

FOX THREE

DASSAULT AVIATION - SNECMA - THALES **N°8**



**Rafale Enters
FRENCH AIR FORCE**

Editorial

Here is the 8th edition of "FOX THREE", a RAFALE INTERNATIONAL publication specifically dedicated to this new generation omnirole fighter: the RAFALE!

From this edition, we elected to evolve the "FOX THREE" newsletter into a twice-a-year publication with more content and photos.

A new format for a lot of RAFALE news, with the latest order announced by the French MoD for 59 new RAFALEs bringing total orders so far to 120 aircraft. Some articles about this fabulous omnirole fighter already operational in the French navy, and now entering French Air Force service. And, the timeline of the RAFALE in-flight display to be flown during Le Bourget Air Show 2005: don't miss it...

Enjoy!

The "FOX THREE" Team.

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FRENCH MINISTRY OF DEFENCE ORDERS A FURTHER **59 RAFALE FIGHTERS**



The French MoD has recently announced an order for 59 Rafale omnirole fighters, bringing total orders so far to 120 aircraft - 82 Rafale B/Cs for the Armée de l'Air and 38 Rafale Ms for the Marine Nationale - out of 294 required. Deliveries of these 59 Rafales will stretch from June 2008 to January 2012, with 47 fighters for the French Air Force (11 Rafale B two-seaters and 36 Rafale C single-

seaters) plus 12 Rafale M carrier-borne fighters for the French Navy. The order also encompasses 138 Snecma M88-2 turbofan engines.

The 59 fighters will be produced in the latest, fully omnirole F3 Standard capable of undertaking an extremely wide range of roles: air-defence/air-superiority missions with Mica IR and EM air-to-air missiles, precision attacks with Scalp cruise missiles and AASM



modular air-to-surface armaments, anti-ship strikes with the acclaimed AM39 Exocet sea-skimmer, reconnaissance with the Thales new generation reconnaissance pod, and nuclear deterrence with ASMP-A missiles. Among other improvements, Standard F3 Rafales will be fitted with the Sagem Gerfaut Helmet-Mounted Sight and with an enhanced Thales Spectra self-defence suite. Their Thales RBE2 radar will offer high-resolution cartographic modes plus a radar terrain-following capability on top of the high-resolution 3D digital database introduced in the F2 Standard variant.



FRENCH AIR FORCE RAFALE **OMNIROLE FIGHTERS ENTER SERVICE**

In December 2004, the first three Rafale fighters arrived at Mont-de-Marsan Air Base, in the south-west of France, where they are utilised for initial conversion training and for the Rafale operational evaluation.

CEAM

The whole evaluation phase will be conducted at Mont-de-Marsan by the CEAM (Centre d'Expériences Aériennes Militaires), the French Air Force Evaluation Centre. «The CEAM has now begun a rigorous series of tests to assess the Rafale's performance in all mission areas, explains General Eric Rouzaud, CEAM Commander. Whereas development testing conducted by the integrated test team mainly involves demonstrating that the aircraft meets or exceeds

the specifications laid out by the Ministry of Defence, operational testing is geared towards using the aircraft in its role as a fighter. As a result, the Rafale will be flown in a wide variety of scenarios against various threats. Here, we also handle initial Rafale pilot conversion and we develop new tactics and procedures adapted to the aircraft.» The number of French Air Force Rafale pilots is currently rapidly expanding, with a steady flow of newcomers arriving at Mont-de-Marsan from various Armée de l'Air bases. The first five pilots and

five navigators were all experienced aviators drawn from a wide range of backgrounds, and some of them had previous Rafale experience with the French Navy. They started flying the Air Force Rafales at Mont-de-Marsan in December 2004 and became the first cadre of instructors in order to train the following waves of front-line aircrews.

In-depth evaluation

The evaluation of the Rafale's robust air-to-air and air-to-surface capabilities will impose a major effort to the CEAM. «The advent of the Rafale with its modern RBE2 electronic-scanning radar, its Front Sector

Distribution System link 16 datalink has forced us to devise a comprehensive evaluation programme, says Lieutenant-Colonel François Moussez, the Officer in Charge of the Rafale evaluation at Mont-de-Marsan. It is anticipated that, by mid-2006, more than 600 Rafale evaluation sorties will

year, with Mica IR air-to-air missiles, Scalp cruise missiles and AASM air-to-surface armament, all to be tested in realistic conditions, including jamming. When operational testing is complete, the aircraft will be declared fully combat-ready in the air-to-air and air-to-surface arenas, and the oper-



Optronics, its advanced electronic warfare suite and its Multifunction Information

have been logged by CEAM specialists. Numerous firings will be conducted in the coming

ating manuals will be ready for the first front-line squadron.»



French Minister of Defence Flies in a Rafale fighter

On 24 February 2005, Mrs Michèle Alliot-Marie, the French Minister of Defence, undertook a sortie in two-seat Rafale B304 from Mont-de-Marsan Air Base. The pilot who flew the Minister of Defence, Lieutenant-Colonel François Moussez, said Mrs Alliot-Marie was 'totally at ease' during the 1 h 30 min sortie. The mission included long-range and short-range air-to-air engagements, an in-flight refuelling by a French Air Force C-135FR tanker and some low-level flying during a simulated attack profile with Scalp cruise missiles.





...FRENCH AIR FORCE RAFALE **OMNIROLE FIGHTERS ENTER SERVICE**

A fully omnirole squadron

By early June 2005, six Rafales will have been delivered to the CEAM and this number will grow to fourteen by the end of the year. «In July 2005, the first Rafale squadron, Escadron de Chasse 1/7 'Provence', will officially reform at Saint-Dizier, in eastern France, reveals Lieutenant-Colonel Louis Pena, EC 1/7's future Deputy Commander. However, the aircraft and aircrews will remain at Mont-de-Marsan until early 2006, when the first Rafale fighters will relocate to Saint-Dizier. Currently, the squadron and the operational evaluation unit share the aircraft.»

When the first squadron is declared operational, in September 2006, the aircrews will be cleared to carry out a wide range of missions with their radar-guided (Mica EM) and infrared-guided (Mica IR)

missiles, their AASM powered bombs and their Scalp missiles. EC 1/7 will eventually be equipped with 20 Rafales, fifteen two-seaters and five single-seaters. It has already been announced that the second Rafale squadron will be stationed in Saint-Dizier too, whereas the third will be based in Mont-de-Marsan.

A superb fighter

The aircrews at Mont-de-Marsan are all enthusiastic about their new aircraft. «So far, we are extremely pleased with the first results of the evaluation, stresses General Rouzaud. Obviously, we have taken advantage of the Navy's experience: thanks to the expertise they have passed on to us, the Rafale's introduction is all but a step into the unknown for the French Air Force. Dassault's technical support is outstanding, and our strong partnership will allow us to fully exploit the capabilities

of the fighter very soon.» All aircrews agree that the Rafale is a big improvement on existing jets. «Early assessment has been satisfactory, explains Louis Pena. The man-machine interface is very intuitive and easy to use. The reclined seat proves extremely comfortable and g-tolerance is massively ameliorated. Endurance is excellent, even at low-level where we can fly at 450 knots for 1 h 30 min in a clean configuration.» The airframe, engines and avionics suite are also highly praised. «The fighter proves extremely agile and the Snecma M88-2 turbopfans are very powerful, confirms François Moussez. Engine response is instantaneous, a crucial advantage in a dog-fight. The Front Sector Optronics will allow new, innovative tactics to be devised. Finally, the RBE2 radar can track multiple targets, even when enemy fighters split.»

Rafale squadron facility construction begins

Construction of a new high-tech facility for the first Rafale squadron officially began at Saint-Dizier Air Base on 03 February 2005 when General Wolsztyński, the French Chief of the Air Staff, laid the building's foundation stone. When fully operational, in December 2005, the 12,000 square meter building will be divided into four areas: a hangar large enough to accommodate five fighters, a maintenance / servicing facility, a storage area and an office / mission planning block.



AIR-DEFENCE MISSION **FOR FLOTTILLE 12F**

In early 2005, Flottille 12F, the first naval Rafale unit, was tasked to participate in the air-defence of the French airspace. Two Rafales were detached to Lann-Bihoué Naval Air Station, in western France, to replace a pair of French Air Force Mirage 2000-5 fighters. It is highly unusual for Navy aircraft to take part in a traditional Air Force mission, but Armée de l'Air Commanders had requested help from their Navy counterparts to share the burden for a week, as an experiment.

At Lann-Bihoué

The detachment was composed of two pilots and seven maintainers/armourers. The two Rafales were each armed with two Magic 2 heat-seeking missiles at the wingtips, and one of them also had two Mica EM fire-and-forget radar-guided missiles under the wings. Both were equipped with a 1,250 litre fuel tank on the centreline pylon and with an array of flare and chaff decoys. During the whole week, the two fighters were cocked and ready to go in just seven minutes, ready to be vectored off to intercept any threat. At the end of each sortie, the engineers had 30 minutes to turn around the fighter, including ten minutes to fill up the tanks. However, the aircraft was usually operational again in 15 minutes, and no major technical problem arose during the deployment.

A very well-suited fighter

«The Rafale is ideal for the job, stresses one of the two duty pilots. It can climb to 40,000 feet in under two minutes and accelerate very rapidly to supersonic speed. More significantly, it can supercruise in dry power, even with four missiles and a belly drop tank. Endurance is excellent too, and we can stay airborne up to two hours with one tank.» The pilots also praise the Rafale's advanced man-machine interface which considerably reduces their workload. On average, the fighters were launched once a day for training, but two live intercepts were also carried out. The participation of Flottille 12F to the French air-defence effort has been so successful that it is expected that the experiment will be re-conducted in the fall, between two training deployments of the Charles de Gaulle's carrier air group.





First Rafale participation in the Tactical Leadership Programme

To further increase its tactical capabilities and ameliorate aircrew effectiveness, the French Navy decided to send three Rafale fighters to Florennes, in Belgium, to take part in the prestigious Tactical Leadership Programme. During the exercise, the three aircraft (including one spare) flew 50.6 flying hours in 28 sorties, recording a remarkable 100% mission availability rate. The Rafales were mainly used in the escort role, and they usually took off first and landed last after two hours airborne without in-flight refuelling, a testimony of their outstanding endurance. Their weapon system and their self-defence suite proved extremely reliable and impressed all participants.









THE RBE2 AESA: *a major asset for the Rafale and a critical component of operational superiority*

Designed from the outset to deploy an electronically scanned radar, the Rafale is equipped with the RBE2 radar from Thales. In production since 1997, the RBE2 is the first multi-function electronic scanning radar developed for a combat aircraft. With its advanced electronic scanning technologies, the RBE2 offers new capabilities, particularly in air-to-air, air-to-ground and air-to-surface functions, terrain following and terrain avoidance. Most of these new capabilities are beyond the reach of conventional radars. Electronic scanning in both planes makes it possible to authorise simultaneous designation of multiple targets to different air-to-air missiles, while at the same time performing searches in directions completely independent of the targets tracked. In this respect, the RBE2 marks a radical break with all previous-generation radars. This level of tactical situation awareness gives the Rafale the ability to counter enemy tactics with remarkable effectiveness.

For very low-altitude penetration missions, the RBE2 uses electronic scanning technologies to generate a three-dimensional ground map covering a wide area forward of the aircraft, supporting terrain following and manoeuvres in the horizontal plane within the area scanned by the radar. In addition, the RBE2 on the Rafale F3 standard will offer high-resolution ground mapping modes that are also unique in Europe. To date, the RBE2 is the only European electronic scanning radar equipping a new-generation combat aircraft in operational service. It has successfully completed various assessments and out-of-area campaigns.

The active electronic scanning antenna (AESA)

Certain radar functions were designed from the outset to be performed by an electronically scanned antenna, and the RBE2 is thus inherently suited

to the AESA active antenna. The transition to electronic scanning technology, which in the case of the RBE2 concerns transmit and receive technologies only, will provide new capabilities and enhance performance, while at the same time improving reliability and reducing maintenance costs. The radar therefore offers a unique opportunity to capitalise on the know-how gained through the development of its various functions, which are based, from the start, on electronic scanning technologies. Thanks to the RBE2's scalable architecture, the upgrade to the active antenna simply involves replacing the tube transmitter and passive electronic scanning antenna with around 1,000 active modules. This operation is independent of other functional developments underway. An active module is a transmitter/receiver based on solid-state technologies (gallium arsenide semiconductors).



Enhanced operational effectiveness

In July 2004, the French defence procurement agency (DGA) awarded Thales a contract to develop the second-generation active electronic scanning antenna (AESA), specially adapted to the RBE2. Development is underway. The first demonstrator met all performance objectives and has been flying on the Rafale since April 2003.

The AESA active antenna will increase the RBE2's range and the quality of its angular coverage.

In air-to-air mode, longer range makes it possible to detect new threats with low radar reflectivity (new-generation fighters, stealth targets, etc.) at an earlier stage, allowing more time to process them, and ensures coherence with the arrival of future missiles (Meteor, etc.). In air-to-ground mode, the higher power budget translates into better contrast on synthetic aperture radar (SAR) images.

In addition, due to the antenna's large number of active modules and the phenomenon of progressive degradation, failure of some of these

modules will have no noticeable effect on performance. Real-time analysis of antenna status can be performed at any time for maintenance scheduling.

As a result, the active antenna is much more reliable from an operational point of view, thereby guaranteeing higher operational availability of the Rafale. Its simplified maintenance concept will also contribute to reduced cost of ownership.

Lastly, the use of active antennas opens up new possibilities for further development of radar functions, particularly in areas such as resistance to countermeasures.

Radarology: an antenna is said to be "active" when its radiating surface comprises several tens or hundreds of elementary modules, each performing both transmit and receive functions. These modules are based on solid-state technologies. In other words, they use monolithic microwave integrated circuits (MMICs) and not tubes.



FOCUS ON THE M88

A state-of-the-art fighter engine

The M88-2 engine powers the new-generation Rafale multi-role fighter. Featuring a redundant fully digital control system for exceptional ease of handling, the M88-2 also offers a modular design for enhanced maintainability, new-generation materials and other advanced technologies. The outstanding performance of the M88-2 is largely due to its state-of-the-art control system, designed to optimize engine operation throughout the flight envelope. The engine is particularly well suited to low-altitude penetration and high-altitude interception missions. Powering both the carrier-

borne and land-based versions of Rafale, the M88-2 has already proven its excellent performance and dispatch reliability in service.

Snecma has developed a new version of the M88-2, the M88-2E4, that offers lower fuel consumption and cost of ownership, with longer service life for the engine's critical parts. A new demonstrator engine, dubbed "ECO", has also been developed as part of an advanced R&D program. It aims to demonstrate the feasibility of reducing the life cycle cost (LCC) of the M88-2 at its current thrust level. A secondary aim is to use the technologies developed through the ECO program to pave the

way for a higher thrust engine. The possibility of developing an engine developing 90 kN (20,200 lb) of thrust with reheat has been demonstrated.

Snecma has delivered 90 M88-2 engines to date, with the fleet logging over 22,000 hours in flight. The M88-2E4 engines deployed by the French naval air arm and air force have posted outstanding dispatch reliability.

A recent flight evaluation with a foreign Air Force spotlighted the excellent performance of the engine, along with the advantages of its innovative maintenance concept.

At the end of 2004, the French Ministry of Defense placed an order for 59 additional Rafale combat aircraft. For Snecma, this means the production of 118 M88-2 engines as well as the associated spares, for delivery starting in 2007.



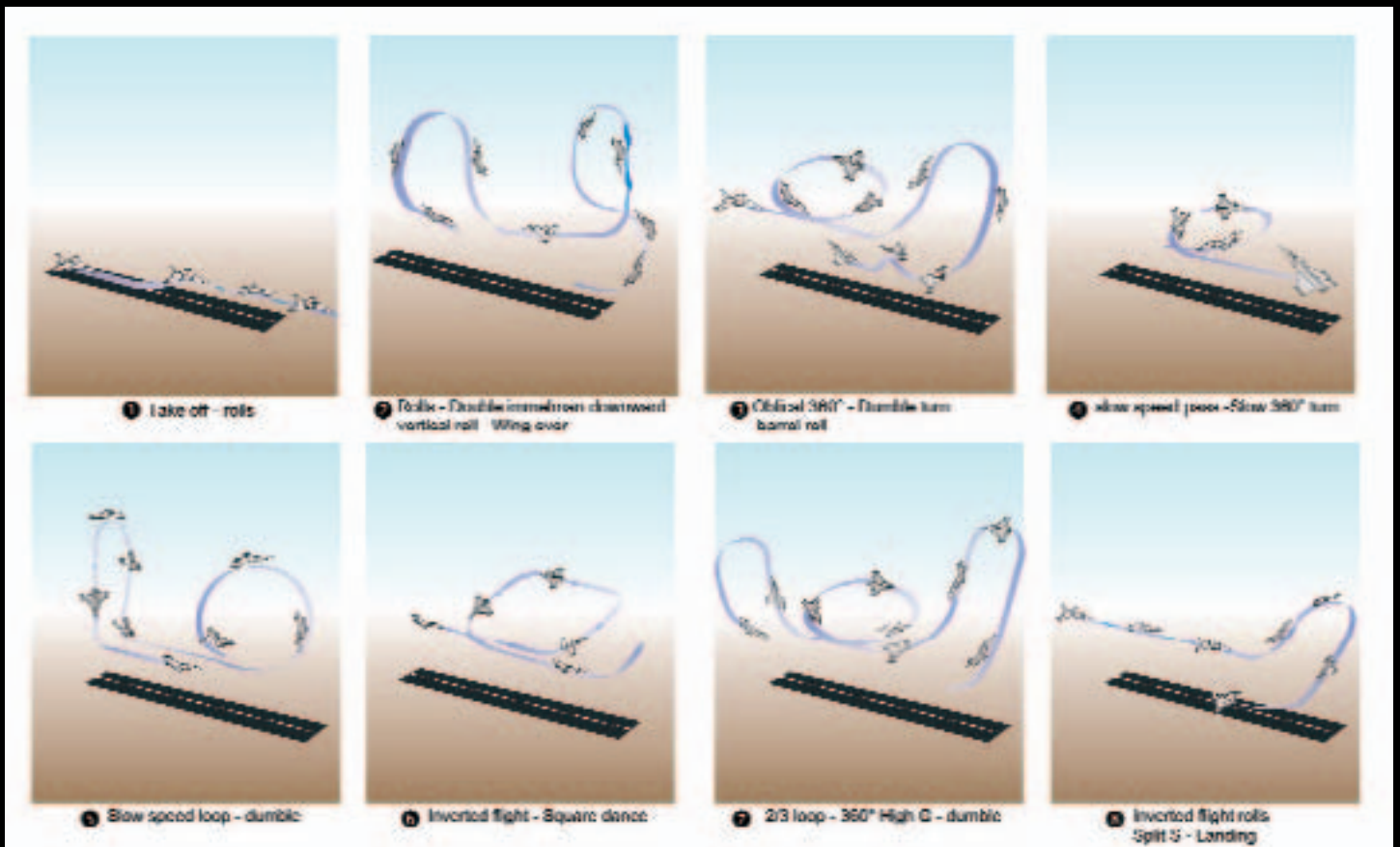


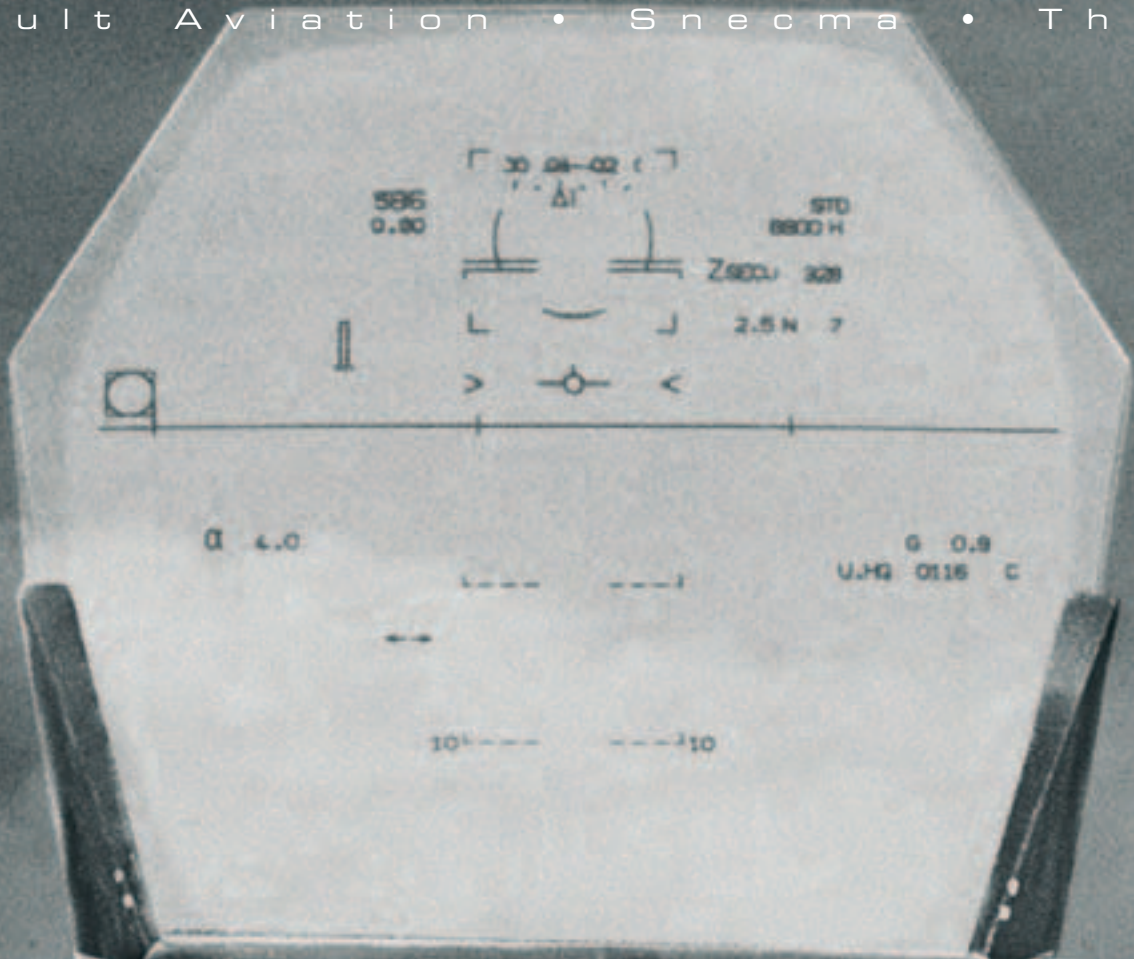
RAFALE FLYING DISPLAY

The Rafale omnirole fighter is regularly displayed at major airshows around the world by Eric Gérard, a Dassault Aviation test pilot credited with over 5,300 flying hours, including 600 in

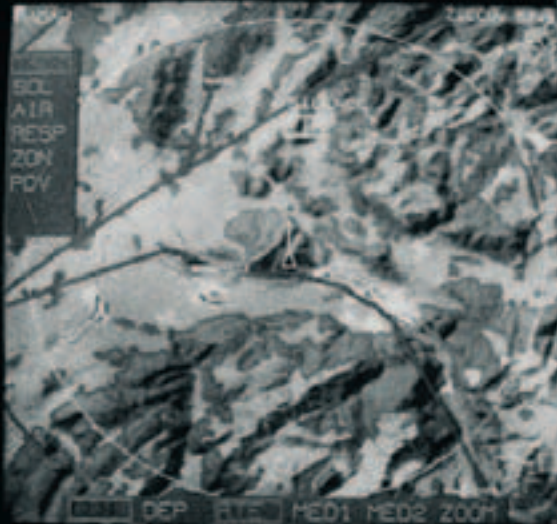
Rafales. «During the tight display routine, I push the aircraft to its limits to demonstrate both its outstanding agility and the fly-by-wire's 'carefree handling' feature that won't let the pilot stall the aircraft or pull too much g, he says. The highlight of the display is the Square Dance, a 360 flat turn with four rolls, a very violent manoeuvre only performed by

the Rafale.» During the six-minute show, speed will vary from 100 knots for the slow pass to 500 knots, roll rate will reach 270 degrees per second, and g-load will peak at -2.5 / +9 g. Airfield performance is impressive too, with a 500 metre takeoff distance and a 400 metre landing run, even without a brake chute.





DATA FUSION



RAFALE 
INTERNATIONAL

While rival late-generation fighters build pilot ergonomics around inherited technologies, Rafale offers a revolutionary man/machine interface designed around the plane's most vital component: the pilot. The result is the most advanced modular integration of data, communication and control ever engineered into a combat aircraft. *Rafale. The OMNIROLE fighter* ■