ROYAL AERONAUTICAL SOCIETY
Loughborough Branch

5th November 2018
Taranis – Flight Testing
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This was a presentation referring to a UK leading-edge technology project that is the nation's most sensitive aviation development programme (known) to be underway currently. The speaker therefore had to stress there would be little specific data. He was allowed to talk about the objectives of the on-going flight trials and to provide an insight into progress, but informed us that he could refer to phases 1 and 2 only of a programme that has proceeded further, and that technical and performance data content would be limited. These notes respect the information constraints and are based solely on what was said at the meeting.

Since the project's inception, in 2005, the hub of design and development of Taranis has been within BAE Systems. He referred to the expertise that had been evolved over recent decades and referred to the Fly-by-wire Jaguar and Experimental Aircraft Programme (EAP)[1], the Eurofighter Typhoon, and the unmanned air vehicle (UAV) projects, Mantis and Raven. Each of these development and production programmes were technology bases critical to the Taranis project: an unmanned combat air system (UCAS). The programme funding was cited to be £180million, and work has been conducted collaboratively with the UK Government, Rolls Royce, and a wide range of specialist component and equipment providers.

Taranis during 1st phase trials *photo : BAe copyright 1434573404570*

Taranis was revealed in 2010, and has not been shown publicly. The aircraft is referred to as a low-observable (LO) configuration, and to be of a similar size to the BAE Hawk. There is a single engine with a V-shaped intake above the centreline apex of the lifting surface that has a recognisable un-

[1] both of these airframes were loaned to the Loughborough University Aeronautical and Automotive Engineering department between 1990 and 2011 (and are now at the RAF Museum, Cosford)

tapered 'stealth' planform. The engine exhaust is on the centreline and there is a retractable tricycle landing-gear. Configuration of control surfaces was not discussed, the absence of a fin means that differential spoilers are used for directional control. The speaker stressed that photographs of the aircraft with a nose-mounted air-data sensor boom was a phase 1 flight trial installation, and that already Phase 2 trials have used only 'conformal air-data sensors', and the boom has been removed.

Flight trials started on 13 August 2013, and a second flight was conducted four days later. Initial trials had a chase aircraft monitoring the aircraft, and it was not said whether this procedure is still practiced, although the speaker did outline in his review of safety cases that the aircraft's 'autonomous' capability meant that the chase aircraft had to remain at specific minimum vertical and horizontal distances from the UCAS to allow its autonomous manoeuvres to be possible without introducing the risk of a collision.

All trials have been conducted at Woomera in Australia. The site is remote and the available range covers 122,000sq.km. of unpopulated and relatively flat terrain. Trials are not conducted, at this stage, in the UK because of population risks.

Systems are at the very core of this project. It does have a ground-based pilot but only as a reversionary back-up and primarily relies on an advanced flight control system with three modes: automatic (akin to a conventional AFCS[2]), autonomous (generates flight control commands that are relevant to the path it has determined as necessary for mission requirements) and manual. The latter is principally for recovery in the event of a significant failure in system elements. There was no reference to sensors – beyond the air-data system – but the need to minimise any transmission in an electromagnetically-active environment was referred to in respect of the aircraft being able to make decisions, communicate data, and conduct manoeuvres as appropriate with a minute electromagnetic signature.

Two flights were described with details illustrated on charts. These were early flights but already included flight test manoeuvres that were akin to traditional flight test procedures, such as engine slams and wind-up turns: in respective cases looking at propulsion and flight control performance in critical operational conditions. We were assured that the outcomes met all expectations.

Although it has two internal weapons bays the prototype is packed with flight-test instrumentation, vital to the aims of monitoring and developing the autonomous control capability. This includes the capability to identify and recognise targets, and conduct flight manoeuvres relevant to the operational aims without any external assistance.

Regarding handling and the flight test programme it was noted that LO needs cause the aircraft to be 'slippery' when it comes to losing speed in steady flight, and this seemed to be most relevant to the recovery and landing back. Some video footage was shown that showed take-off and landing, and air-to-air observations from a chase aircraft in steady flight that suggests good stability has been achieved. It was cited to have experienced and ridden turbulence in trials.

The flight test safety programme was described in detail, showing the thoroughness essential for the trial of such a capable and autonomous aircraft.

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[2] Automatic Flight Control System

One aspect centred on determining areas in which aircraft manoeuvres were planned, and wider regions that would ensure overall safety according to criteria that were in accordance with existing operational procedures. Critical parameters were quoted that coincide with conventional military aircraft safety assessments.

Plans to cope with emergencies were reviewed too, and especially pertaining to autonomous operations. Following a recognised failure, predetermined safety procedures would be enacted by ground crew members. There were circumstances when the ground pilot would monitor or take-over control of the aircraft, aiming to establish a descent (in flight trials this should allow recovery from the desert), and in all cases ensuring that the aircraft would be recovered as intact as possible. There was a final option: press the red button. This would lead to the aircraft and its systems being unrecoverable.

Q&A time was not wasted, but there was clearly a desire that numerical or comparative data be revealed: which was not going to happen.

Overall, this was very refreshing presentation, as the insight was as deep as can be expected of such an ambitious entry into a field of operational capability that is constrained by security regulations. It did show that nothing has been wasted in terms of harnessing the best possible capabilities of the UK aerospace community. As an example of the combined efforts of airframe, propulsion, mechanical and electronic systems specialist, and others, to attain the degree of integration presented was a delight to hear. This was a refreshing insight through a relatively small field-of-view window that highlighted the opportunities and challenges still facing businesses that maintain confidence in the future. The audience of about 130, from young to old, left the meeting with a shared feeling of being encouraged to keep abreast of what opportunities remain within our sights.

The question that no one asked - here is the answer :
In Celtic mythology **Taranis** was the god of thunder worshipped essentially in Gaul, Gallaecia, the British Isles, but also in the Rhineland and Danube regions.

Lecture notes by Mike Hirst