By Richard Gale - Researcher, UK Defence Forum

After reviewing the development of the Joint Strike Fighter programme and the numerous challenges it has faced in Part 1 (published 13 January 2012), Part 2 aims to briefly analyse some of the key capabilities of the F-35 and also evaluate the programme's immediate and future export prospects.

The JSF is designed to cover a variety of different combat roles which are only currently available through multiple aircraft deployment. It combines low observable stealth technology; it incorporates offensive and defensive avionics, internal and external weapons and with its three variants, could dominate the way Western air power is deployed for a generation. But many have questioned the full extent of its listed capabilities, particularly as the costs rise and the delays lengthen.

Stealth

The incorporation of advanced stealth technology to a multi-role fighter is something Lockheed Martin were keen to highlight from the beginning. The unusual airframe design of the aircraft does improve its stealth ability and is increased by additions such as its internal weapons bay. Chief Test Pilot Andrew Norman recently stated that its 'stealth wrapping' significantly improves the "1st look, 1st shoot, 1st kill" capabilities. However, according to some reports, it lacks the stealth capacity of comparable aircraft such as the F-22. Additionally, some have stated that the F-35 may not match up to its SU-30 counterparts and with advances in Surface-to-Air Missile (SAM) technology, the F-35's lower infrared and radar stealth means these advances will affect it much more than the F-22. But negative comparisons to the F-22 are somewhat unjustified as not only will the F-35 will serve alongside the F-22, but it does not need to focus solely on stealth, particularly because its radar and avionics are actually more advanced. Undoubtedly the F-35's avionics were based on the F-22's stealth and 1st look, 1st shoot, 1st kill technology advances. Like the F-22, it uses sensor fusion, integrating of the AN/APG-81 radar and the AN/ASQ-239 EW system. But it builds significantly on the F-22's Joint Integrated Avionics Working Group core avionic system and in turn will help develop the understanding of the F-22's own systems and capabilities. The vital question will be whether all of this will allow the aircraft to perform well in a rapid and flexible carrier based deployment and if its stealth abilities will allow it to successfully penetrate deep into enemy airspace, avoiding both SAMs and radar systems.

Electronics

The sophisticated electronics on the F-35 will allow the pilot to take on the role of a 'tactician'. Its Integrated Sensor Fusion systems enable the radar and electro-operating systems to alert one another without the need for pilot integration. This means the pilot can assess the situation, plug

in to the battlefield and pick up and pass on data - all on one sortie. A distributed-aperture-infrared sensor system also means the pilot can "see through" the aircraft and in addition to providing warnings of missile launches, battlefield information can be displayed on the pilot's helmet mounted display, eliminating the need for night-vision goggles. However, pilots have complained that the visual on the helmet display is "jittery" and does not perform well at night. But this is only as a development issue intended for fine-tuning during testing. If fixed and if reliable, it does mean the pilot is extremely well placed to perform impressive 'electronic attacks' on satellite and radar communications in the battlefield (something which will be vital in the ever-developing world of cyber security). Chief Test Pilot Andrew Norman has also highlighted that the overall electronics and avionics aid its manoeuvrability - "In other fighters you will have to change the laws of physics to match us....and in a very short time".

Weaponry

The stealth enhancing internal weapons bay will allow the F-35 to either carry the GBU-32 1,000-lb or 2,000-lb version of the Joint Direct Attack Munition (JDAM) for ground attacks. Additionally, the F-35 can carry wingtip air-to-air missiles, the A and C variants up to 18,000 pounds of external ordnance mounted on under wing pylons. Each variant will also have an internal 25 mm cannon, enabling pilots to engage targets from higher altitudes and at longer range. Significantly for the UK, it can carry the Storm Shadow missile with seven external stations providing a variety of different air-to-air and air-to-ground weapons (including the full range of smart munitions). However, the F-35 can carry only two air-to-air missiles in its 'all rounder' configuration and only half as much as the F-22 in its full Air-to-Air configuration. Additionally, the STOVL variant's internal bays have been redesigned and are now shorter and reduced in width in order to meet other performance goals. As a result, the STOVL variant is no longer compatible with JSOW and 2,000-lb JDAM weapons.

Variants

One of the issues raised for both the B and C variants is of its relatively short range of 600 miles. Chinese developments of new stealth aircraft, carriers and accurate anti-ship ballistic missiles could push American carriers out into the western Pacific, well beyond the range of the these variants. The F-35A variant's defensive range capability has also been questioned recently as the Pentagon announced a shortening of its combat radius requirements. However, General Norton Schwartz, the US Air Force Chief of Staff, has since rebuffed this stating that reducing the combat radius by five miles is more cost-effective than modifying the fighter to meet performance goals set a decade ago. Whilst its range does improve on current legacy fighters such as the F-15 and F-16, the debate has fuelled the argument that the US in particular should actively focus on UAVs, drones and hypersonic cruise missiles as its primary form of attack. The F-35C carrier variant has had various issues in testing, particularly with its arrestor hook. At just seven feet away from the undercarriage it has proved too close to be able to function correctly.

These issues have become even more apparent in Britain recently as sources close to the MoD believe that the UK will revert back to the F-35B STOVL variant. Costs in redesigning the new

Queen Elizabeth Class Carriers to accommodate a 'cats and traps' capability and the relatively untested electro-magnetic launch system, could spiral to £1.8 billion. An in-depth study into the feasibility of carrying out a conversion is already said to have cost £40m, out of a total allocation of £80m. An official announcement is set to be made before Parliamentary recess on the 27th of March 2012, but Defence Secretary Philip Hammond has held meetings with the Prime Minister discussing the potential switch, fuelling an already lively debate in Britain.

According to the SDSR in 2010, two of the main reasons behind the decision to choose the F-35C instead of the F-35B were not only that it offered a longer range, 640nm to 450nm, but the Carrier Variant was able to carry more ordnance. By analysing the two, we can see that the C variant does have bigger payload available, especially since the smaller internal weapons bay of the B variant means that in full stealth mode, it can only carry two 1,000 lbs, compared to two 2,000 lbs in the case of the C variant. On the external ordnance, the F-35C's external payload can take up to 18,000 pounds whereas the B can only take 15,000 pounds. However both can accommodate the Sidewinder, Maverick and Storm Shadow missiles. One of the issues discussed in a published "F-35 Concurrency Quick Look Review", was the possibility that the variants will not be able to fire the British ASRAAM. However, the new MBDA Meteor missile could be used on the F-35, and while not yet fully tested, is the next generation of British beyond-visual-range Air-to-Air missiles. This missile will be also be used across the Eurofighter range, which itself will work in tandem with the F-35 for the UK, however firm details are hard to come by as the MoD has kept relatively silent on its development and future use.

This concurrency review also suggested that back in 2002, the UK selection of the STOVL variant was not cost effective. One suggestion has been that it was selected due to the power of the Rolls Royce lobby in the UK when the F136 engine was still in competition to be used as the main STOVL engine, especially since the Labour government threatened to walk away from the programme should the Rolls Royce engine be ditched. However, the Pratt and Whitney F135 engine was finally chosen as the preferred engine and Rolls and GE decided to cancel its separate production of the F136 in December 2011. Despite Rolls and GE having said it was 80% complete at the time of cancellation and there could be a slight possibility it could be re-started if the UK chooses the STOVL variant in the coming weeks, it is highly unlikely that such a costly and relatively unreliable programme during the initial competition will be re-ignited.

So why would the UK re-choose the STOVL variant? As described, the price of each jet and the maintenance cost of 2 engines will be higher, the carrier modifications could see costs escalate to unfathomable proportions and the B variant has a demonstrably smaller range and ordnance capability. However, the B variant does provide reduced training and qualifying requirements for Britain. The UK has extensive experience in STOVL jets through its years of Harrier use and the first F-35 built by Lockheed for the UK in November and set to be delivered for testing and training, is a STOVL variant. Additionally, the B variant has lower attrition rates and increased fatigue life of airframes. According to a US study, the F-35B can generate up to 30% more sorties than conventional carrier aircraft on targets out to 400 Nautical miles and 15% more out to 700. The B variant also would provide greater flexibility with other arms of the UK's defence forces as it has the unique capability to operate from ships, roads and bases near frontline combat zones, enhancing sortie generation rates. In regards to the carriers themselves, one advantage of reverting back to the F-35B variant is that both HMS Queen Elizabeth and Prince

of Wales could be operationally viable, despite the SDSR plans to mothball one from the outset. It may also mean that the carrier's operational ability could be brought forward especially if the B variant's production targets and testing development are successful.

This final decision will undoubtedly be made on the basis of cost first. It is understood Prime Minister David Cameron has been warned if the plans to convert the carriers for the F-35C is not abandoned, then the carrier programmeme could be delayed by as much as seven years, or even until 2027. Reviewing the capabilities of the B and C variant does show that the 2010 decision to convert to the C variant was entirely logical. The issue is that the carrier's from the start were designed without in depth knowledge of the costs and capabilities of the aircraft it would deploy. The decision to convert to a carrier variant was also then made on the basis of a variant whose launch and landing mechanisms were underdeveloped and untested.

The significance of this order choice in Britain, could serve as a precedent to the decisions of other nations in the near future. Britain's carrier strike capability depends on the F-35 and choosing the correct variant which covers the strategic as well as cost efficient objectives, could potentially put other order numbers for either the STOVL or the CV under threat.

Export Prospects

The US has only recently committed to the further development of the Marine Corps' version of the F-35, whilst Leon Panetta has taken the STOVL variant off probation, believing it to be a vital element to maintaining and enhancing the level of its air superiority. But production looks as if it will be slowed down in order to save money. Sources close to the Pentagon suggest that it will delay U.S. orders for another 179 jets until after 2017, bringing the total number of U.S. jets delayed to over 400. The Pentagon's last official estimate put development and production near $380 billion for more than 2,800 U.S. and international aircraft. But the Pentagon and Lockheed are working to reduce the sustainment price of $1 trillion, fearing this could also affect overseas orders.

The programme overall took a major boost when Japan recently chose the F-35 over the Super Hornet and Eurofighter. But Japan's Defence Minister Naoki Tanaka said in February that the country may cancel its $4.7 billion order if Washington fails to stick to the proposed price and deadlines. Whether this is mere posturing from defence officials in order to quicken the pace of development is unclear – especially as the US Navy Vice Admiral David Venlet has said that the deal stands firm. If Japan did cancel this order, it would be a significant hit on the programme and the nature of procurement itself as Japan has historically depended on US military hardware.

In other partner nations, Turkey has already halved its initial order and Australia is rethinking when to buy the next 12 of its initial order of 14. Italy has reduce by half its initial order for the STOVL variant and Norway's parliament will decide this year on plans to buy up to 52. In Canada, an often ardent supporter of the programme, Minister Julian Fantino told the defence committee recently, "We have not as yet discounted the possibility of backing out of the programme". The downsizing of orders and uncertainty in variant decision making is no surprise considering the costs and delays involved. But as British Air Chief Marshall Sir Stephen Dalton

has rightly pointed out, all complex programmes take time:

"...going back to the F-15 Eagle; it was originally a two-seater and when it had problems it was cut to a single-seater, and then it was almost cancelled.....All these programmes are incredibility complex technical programmes and unfortunately things take longer that we would like....but we should make allowances."

Conclusion

These allowances have meant that the JSF programme and the F-35 itself have proved to be controversial. While innovative, the programme hasn't yet proved that the aircraft it has produced is the advanced, all encompassing, 5th generation fighter it is intended to be. It's true the F-35 has been "designed with the entire battle space in mind" and it does cover a multitude of flexible roles which will be invaluable to defence forces. But this overall aim has caused the F-35 to lose some key capability advantages. Its stealth may not be advanced as its counterparts; its weapons load is restricted; its range has been shortened and its 3 variants relatively untested. All in turn causing price rises and delays in the aircraft's readiness for active service.

However, governments currently debating the overall worth of the programme and the aircraft itself should by no means be look at it as a failure. The development of a multi-role, 5th generation fighter on a variety of platforms would always be a challenging task. But whilst results are far from clear at the moment, given time the F-35 will be well worth the investment. Its technological advances in avionics, electronics and communications means it has a huge lead over legacy fighters and will greatly enhance the other arms of the defence forces it works with. In an ever changing and modernising battlefield, the aircraft will be more precise and become a vital asset to have. The next 20-30 years will see radical differences in the way warfare is fought and the significant ability the F-35 has, it is that it will be able to develop alongside new technology. Additionally, as a multinational programme it will greatly improve international defence collaboration; meaning we could see strong international cooperation of air power that we have never seen before. As F-35 test pilot Bill Gigliotti states: "Commonality breeds trust and understanding".

We cannot forget that the aircraft is still in intense testing. Many areas of its development are yet to be concluded and the understanding of its full combat capabilities is yet to be discovered. But at a time when many analysts believe western air forces should look to develop UAVs and drones, the F-35 is best placed to prove to the policy makers and air force leaders that manned fighter jets are and will be an essential element in providing and maintaining Western air superiority for many years to come.

Richard Gale is a Researcher at the UK Defence Forum and a graduate of Cardiff University; gaining a BscEcon in Politics and Modern History and an MscEcon in International Relations