sophisticated IRSTS.

In a multibogey, BVR engagement, a force of Eurofighters might even have the edge over a force of F-22s, as the latter will rely on radar and their forward-hemisphere RCS advantage will be less significant. Crucially, the F-22s will also lack DVI, which makes multiple-target sorting and allocation faster for the Eurofighter. In any case, even in the post Cold War world, it is impossible to imagine a scenario in which the Eurofighter and F-22 would find themselves pitted against one another, since the F-22's technology is unlikely to be cleared for export to any nation that could pose a threat. Even the UK probably would qualify for a downgraded Raptor export-version only. Such an aircraft would be significantly more expensive, yet less versatile.

The Eurofighter's job would be to take down large numbers of MiG-29s, Su-27s, Mirage 2000s or possibly Rafales (the French have a history of being less pernickety about to whom they sell advanced weapons) — a mission it is likely to perform extremely well. The Raptor might be even better able to achieve this but the difference in performance against an advanced, super Su-27, for instance, is likely to be no more than 5 to 10 percent. What this means is that a Eurofighter pilot might win about 85 percent of his engagements, while the F-22 pilot could win, perhaps, 90 percent of such encounters. This would be against an Su-27 with parity in radar, weapons and RCS to the Eurofighter. In truth, however, such an Su-27 is never likely to exist. Instead, against the best-conceivable opposition, both the Eurofighter and F-22 are likely to turn in a 9:1 exchange ratio, whereas current-generation aircraft will manage no better than 1:1.

Performance, Price and Timing Advantages

In terms of competitiveness, the European aircraft has an important edge today because of the timing of the F-22 project, its huge price tag and the issue of export sensitivity. Even those nations that might be cleared to receive F-22s may not be able to wait that long and may not be able to afford them. What is more, the Raptor is still far from being ready for service with the US Air Force as it is still only a short way into its flight-test program. Some have recognized the price obstacle and have suggested the JSF might be a suitable alternative to the Eurofighter. Given the roles the European aircraft will fulfill however, it is a far less credible option.

The JSF is much more like the French Rafale — intended to be cheap and optimized for the air-to-ground role. The JSF may be stealthy but in the air-to-air role it will lack the Eurofighter's sophistication, capability and performance, especially in terms of *g* and specific excess power.

For many years, the Eurofighter's immaturity gave it a credibility problem. Would the aircraft do what its creators said it would? The aircraft is now far into its flight-test program and, following its impressive showing at the Farnborough Air Show last year, people are starting to believe it will be what its designers promised — the most cost-effective fighter aircraft of its generation.

At Farnborough in 1998, the aircraft demonstrated a level of agility that no other fighter present could match, including maneuvers that graphically illustrated the benefits and degree of "carefree" handling endowed by the aircraft's sophisticated fly-by-wire flight control system. It should be remembered, too, that while the Eurofighter was no longer flying in "worst-case failure mode," it was only operating at the show with FCS Phase 2A, which limited it to 7.25 *g* and a 28° angle of attack (AoA). It was still without autopilot and autothrottle, which will be added in FCS Phase 2B1 this year. Increased *g*, AoA and an expanded "carefree" handling envelope will be made available by FCS Phase 2B2 and, at IOC, the aircraft will be capable of flying at 9*g* at AoAs of more than 30°. What is more, it will enjoy "carefree" handling throughout the service envelope.

Judging a fighter on the basis of air show performances is unwise, though extremely tempting. When the Russian MiG-29 and Su-27 demonstrated their very-high-Alpha and poststall capabilities in the late 1980s and early 1990s, people were quick to point out that the tactical application of tailslides, cobras and the like were very limited. This was fair comment but the real significance of the Russian performances lay in the fact that they demonstrated an extraordinary degree of confidence in high-Alpha handling at air show altitudes. They also demonstrated a useful ability to point the nose "off axis" for a snap missile release or gunshot. Similarly, the Eurofighter's high-Alpha velocity vector (HAV) roll would have relatively limited combat applications because any low-speed, decelerative maneuver needs to be used with care. Further, the sensible fighter pilot will always "bug out" rather than engage in a slow-speed, close-in turning fight because of the latter's unpredictable outcome. But the HAV roll did demonstrate an ability to change direction quickly and unpredictably and, more significantly, gave an impressive demonstration of its pilot's confidence in the aircraft's "carefree" handling. In other words, a Eurofighter pilot can make maximum control inputs in any situation and still be confident the flight control computers will sort it out.

Independent analysis suggests the fighter enjoys the same degree of superiority over its rivals in a slow-speed turning fight as it does in BVR combat. This is because of many factors that include not only high-Alpha and high-*g* capabilities but high rates of roll, its sophisticated helmet-mounted sighting and display system and its comprehensive array of short-range weapons and aiming systems.

As well as being an agile aircraft in a close-in turning fight, the aircraft's subsonic maneuverability is matched by superb supersonic agility, with impressive instantaneous and sustained turn rates and very rapid acceleration. From "brakes off" on takeoff, the aircraft (loaded with internal fuel, four AIM-120s and two AIM-9s or ASRAAMs) lifts off in seven seconds using 1,400 feet of runway. Two and one-half minutes from brakes off, the aircraft can be at 35,000 feet, scorching along at Mach 1.5.

At low weights, the aircraft has a thrust-to-weight ratio of unity (1:1) with maximum dry power and can accelerate from 200 kts to Mach 1 in just 30 seconds without recourse to afterburner and with one engine at idle! And the aircraft can maintain supersonic flight without reheat (supercruise) with a load of six air-to-air missiles. Even with interim RB.199 turbofan engines, the Eurofighter has demonstrated its ability to exceed Mach 2. It should be remembered, too, that the fighter is not a modern-day Lightning that had to sacrifice range and payload for outright performance. In air-to-air configuration, the aircraft has about the same range as the Panavia Tornado F.Mk 3 and is capable of flying from Munich to Farnborough, for instance, on internal fuel.

In the air-to-surface role, the Eurofighter can carry a SEPECAT Jaguar-sized payload twice as far as that aircraft and, in payload/range terms, is broadly similar to the Tornado IDS. Minor modifications already being considered (including provision for conformal tanks) could give the fighter an equivalent payload/range capability to that of the F-111 Aardvark, formerly in US service. Yet it would still remain more agile than the new JSF.

Fleet Introduction

For many years, the Eurofighter's service entry seemed to be very much in the future. Today, initial "first-tour" pilots destined to fly the aircraft in 2004 are probably already learning to fly with their university air squadrons! Many young pilots now on front-line squadrons will still be serving when the Eurofighter enters service and it is likely they will be the first flight commanders and squadron bosses. For these young men and

women, the new fighter must seem very real and immediate. Each customer air force has its own timetable for inducting the aircraft into service, and the RAF's schedule is broadly representative. With 55 aircraft in the first tranche (for delivery from 2002 to 2006), the pace of reequipment may be faster in Britain than in some other nations, however. Seven squadrons of RAF Eurofighters will replace six Tornado F.Mk 3 and three Jaguar units, although one of the Tornado squadrons has already disbanded as part of cuts imposed under the Strategic Defence Review. The Eurofighter units will form at Coningsby (two squadrons plus the OEU and OCU) from 2002 to 2006, Leeming (two squadrons) from 2006 to 2008, and Leuchars, Germany (three squadrons) from 2008 to 2010. Each base will have its own advanced synthetic training aids, though, as indicated, Coningsby will be home to the conversion unit. The future of the Jaguar force's home at Coltishall is uncertain.

The 232 Eurofighters for the RAF will include 40 two-seaters that will loom large in the early production batches to allow a rapid buildup.

Although every Eurofighter aircraft will be fully multirole capable, it seems unlikely that all aircrew will be fully multirole trained. The exact composition of the RAF's Eurofighter force has yet to be confirmed but it seems likely that four of the seven squadrons will be assigned to the all-weather air defense role, another to offensive support and two will be multirole units. It is surprising, perhaps, that more will not be multirole since the training penalty is likely to be small. Multirole pilots require only a few more flying hours per month than pilots dedicated to a single role. Aircraft mission changes will be achieved simply by loading the appropriate armament. No additional software loading will be necessary.

The RAF is presently studying how to gear up its training to produce pilots for the Eurofighter and for other new-generation combat aircraft that will follow. At the moment, 70 percent of the RAF's fast-jet pilots fly in two-seat aircraft, yet the future firmly lies with single-seaters, at least insofar as the Eurofighter is concerned. In order to prepare a cadre for the new aircraft, a number of F.Mk 3 pilots are to be retrained and will fly a tour on the Jaguar or Harrier gaining relevant single-seat and offensive support role experience. Similarly, some Jaguar and Harrier pilots are to be sent to the F.Mk 3 force to gain experience of air defense flying, the techniques and tactics of BVR air combat and the use of related systems like radar and JTIDS.

With the shortage of fast-jet pilots likely to worsen, there is a possibility the service might even have to retrain Tornado F.Mk 3 navigators as pilots. By definition, these crews are master air defense tacticians and system operators. This is heady and controversial stuff but a feasibility study might be a sensible option.

RAF sources now seem confident that the Eurofighter will be delivered and will enter service on schedule. This schedule is an "alphabet soup" of dates and impenetrable acronyms. The logistics support date (LSD) is set for March 2002 and initial operational clearance (IOC) and the entry into service date (ESD) are to be achieved in June 2002. These milestones will be followed by an introduction to service date (ISD) in January 2005 and full operational clearance (FOC) in February 2005. Enhanced operational clearance (EOC) with new weapons and other systems is set for February 2006. Pilots for the first RAF front-line squadron will complete their conversion training in 2004 and the unit is due to be declared operational in 2005.

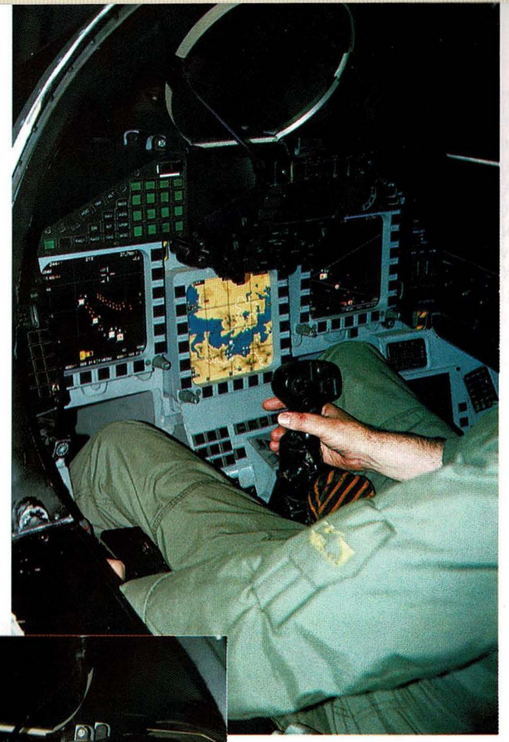
Export Prospects

The company's first serious attempt to find a customer outside of the four nation consortium was not successful. The aircraft was never going to be suitable for the United Arab Emirates in terms of its cost and availability time frame. It was remarkable, in fact, that it was even seriously considered. Anyone with even one foot in the real world realized that the UAE was not a serious possibility for the Eurofighter. The competing designs under evaluation were little more than an attempt to extract the best possible price from Lockheed Martin for the F-16s, which it had, in effect, already selected. There are some doubts whether the European contender even made a formal bid. Furthermore, there have been suggestions in some quarters that the Eurofighter's consideration was talked up in order to claim a sales victory for the F-16, thereby undermining the credibility of the European aircraft.

Such a hopeless situation was a depressing way for the company to start its sales drive, though the disappointment was short-lived.

The aircraft has since been short-listed to meet a Norwegian requirement for 20 multirole combat aircraft (with an option for 10 more), and a request for proposals was made on 1 February 1999 with responses due by May 1999. A Norwegian pilot, Maj. Frode Evensen, flew three evaluation flights on 15 and 16 December 1998. Although a career F-16 pilot and a USAF-trained test pilot, he was evidently stirred by the Eurofighter's power and handling and by the low-workload cockpit. As an existing F-16A MLU operator, Norway ought to be a "sure bet"

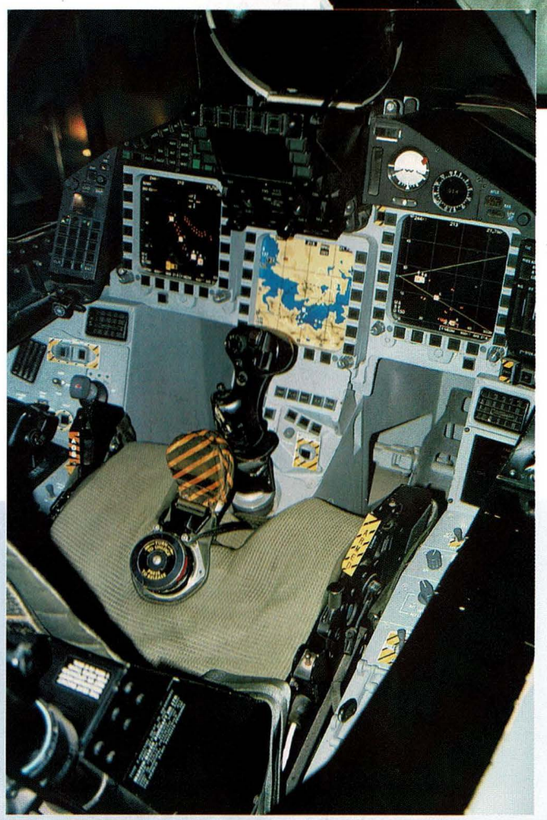
top: **Flying without paint, DA4 reveals the extent of composite materials used in the Eurofighter's construction (about 70 percent of the aircraft's surface area). The raised spine behind the two-seat cockpit houses additional fuel and offsets, to some extent, the capacity lost in accommodating the second crew position.**
above: **Engine manufacturers from the four consortium countries have developed the Eurojet EJ200 engine. They include Rolls-Royce of Great Britain, Motorenund Turbinen Union (MTU) of Germany, Italy's Fiat Avio, and Industria de Turbo Propulsores (ITP) of Spain. Rolls-Royce has a major stake in the latter company. The EJ200 is rated at around 20,000 lb st (89 kN).**
(photos British Aerospace)



right and below: **Among the work falling to British Aerospace is design and integration of the advanced cockpit planned for production aircraft. Sophisticated multi-function displays (MFDs) are being developed by Smith's Industries, and GE Marconi Avionics is producing the head-up display (HUD). This mock-up was displayed in February of last year at Asian Aerospace '98, held at Singapore's Changi IAP.** *(Mel Williams)*

for Lockheed Martin's new F-16 Block 50N but most observers believe the Eurofighter is in with a chance. Norway's experience with the MLU upgrade has been somewhat mixed with reports of overpricing and underprovision of agreed offsets. The Eurofighter has leapt into the potential breach, offering an antiship capability with the indigenous Penguin missile. Norway's decision is due at the end of this year.

Chances in Greece are, if anything, even better. At a cabinet meeting on 12 February 1999, Defense Minister Akis Tsochatzopoulis announced that his government would negotiate for between 60 and 80 Eurofighters to meet its requirement for a new-generation fighter to be delivered beginning in 2005. The aircraft was selected in preference to the F-15E, Su-30, Mirage 2000-5 and F-16 Block 50 Plus, though a small interim purchase of 30 Mirage 2000s and Block 30 F-16Cs is likely. Greece probably will become a member of the Eurofighter consortium and have some industrial participation when its order is confirmed. The Greek decision favoring this aircraft is certain to be extremely influential, not the least in the eastern Mediterranean. It was already considered to be a strong contender in Turkey, and Greece's interest will improve its prospects.



Continuing disagreement between the UAE and the US over the release of software codes for the F-16 have already pushed back F-16 deliveries to mid-2003 at the earliest. Any further delays may impact timing even more significantly and threaten to leave a gap in F-16 production. What is more, further delay could enable the Eurofighter to become a serious contender.

Each of the Eurofighter partners is assigned "lead" status in export efforts aimed at specific potential export markets. This is based partly on the requirements of work sharing and partly on the basis of exporting experience to the country in question. Thus, BAe has leadership in export efforts in Australia, Bahrain, Canada, Indonesia, Kuwait, Malaysia, Saudi Arabia, Singapore and the UAE and will support CASA in South Korea. DASA has leadership in Belgium, the Czech Republic, Denmark, Greece, Hungary, the Netherlands, Norway and Poland and will support Alenia in South Africa. Alenia, meanwhile, leads in Brazil, the Philippines and South Africa and will support DASA in the Czech Republic, Greece and Hungary. CASA is left with export leadership in Chile, South Korea, Thailand and Turkey, supporting BAe in Australia and perhaps in Indonesia and Saudi Arabia.

Flight-Test Program Objectives

Today, seven Eurofighters are flying in support of the flight-test program, and the use of so many aircraft and four flight test centers will inevitably lead to some duplication of effort. However, this has allowed extremely rapid test progress to be made. By 3 March 1999, the seven prototypes had amassed 762 flying hours and 21 minutes during 929 flights. The present disposition and tasks of the Eurofighter prototypes are as follows:

DA.1 98+29

The first Eurofighter prototype made its initial flight on 27 March 1994. Initially, it was hoped the type would fly during 1992 and, after that date passed, it was rescheduled for October 1993. The long delay was caused by the need to double-check the critical FCS software, especially after the earlier losses of a YF-22 and a JAS 39 Gripen.

DA.1 was assigned to aircraft handling and engine development and flew from Manching in the hands of Peter Weger without much ceremony. The aircraft was painted in three-tone gray with the palest shade on the undersides and the darkest shade on its topsides (from midway along the fuselage sides and including the fin and the topsides of the wings). A quartered, quadrinational roundel was designed consisting of black (outer ring), red and gold (inner ring) for Germany in the top-left segment; and (clockwise): blue, white and red for the UK; red,

Eurofighter Typhoon

Eurofighter Typhoon

Specifications:

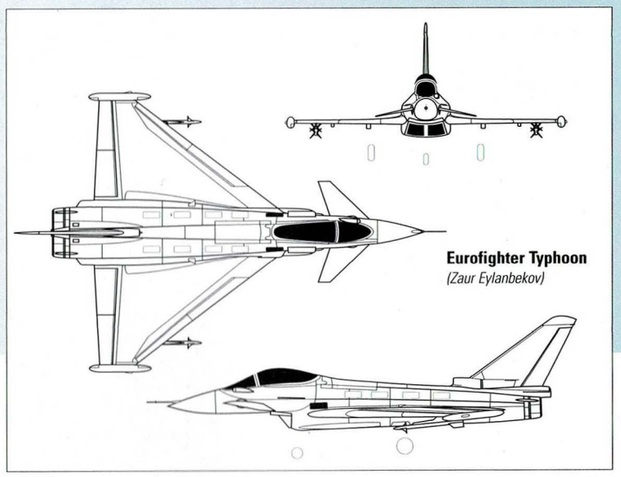
Wingspan	35 ft 11 in (10.95 m)
Length	52 ft 04 in (15.96 m)
Height	17 ft 04 in (5.28 m)
Wing area	538.21 sq ft (50.00 m²)
Wings aspect ratio	2.205
Canard area	25.83 sq ft (2.40 m²)
Empty weight	21,495 lb (9750 kg)
Max. takeoff weight	46,297 lb (21000 kg)
Max. speed ('clean' at 36,090ft)	1,321 mph (1,147 knots)
Max. climb rate	CLASSIFIED
Service ceiling	CLASSIFIED
Combat radius	288-345 miles (463-556 km)
G-limits	+9 /-3

Accommodation:
Single pilot on Martin-Baker zero-zero ejection seat.

Powerplant:
Two Eurojet EJ200 afterburning turbofans, each rated at 13,490 lb st (60.0 kN) dry and 20,250 lb st (90.0 kN) with afterburner.

Armament:
- One 27-mm Mauser BK27 cannon
- Short-range air-to-air missiles
- Medium-range air-to-air missiles
- Air-to-surface missiles
- Antiradar missile
- Guided and unguided bombs

Cannon is fitted in starboard-side fuselage. Other weapons accommodated on nine hardpoints and four underfuselage missile stations. Total ordnance load 14,000+ lb (approx. 6500 kg).



Eurofighter Typhoon
(Zaur Eylanbekov)

Designed as an advanced multirole combat aircraft that will serve during the first half of the next century, the Eurofighter Typhoon has been developed by four European partners – Britain, Germany, Italy and Spain. The origins of this "fourth generation" warplane go back more than 20 years and, if the current program stays on schedule, the type should be operational with the Royal Air Force by 2004-2005. Development is being undertaken using seven prototypes (known as Development Aircraft) and each partner nation is responsible for specific aspects of testing and evaluation. Similarly, for the production of each aircraft, the partners are tasked with construction of specific elements and final assembly will take place at one of four production lines (one in each country). Each nation's work share has been determined based on its purchase commitment from the initial production run (620 aircraft).

The same four countries have set up a powerplant development consortium called Eurojet to design and build the Eurofighter's engine. Jointly working on the EJ 200 are Rolls-Royce, Motorenund Turbinen Union (MTU), Fiat Avio and Industria de Turbo Propulsores (ITP).

left: **Development Aircraft One (DA1) trails DA5 as they fly over the German Alps. These single-seaters were assembled in Germany by the company now referred to as DaimlerChrysler Aerospace.**
(Eurofighter GmbH)

yellow and red for Spain; and red, white and green for Italy. This multinational roundel was applied on the forward fuselage, aft of the canard foreplane and above and below each wing. German crosses, with the code, were applied further aft on the fuselage and above the port and below the starboard wingtip. At one time, it was intended that DA.1 would be transferred to Warton, and a British military serial (ZH586) was reserved for it. This was not used, however, when DA.1 was briefly detached to Warton for supersonic trials in 1987. Scheduled to fly 635 sorties in support of the flight-test program, DA.1 is primarily used for handling and engine testing. By 3 March 1999, the aircraft had completed 123 flights totaling 126 hours and 20 minutes. It had also been reengined with EJ200 powerplants.

DA.2 ZH588

The maiden flight of DA.2 was delayed until 6 April 1994 by poor weather. Chris Yeo was the pilot for the highly successful, 50-minute flight undertaken from Warton. The aircraft was used for envelope expansion and "carefree" handling trials. DA.2 wore the same basic color scheme as DA.1 but with toned-down RAF roundels instead of "Iron Crosses" and with placement of these above and below each wing, outboard of the quadrinational roundels. For the third phase of its flight-test program, DA.2 was fitted with a spin recovery parachute on a gantry anchored to the bottom of the rear fuselage between the engines and to the upper fuselage alongside the fin root. The aircraft is scheduled to complete 635 test sorties, flying envelope expansion and "carefree" handling trials and, as such, was the first Eurofighter to exceed Mach 2. This achievement was recorded by Paul Hopkins during flight number 203 on 23 December 1997. The same aircraft had deployed to Leeming in July 1997 for HAS compatibility trials.

DA.2 was also the first aircraft to fly with an in-flight refueling probe fitted and flew "dry" in-flight refueling "prods" with an RAF VC10 K.Mk 3 in January 1998. It is anticipated that all single-seat prototypes will be retrofitted with such probes. DA.2 was reengined with EJ200 powerplants and made its first flight thereafter (number 217) on 26 August 1998. The aircraft was

left and below: **Britain's first prototype, DA2, makes a "dry" hook-up with a DERA-operated Royal Air Force VC10 during air-to-air refueling trials. The Eurofighter's in-flight refueling probe retracts into the starboard-side fuselage, ahead of the pilot.** *(via author)*

right: **Eurofighter Typhoon DA1 in echelon with another product of European cooperation, a Panavia Tornado, belonging to the *Luftwaffe's Einsatzgeschwader 1*. DA1 made its first flight on 27 March 1994.** *(DASA)*

middle: **The first missile firing test was undertaken by Italy's second development aircraft, Alenia-assembled DA7, when it fired an AIM-9 Sidewinder in mid-December 1997.** *(Eurofighter GmbH)*

decorated with the same lion, crown and rose badge originally applied to DA.4 and received a similar red, white and blue tail chevron. By 3 March 1999, DA.2 was on a scheduled layup (having last flown on 11 February) but was the Eurofighter "fleet leader" with 224 hours and 37 minutes flying time amassed during 267 flights. This represented more than a quarter of the entire fleet's total.

DA.3 MMX602

The first Italian-built Eurofighter first took to the air on 4 June 1995 and was the first aircraft to fly with EJ200-1A engines. Before the reduction from eight to seven prototypes, the aircraft was to have been designated DA.4, and the DA.3 designator was to have been allocated to Warton's two-seater, which became DA.4. DA.3 was assigned to EJ200 engine integration, stores release and gun-firing trials. Increased-thrust EJ200-1C engines were fitted to the real DA.3 after the first 40 flights and production-standard EJ200-3A engines were fitted in May 1997. DA.3 wore an overall, single-tone, light-gray scheme with multinational insignia in the same positions as on RAF aircraft but with Italian roundels carried only on the fuselage. The aircraft also had a red, white and green chevron on each side of the fin and later gained a Reparto Sperimentale di Volo (RSV)

fin badge. The RSV is Italy's evaluation and acceptance/clearance unit.

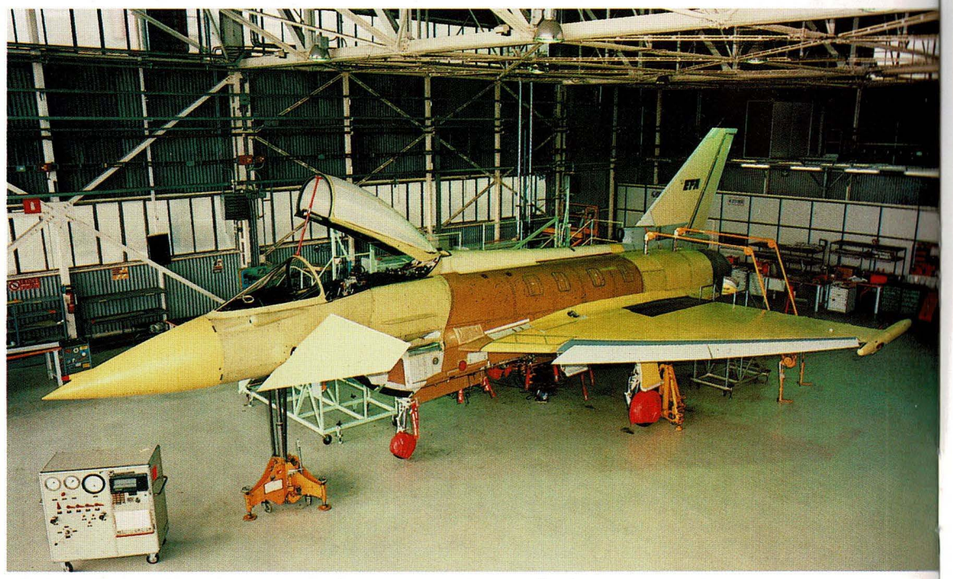
DA.3 was not fitted with radar and so, like DA.1 and DA.2, was fitted with a test instrumentation boom above the nose. The aircraft has hardpoints for underwing pylons and has flown with fuel tanks fitted. Plans call for DA.3 to fly 430 sorties in support of the flight test program. The aircraft is primarily tasked with stores release and gun-firing trials. Utilization has been lower than planned due to fuel tank leaks and, in March 1999, the aircraft was on layup prior to fitting of the gun having flown 131 hours and 49 minutes in 161 flights.

DA.4 ZH590

The second Warton-built prototype was originally to have been designated DA.3 but was redesignated

right and below: **Britain is responsible for manufacturing the forward fuselage, canards, windscreen, canopy, dorsal spine, vertical fin, inboard flaperons and a section of the rear fuselage. Germany is responsible for the center fuselage, whereas Italy produces the left wing and outboard flaperons. Production of the right wing and leading-edge flaps falls to Spain.**

(right: via author, below: British Aerospace)



following reduction (from eight to seven) in the number of flying prototypes. The aircraft was rolled out in an overall single-tone, gray color scheme similar to that applied to the Italian prototypes. However, national insignia were painted in the same positions as on DA.2. The aircraft was entirely stripped of paint, before its first flight, which was made in primer finish. It was then re-painted in an overall gray shade slightly darker than the radome. The aircraft received a red, white and blue chevron on the tail fin (similar to that applied to the Italian aircraft). However, the fin flash was positioned closer to the fin cap and a new badge combining a crown, a red Lancashire rose and a golden lion on a black shield was applied. Planned to fly 420 sorties, DA.4 is tasked with two-seat handling trials and with radar development, as well as avionics integration and development. Although it was the first two-seater, it was the last of the prototypes to fly. It made its maiden flight in the hands of Derek Reeh on 14 March 1997. Like DA.6 (the other two-seater), it is not expected that this aircraft will be retrofitted with an in-flight refueling probe. The aircraft was temporarily grounded due to unexpected and unspecified equipment shortages and the opportunity was taken to incorporate modifications while the aircraft was laid up. As of March 1999, this Eurofighter was still on layup and had recorded only 36 hours and 52 minutes of flight time that were amassed during 37 flights — the last of which took place on 26 July 1998. At press time, it was due to fly again fitted with the latest EJ200-1C engines.

DA.5 98+30

The original DA.5 was cut from the flight-test program and was to have been a Warton-built prototype. However, those responsibilities were transferred to DA.4 and the eventual DA.5, Germany's second Eurofighter (which, originally, was to have been called DA.6). DA.5 initially flew in primer (apart from the radome, which was fully painted) with codes and national insignia in the usual positions and with a quadrinational roundel below the cockpit. The code JP005 was stenciled on the tail fin. It is assigned to radar development and weapons systems integration and now wears a two-tone disruptive camouflage with a darker shade of gray covering most of the upper fuselage, the lower part of the tail fin and inboard parts of the upper surfaces of the wing. The aircraft wears a Bavarian flag and "BAVARIAN AIR FORCE" logo on each side of the tail fin together with the title "DA 5 - EJ200." DA.5 was the first Eurofighter to fly with radar (which was fully functioning during the first flight on 24 February 1997) and is powered by EJ200-3A engines. In October 1995, DA.5 clocked up the type's 500th flight and, during 1998, was used as the display aircraft at the air shows in Berlin and Farnborough. It is scheduled to fly 385 sorties and, by March 1999, when it was on layup, had made 115 flights and flown 71 hours and 5 minutes.

DA.6 XCE-16-01

DA.6 (originally to have been DA.7) was the first two-seat Eurofighter to fly beating DA.4 into the air by making its maiden flight on 31 August 1996. The pilot was Alfonso de Miguel. The aircraft flew with Phase 2A FCS software tasked with two-seat handling and with developing and testing two-seat avionics and systems in a 315-sortie flight-test program. DA.6 wore the same basic overall-gray color scheme as the Italian aircraft. Quadrinational roundels (but no national insignia) were applied above and below each wing and the aircraft wears a stylized bull badge on each side of its tail fin. As a two-seater, it is not expected to receive a retrofitted in-flight refueling probe. Currently on layup for installation of the active rear cockpit, radar and EJ200-3A engines, the sole Spanish prototype has flown 106 times and has amassed 96 hours and 10 minutes of flight time.

right and below: **With the development program continuing at a respectable pace, the Eurofighter is likely to be the first to enter service from the current field of advanced fighter projects. As a consequence, export potential should be strong**
(right: Daimler-Benz Aerospace, below: via author)

bottom: **With its flying demonstration completed for the day, DA5 taxies back to the ramp at ILA '98 held at Berlin's Schönefeld Airport, Germany during May.**
(Mel Williams)

DA.7 MMX603

The second Italian prototype (originally to have been known as DA.8) made its maiden flight on 27 January 1997. It is tasked with performance testing and weapons integration in a planned 290-sortie flight program. The aircraft undertook the Eurofighter's first missile launch (an AIM-9) on 15 December 1997. DA.7 wore the same color scheme as the first Italian prototype, DA.3, and sported the same red, white and green chevron and RSV fin badge. Currently laid up for cannon installation, DA.7 has amassed 75 hours and 28 minutes flying time during 120 flights. ❑

Readers wishing to learn more about the history of the Eurofighter program are advised to read the author's 43-page special focus report in *World Air Power Journal* Volume 35. It is available to readers in North and South America at a cost of $16 plus shipping and handling, directly from AIRtime Publishing Inc., 10 Bay Street, Westport, CT 06880. Telephone 1 800 359-3003. Readers from the rest of the world should contact Aerospace Publishing Ltd., 3A Brackenbury Road, London W6 0WE. Tel 0181 740-9554. Website http://www.airpower.co.uk

Combat Aircraft's Superfighter Profile No. 2 will feature the Lockheed Martin F-22 Raptor, and will be published in three months. Other fighters to be covered in this series include the Dassault Rafale, Saab Gripen and Sukhoi Su-35.