A FLIGHT TO SUCCESS?
The history of the Joint Strike Fighter programme

The story about the Joint Strike Fighter is not just a story about one aircraft, it actually concerns seven different aircraft. All these aircraft have different capabilities and this story of the JSF is on how the US merged all these different programmes into just one. One programme, concerning one aircraft structure and three applications.

THE PREDECESSOR
In the early 1970’s, the US Department of Defence (DOD) signed a contract with the British Hawker Siddley for buying the AV-8A version of the Harrier. A very exceptional fighter aircraft that could not only perform ground attacks, but was a reconnaissance aircraft too and it had phenomenal vertical/short take-off and landing (V/STOL) capabilities. This made it an extremely good aircraft to use on amphibious assault ships, which are ships that can provide air, sea and ground support close to the shore in hostile areas. These ships are relatively small, compared to aircraft carriers, and thus the design of the Harrier enabled the support of a good fighter instead of mostly helicopters or F-18’s that had to come from far away from large aircraft carriers. However, the US actually wanted to design their own V/STOL fighter that could also go supersonic and did so by starting with the Rockwell XVF-12A programme (see Figure 1). Sadly enough, only a small amount of this type were indeed built and none of them ever flew successfully due to a lack of vertical thrust. And since any improvement of the design would be too costly, the programme was cancelled and the American dream of having a US supersonic V/STOL aircraft design would have to be postponed.

Instead, since they did want to upgrade their Harriers at the end of the 70’s, they started a joint project with the British to design an updated version of the Harrier. After some complications caused by funding cuts by the British government leading to the United States Marine Corps (USMC) and the Royal Air Force (RAF) going separate ways, the British re-entered the programme in 1981 and designed the McDonnell Douglas AV-8B Harrier II (see Figure 2) for the US and the GR/S Harrier II for the British. Entered into service in 1985, the Harrier II proved to give the pilot a better sight from the cockpit, have improved aerodynamics and a refined structure, allowing the use of seven hardpoints instead of five. Later updates also gave the Harrier night-flight abilities, a HUD and better radar, enabling the aircraft to use beyond-visual-range missiles.

A SEARCH FOR SUBSTITUTES
The US DOD still wanted an aircraft to replace the Harrier, and also the rest of the ageing fleet of tactical aircraft that had found its origin from the Cold War period. This was a period during which the construction of different aircraft had exploded. All these aircraft came with extreme maintenance costs, not only because they became older, but also because there were just so many different designs. That’s why three different programme lines were made, one mostly concentrating on the Grumman F-14 Tomcat, the A-6E Intruder and the McDonnell Douglas F-18 C/D Hornet; another on the F-16 Fighting Falcon, the General Dynamics F111 Aardvark and the Fairchild Republic A-10 Thunderbolt II; and the third one on the McDonnell Douglas AV-8B Harrier.

For the first three aircraft, this led to the VMF X-Programme in 1981. Unfortunately, this programme was cancelled in 1983 since it turned out to be too expensive and the US Navy (USN) just upgraded the two aircraft types to the F-14 D and the A-6 F. After this cancellation the Advanced Tactical Fighter (ATF) Programme was immediately set up, of which the purpose was to replace the A-6 F with the stealthy McDonnell Douglas A-12 Avenger, a flying wing design. Again, this one turned out to be too costly and also this programme was cancelled in January 1991. A little later in 1991, the Advanced Strike Fighter (A/FX) Programme was launched, continuing the search for the F-14, A-6 F and also F-18 C/D replacement.

The second programme line was the Multi-Role Fighter (MRF) Programme, which started in 1989 and planned to be ended in 1993. This programme was intended to replace the F-16, F-111 and the A-10.

The reason for the third line was that there was still no obvious successor for the AV-8B or GR-S. So the US started looking for a supersonic replacement by a joint study with the British in the Advanced Short Take Off and Vertical Landing (ASTOVL)-Programme in 1986. Very much involved in the programme were, of course, the three largest jet engine companies Pratt & Whitney, Rolls Royce and General Electric. They were all ordered to study the use of plenum chamber burning, remote augmented lift, lift engine ejectors and the tandem fan. (For more information see
Reference [1]

While the A/FX, MRF and ASTOVL Programmes were all busy, the Common Affordable Lightweight Fighter (CALK) Study was brought to life. From 1993 to 1996 this study aimed at the testing and research of critical STOVL techniques, which was something the US had learned to do after the XFV-12A Programme had failed because of the absence of such knowledge. This study initially attracted six companies: Boeing, McDonnell Douglas, Lockheed, General Dynamics (GD), Northrop and Grumman. After Lockheed bought the Forth Worth Division from GD (the division that had built the F-16) in 1993 and Northrop bought Grumman in 1994 (leading to the Northrop Grumman Corporation (NGC)), some mergers took place, leading to only two competing parties. Boeing and Lockheed were on one side and Northrop, British Aerospace and McDonnell Douglas on the other.

During this study, the MRF and the A/FX programmes were stopped by the US Government in 1993, calling for the start of a new programme: The Joint Advanced Strike Technology (JAST) Programme. A programme that focused on the CALK Study, but also investigated how they could modify existing conventional aircraft into STOVL aircraft. This went so well that the existing JAST, the ASTOVL and the CALK became a new JAST Programme.

THE JAST/JSF PROGRAMME

The new JAST Programme practically summed up all the previous programmes that it consisted out of into one programme, although this time some more specific criteria were added. The aircraft had to carry only one fighter pilot and have only one engine. Furthermore, the aircraft had to be stealthy, long-range and able to carry its armaments inside. To make it even more complicated, the US wanted three different designs for different purposes, but which had one airframe, giving the three types an 80% commonality. The philosophy behind this approach was that this would decrease the development, manufacturing and maintenance cost, making the aircraft affordable and capable of being produced in high numbers. The three versions to be designed are the following:

First of all, the Short Take Off and Vertical Landing (STOVL) aircraft should be designed for the US Marine Corps (USMC) and the UK. From the former studies it had become clear that it would have a shaft-driven lift fan propulsion system. This version would be the one replacing the AV-8B and the F-18 for the USMC. Secondly, a design should be created that would be able carry out take-offs and landings on aircraft carriers. This design would of course be needed for the US Navy (USN) to complement their F-18 E/F Super Hornets. Since this design doesn’t need to hold thrust-vectoring systems, there is room for more fuel and armament. This will increase the range and effectiveness of the aircraft, which are crucial criteria for carrier aircraft. Thirdly, the structure should enable the design of a Conventional Take-Off and Landing (CTOL) aircraft for the US Air Force (USAF). Again, there is more room in the aircraft for fuel and weapons. This design should complement the already state-of-the-art Lockheed Martin F-22 Raptor and replace the F-16 and the A-10.

The big question would now of course be: Who’s going to be the lucky one going away with the multi-million dollar contract? Well, in December 1994 Boeing, Lockheed, McDonnell Douglas and NGC all signed the 15-month Concept Definition and Design Research contract. Shortly after this, McDonnell Douglas, NGC and British Aerospace decided to cooperate with each other and Lockheed and Martin Marietta incorporated in March 1995 to become Lockheed Martin. It’s now the Lockheed Martin Skunk Works (LMSW) division that takes on the JAST Programme for Lockheed. Within Lockheed, the Skunk Works division is a division that specialises in advanced projects and has a high degree of sovereignty with only little bureaucracy to speed up all the processes. On November 16, 1996 the US DOD only let Boeing and LMSW battle each other in the concept demonstration phase, while also calling the programme the Joint Strike Fighter (JSF) Programme. During this phase each contractor should build and test one CTOL and one STOVL aircraft to determine whether or not they could meet the requirements set by the programme. The X-35A CTOL type (for the USAF), the X-35B STOVL type (for the USMC, the UK Royal Navy and the RAF) and the X-35 C carrier type (for the USN) all perform very well on all the requirements such as aerial refuelling, aerodynamics performance and agility. Finally, on October 26th 2001 the US DOD decided that it would be a team of engineers led by LMSK that would become responsible for the Joint Strike Fighter.

References

[5] Younossi, Obad et al. (2005), Lessons Learned from the F/A-22 and F/A-18/EF Development Programs, RAND Corporation

Aviation Department

The Aviation Department (LVD) of the Society of Aerospace Engineering Students 'Leonardo da Vinci' fulfills the needs of aviation enthusiasts by organising activities like lectures and excursions in the Netherlands and abroad.