

Boeing's first X-32 demonstrator is due to fly in the coming weeks. Inset shows Boeing JSF cockpit concept.



# Joint Strike Fighter fit for duty in Europe?

**JSF is trying to be one fighter for all requirements. How well will it adapt to the European environment?**

**A**s this issue went to press, the JSF Program Office of the US Defense Department was due to hand the definitive design specifications to Lockheed Martin and Boeing. The two aerospace giants will each develop a Preferred Weapon System Concept (PWSC) and fly two demonstrator aircraft.

The selection of a winning design will be made in Spring 2001, clearing the way for the production of some 3,000 aircraft for US and UK forces alone. Export orders could add another 3,000 to that number.

Although JSF will be a distinctly international programme, the requirements for the aircraft are primarily geared towards the main customer: the US Department of Defense. So how well does the aircraft fit the needs of other air arms — notably in Europe, where the majority of foreign partners in the programme are to be found — who lack the immense resources and diversity of weapon and support systems of US forces.

## Operational performance

The Joint Strike Fighter will have a manoeuvrability comparable to present-generation fighters like the F-16 and will have a better payload-range performance. However, its top speed will be Mach 1.4-1.6 whereas the top speed of the present generation of fighters is at or above Mach

2. According to industry sources, the sustained turn rate of the JSF may be less than that of current-generation fighters. On the other hand, the internal carriage of ordnance will likely give the JSF an important advantage over current aircraft in terms of aerodynamic efficiency.

So the actual performance of the JSF with an operational weapons load may not differ all that much from that of current-generation fighters, even if its performance under 'clean' conditions in terms of top speed and acceleration might be a bit less sparkling.

But compared to the generation of fighters now coming into service, the Joint Strike Fighter has some distinct disadvantages. Aircraft like the F-22, Eurofighter Typhoon, Dassault Rafale and perhaps future versions of the Russian Sukhoi Su-27/Su-35 family will be able to supercruise while carrying air-to-air weapons. Some of these aircraft will also employ thrust vectoring, giving them unprecedented manoeuvrability, especially at high angles of attack.

Conventional wisdom would seem to suggest that a Joint Strike Fighter, once detected, could not escape from next-generation fighters with their higher cruising speed, and would be hard pressed holding its own in a dogfight. But the JSF differs in an all-important aspect from nearly all next-generation fighters. It is extremely hard to detect with radar or infrared sensors. In theory, the pilot of a JSF should be able to detect an adversary first and hence have the choice of avoiding an engagement or getting into a tactically advantageous position undetected, thus negating the need for superior flight and dogfighting performance. And all this comes at a cost so low as to be unprecedented for stealth aircraft. A JSF will cost about the same as the most cost-effective fighter presently in service: the F-16.

Of course the situation changes should the stealth performance of the JSF be com-



promised because of advantages in anti-stealth technology. Here, the difference in the operational environment between US and European armed forces comes into play.

### Lifting the cloak of stealth

What are the chances that the cloak of stealth hiding JSFs from unfriendly eyes will be lifted? According to Dana Pierce, Lockheed Martin's JSF International Business Development director, the United States can be sure to maintain the lead in stealth technology. "The development of anti-stealth measures costs more time and money than the introduction of further enhanced levels of stealth for aircraft like the JSF. Also, because the US will likely be the first to introduce anti-stealth measures, it will be the first to know how to counter them."

This means that the Joint Strike Fighter will continue to be protected by its low observability despite possible advances in anti-stealth measures. The question is, of course, whether enhancements in stealth can be retrofitted to existing aircraft and what the costs of those enhancements will be.

According to Mike Raettig, programme leader for JSF at BAe Systems, "JSF is designed as an affordable low-observable aircraft. Technology advances have made low observability more affordable than on previous-generation aircraft. The aircraft has been designed with low observability shaping, and it is envisaged that as technology matures further, low observability upgrades will be feasible to enhance the aircraft further against more capable emerging threats."

From this it could be concluded that the outer shape of the JSF answers the requirements of stealth. If this is so, the level of stealth of JSF can be considerably enhanced without extensively modifying the airframe. This having been said, the search for technologies to detect aircraft that are stealthy because of their shape has already begun. An example is bistatic radar where multiple receivers are carried by unmanned air vehicles or spacecraft. The shape of stealthy aircraft is designed to avoid reflecting radar waves in the direction of the radar transmitter, which traditionally is also the place where the receiver is located. If there are multiple receivers in various positions, the chances

of detecting stealth aircraft may increase dramatically. And, of course, the question is how stealthy the JSF is in the first place. It should not be taken for granted that the USA will export a fighter that is inherently as stealthy as its own top-of-the-line fighter, the F-22. Again, this concern applies equally to both the Boeing and Lockheed Martin JSF designs.

Both Pierce and Graham Williams, director, Lockheed Martin UK Business Development, stress the importance of the advanced sensors of the JSF for exploiting its stealth. Notes Pierce: "The JSF pilot will have a much better level of situational awareness than pilots of current-generation fighters. He or she will know where

An important question is how the sensors will perform against stealthy enemy aircraft and missiles that are in development in, for example, Russia and China. And of course, if enemy air defences are very dense, circumnavigating them may not be an option, regardless of the level of situational awareness that a JSF-pilot may have. A JSF is likely to be more vulnerable to surface-to-air missiles than an F-22, because of its lower speed.

As far as the flight performance of the JSF is concerned, Williams thinks that "acceleration is less important for a strike fighter than it is for an air superiority fighter like the F-22." This view stresses the point that the role of the JSF as an air superiority fighter is indeed limited. It

is interesting that at a press conference during the Farnborough Air Show in 1998, a representative of Boeing indicated that the performance of both the Boeing and Lockheed Martin JSF designs could be significantly improved by, for example, aerodynamic refinements and new inlet designs.

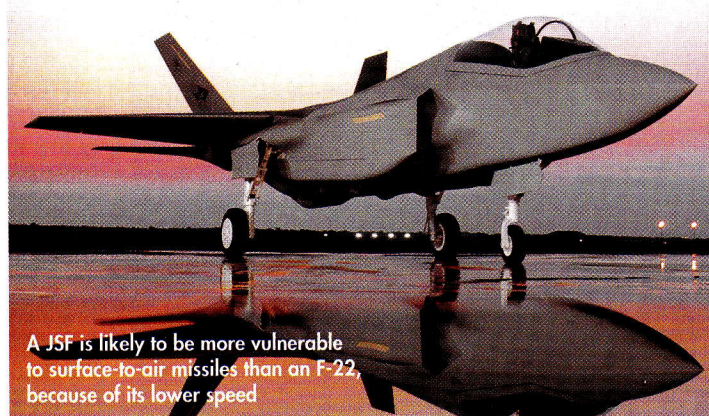
For both designs, maximum speed increases of Mach 0.4-0.5 might be feasible. It has to be assumed that the cost involved would be considerable, but it shows the versatility of the JSF designs. Raettig

says that the performance of the JSF could be considerably improved by engine development. "Historically, the thrust of engines has increased approximately 50% through their life-cycle. The Pratt & Whitney F119 and the alternate General Electric F120 are at the start of their life cycle and therefore have considerable growth potential."

### Future JSF enhancements

This could point to major enhancements of the JSF in the future. It is not clear, however, what the costs of fitting improved engines to existing aircraft are, and whether the potential of an improved engine can be fully realised without extensive airframe modifications with respect to, for example, the inlets. And of course it should be remembered that increases in engine performance have traditionally done little more than offset the increased weight of new versions of tactical aircraft.

There have been suggestions in the trade press that the United States might not be



### "JSF IS DESIGNED AS AN AFFORDABLE LOW-OBSERVABLE AIRCRAFT"

MIKE RAETTIG, JSF PROGRAMME LEADER, BAE SYSTEMS

friendly and enemy planes are, where enemy ground threats are and hence how to stay away from them and avoid detection or set up attacks in close co-ordination with other aircraft. Since every 18 months avionics systems reach a new level of performance and the design of the JSF is ten years younger than that of the F-22, the JSF pilot will have the best avionics available."

This is also true of the passive sensors that the JSF will carry, which will be crucial for preserving its stealth, although Pierce declines to comment on the performance of the sensors. Raettig of BAE Systems says: "A JSF pilot will be far better capable of evading the enemy than pilots of present-generation aircraft."



prepared to release all of the advanced technologies that American JSFs will carry. Especially stealth and sensor technologies might be considered too sensitive for export. Pierce, however, says that "there are no indications that the avionics of US JSFs will differ from those of European aircraft. But the US government will decide which technologies can be exported." It is conceivable that certain sensitive technologies will be incorporated in European JSFs but would be maintained, repaired and upgraded by American contractors.

### Dependent on off-board sensors?

Any fears that the new fighter will be heavily dependent on off-board sensors are unfounded. Pierce: "The JSF will be fully equipped for stand-alone operations. Whereas assets like Boeing E-3 Sentry and E-8 J-Stars airborne warning and control aircraft will obviously enhance the performance of any combat aircraft, the JSF can operate without them with no problems. It can do so much better than current aircraft."

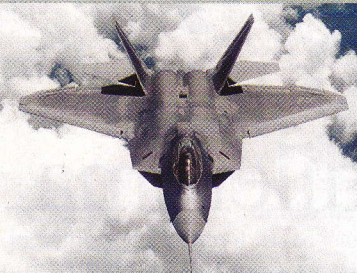
Nonetheless, stealthy aircraft are by their nature more dependent on off-board sensors than conventional fighters. This might affect the effectiveness of European JSFs since it is unlikely that European countries, in the coming thirty to forty years, will possess the bewildering array of intelligence and battle management systems that the USA has at its disposal.

The effectiveness of the JSF in a European environment depends on a number of assumptions: increases in the level of stealth of the aircraft should equal or outpace advances in anti-stealth technology; the sensors of JSF have to remain capable of detecting aircraft and missiles which may become stealthier

over time, and they have to do so without compromising the fighter's own stealth; it should be possible to retrofit to existing aircraft advanced technologies that preserve the aircraft's stealth or increase its flight performance; and in future conflicts, enemy air defences should be neutralised to such an extent that avoiding them is actually an option for JSF pilots. If these assumptions turn out to be realistic, the JSF promises a tremendous increase in effectiveness for European air arms — and possibly at lower cost per air-

## DIFFERENCE BETWEEN THE USA AND EUROPE

A major difference between US and European military forces is that the former will have available the most effective air superiority fighter ever designed. If the Lockheed Martin/ Boeing F-22 Raptor lives up to expectations, it will undoubtedly ensure a level of air superiority that will enable aircraft like the Joint Strike Fighter to operate effectively with acceptable losses. For prospective European



Prospective European JSF customers will not have F-22s in the dedicated air superiority role

customers, the situation is different. Countries that could select the Joint Strike Fighter to replace their F-16s, like Norway, Denmark, the Netherlands and Belgium, will not have a dedicated air superiority fighter. So they either will depend on the USA to ensure air superiority over future operations theatres, or use the JSF as a multi-role fighter like the F-16 is used at present. Of course, they could also turn to the four operators of the Eurofighter Typhoon: Great Britain, Germany, Italy or Spain. The Eurofighter Typhoon does not match the effectiveness of the F-22, but there will be many more around.

In the present geomilitary situation, these options would be entirely feasible. Above Iraq or Kosovo, the JSF would

have performed admirably. In future conflicts, as long as an adversary has no means of breaking the stealth barrier, JSF promises a huge increase in effectiveness, being able to largely avoid enemy air and ground defences and hence, for example, have the option to operate at lower altitudes where attacks on mobile targets can be made more effectively. But what if an adversary is able to

combine an effective command, control, communication and information infrastructure with the technological means to detect stealthy aircraft?

Then it might be impossible to operate JSFs effectively without the assistance of aircraft like the F-22 or the Eurofighter Typhoon. It is, of course, fair to assume that this assistance will be forthcoming, since it is hard to envision future European JSF operators ever fighting an armed conflict without the involvement of major powers like the USA or Great Britain. Still, if this situation occurs, European JSF operators will be forced to play a subordinate role to their bigger allies. And in a larger conflict, allied assistance may not always be available, for political or military reasons.

### AN ENHANCED JSF COULD STILL BE CHEAPER THAN THE TYPHOON ... AND STEALTHIER

craft than is the case with today's F-16s. This is indeed a very attractive prospect for all military officials and politicians involved in the selection of new fighters in Europe and elsewhere.

But because so much information about the JSF is classified, it is impossible to say whether the above mentioned assumptions can be relied on to hold true. It

should be noted that this article is based on unclassified information, so an accurate assessment of the capabilities of either the Boeing or Lockheed Martin design is impossible.

The JSF will be in service to at least forty years from now. During this time, the conditions under which it has to operate may change considerably. Defence ministers and parliamentarians whose task it is to decide whether or not their air forces will fly the JSF will face interesting times in the next few years.

Several European countries that need new fighters are considering the Eurofighter Typhoon as well as JSF. The Typhoon lacks the stealth of JSF but has better flight performance. It is also twice as

expensive. That raises the question whether it would be an option to develop an enhanced version of the JSF with better flight performance, which could still well be cheaper than the Typhoon — and stealthier.

### Multi-role JSF

Such an enhanced JSF — if technically and financially feasible — could be what the F-16 is today: a multi-role fighter with impressive air-to air capability, both at long and short ranges. It would give the US an export fighter between the present version of JSF and the much more expensive F-22. For so big an export market, this possibility might be worth considering. Even the US Air Force might be interested in this enhanced JSF to compensate for the fact that the number of F-22s it will receive has dropped from 750 via 450 to 339.

With the present-day emphasis on affordability, the idea might not find favour with defence officials aimed at keeping JSF out of the political limelight. But it might increase the growth potential of JSF considerably and extend its production life, like the evolution from a lightweight fighter into a true multi-role aircraft did for the F-16. ■