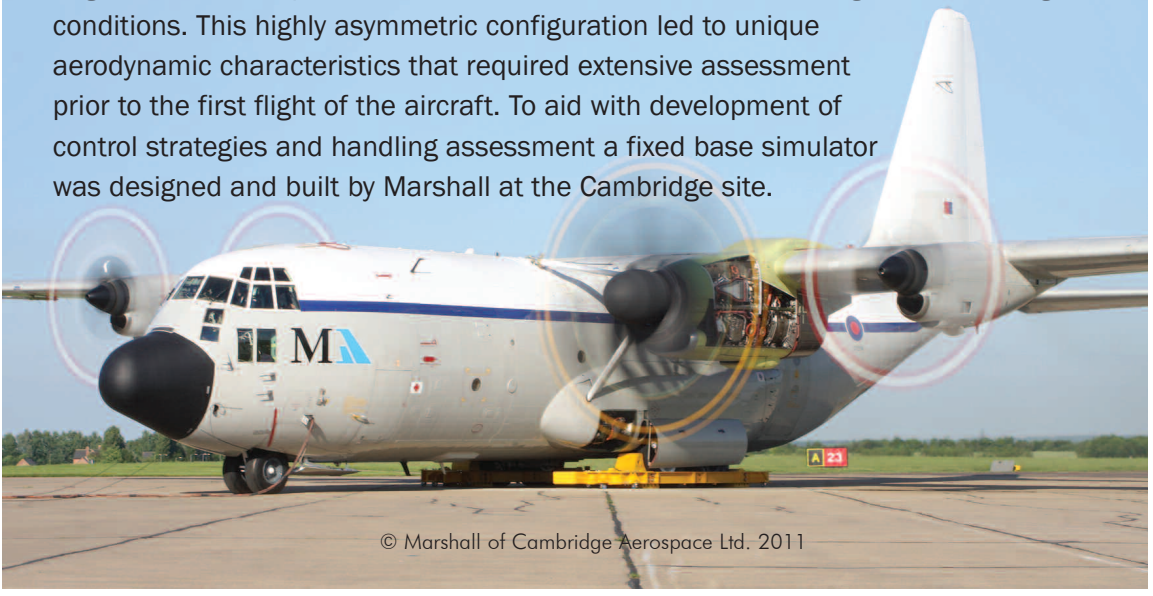
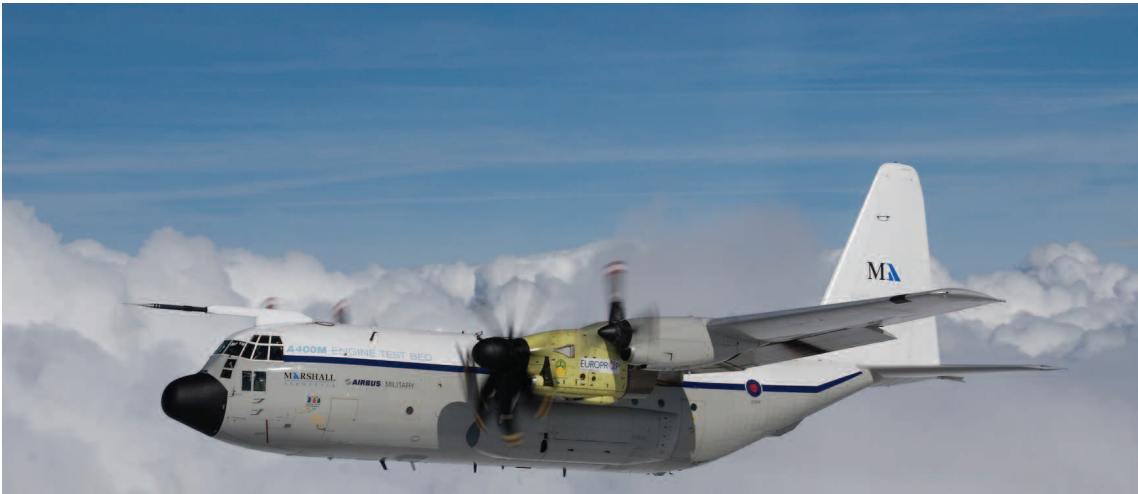
Flying Test Bed programme for Airbus Military

In 2004, Marshall Aerospace was contracted by Airbus Military to undertake flight trials for the new and unproven TP400 power-plant which powers the next generation military transport aircraft, the Airbus A400M. The purpose of the test programme was to gather power-plant (engine, propeller, gear box, nacelle and other ancillary equipment) data which would provide functional and performance evidence in support of risk reduction for the Airbus A400M development programme.

The test vehicle was an ex-RAF C-130 Hercules aircraft, which required specially strengthened wing-structures to support the increased weight and thrust of the test engine. In addition, integration of additional avionics to control and monitor the modern FADEC controlled power-plant was required. These complex tasks were successfully implemented by the Marshall Design team.

The TP400 power-plant is significantly more powerful than the T56 engine it replaced on the C-130 test-bed, producing more thrust at Flight Idle than the T56 engine does at full power, and over 400% the thrust of a T56 engine in some flight conditions. This highly asymmetric configuration led to unique aerodynamic characteristics that required extensive assessment prior to the first flight of the aircraft. To aid with development of control strategies and handling assessment a fixed base simulator was designed and built by Marshall at the Cambridge site.





Throughout this high-risk programme, the Flight Test team utilised mathematical modelling and simulation data to mitigate risks and plan a safe and efficient Flight Test programme. With meticulous planning and use of the flight simulator the project was executed safely and successfully, gathering all of the extensive data required by the customer. Onboard performance monitoring and analysis was a key component, and the Flight Test Instrumentation team measured, recorded and processed approximately 3000 parameters (via dedicated sensors and data bus monitoring).

The aircraft flew approximately 54 hours and accrued 116 hours of TP400 engine running time (including flight and ground testing). During the Flight Test programme, testing was completed across the aircraft flight envelope and a wide range of operating conditions which included:

- Aircraft structural flutter testing
- Aircraft noise and vibration assessment
- Aircraft handling
- Engine slams and chops down to 1.3 Vs
- Engine mount structural testing
- Engine intake distortion testing
- Engine operability
- Engine performance
- Propeller stress testing
- FADEC failure mode tolerance
- Full power take-off
- Feathering and de-feathering
- Assisted and windmill relight testing

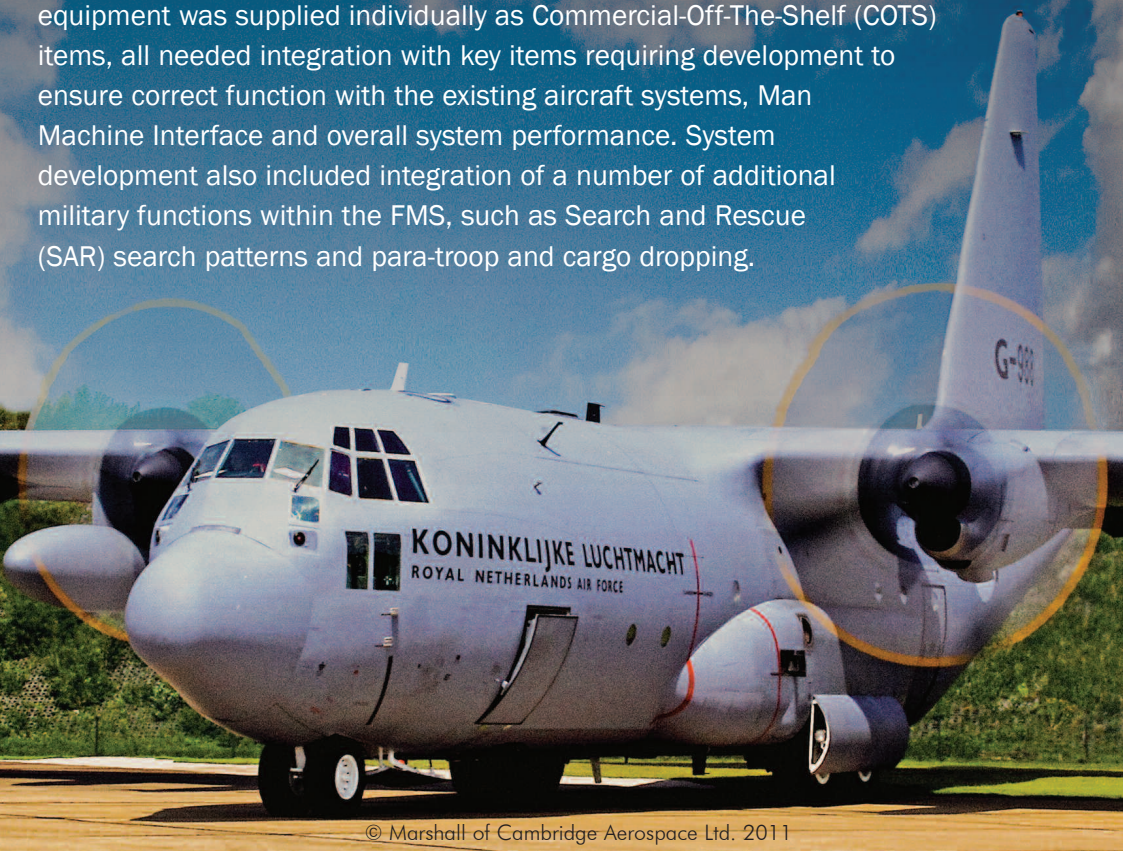
For Further information on this case study please contact Marshall Aerospace.

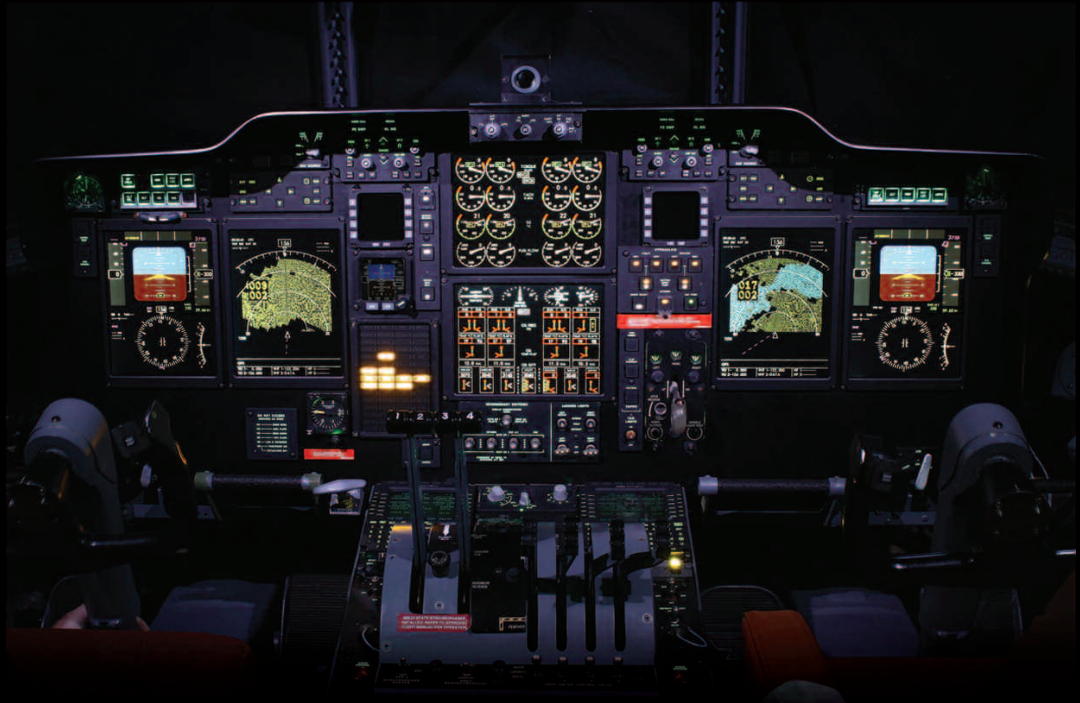
MARSHALL
AEROSPACE
www.marshallaerospace.com

Surveys and Upgrades for the Royal Netherlands Air Force C-130H

Marshall Aerospace surveyed and recovered from desert storage two retired ex-United States Navy C-130H aircraft on behalf of the Royal Netherlands Air Force (RNLAF). The aircraft were dismantled and transported from Tucson in the USA to Cambridge in the UK by sea and road, where the C-130 expertise of Marshall Aerospace's operational support team was brought to bear.

The significant restoration effort of the two short body aircraft included installation and integration of a modern Flight Management System (FMS), new radios, a full glass cockpit and new defensive aids suite, along with many other system upgrades to the avionics, flight deck and cargo bay. Although much of the new equipment was supplied individually as Commercial-Off-The-Shelf (COTS) items, all needed integration with key items requiring development to ensure correct function with the existing aircraft systems, Man Machine Interface and overall system performance. System development also included integration of a number of additional military functions within the FMS, such as Search and Rescue (SAR) search patterns and para-troop and cargo dropping.





Aircraft flight tests included maintenance tests (to verify function of an aircraft that had not flown for decades), along with upgraded systems development and certification testing, on what was effectively a new and unproven type derivative. Performance and handling testing was also carried out to clear the unique fuselage and pylon mounted sensor configuration. The flight test programme culminated in certification flight testing and reporting to verify the aircraft met the Dutch Military Airworthiness Authority certification requirements. To date, Marshall has delivered the two previously retired aircraft and is now beginning a programme of retrofitting the modification to the RNLAF long body C-130H Hercules fleet.

For Further information on this case study please contact Marshall Aerospace.

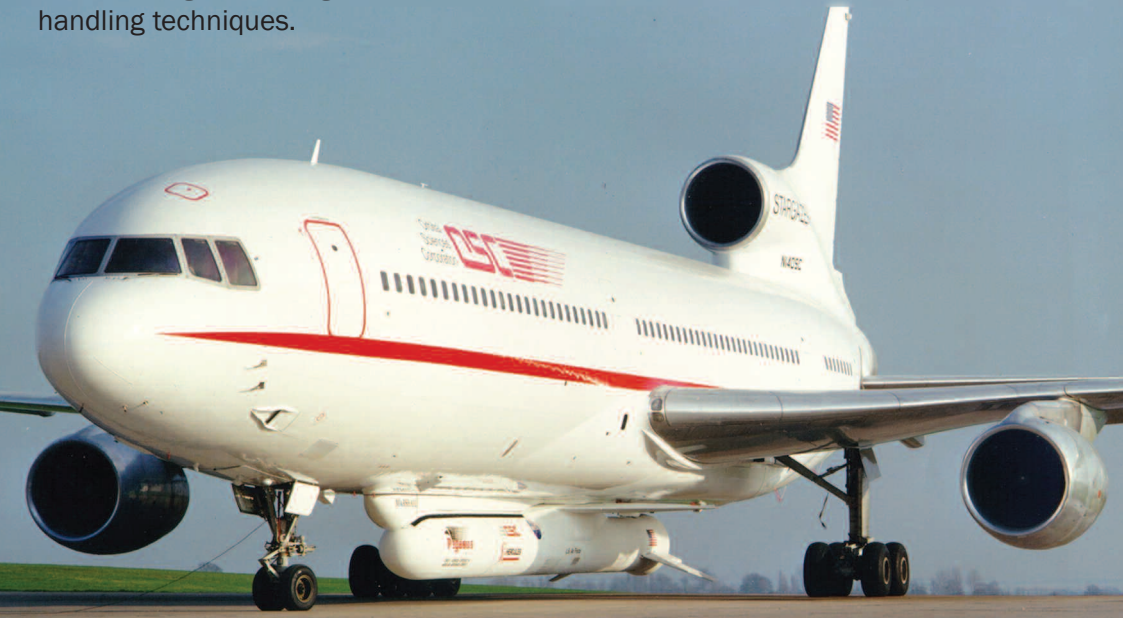
MARSHALL
AEROSPACE
www.marshallaerospace.com

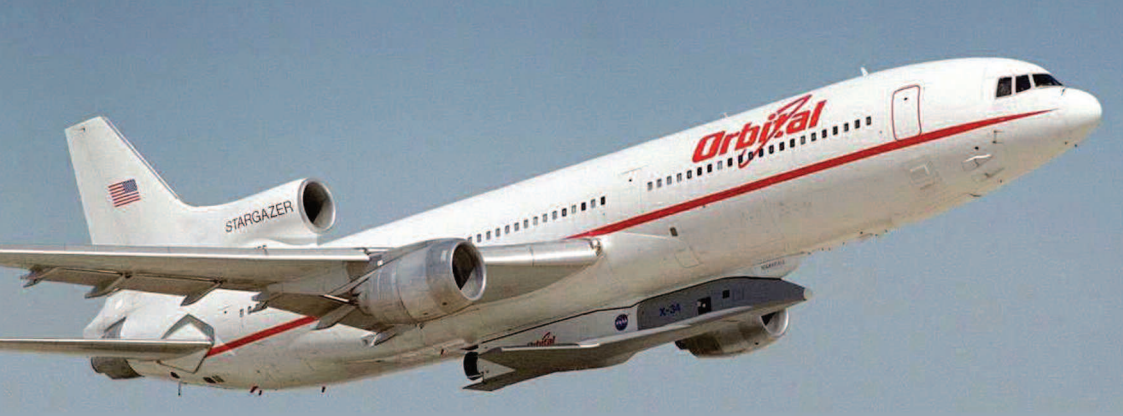
Satelite Launchers programme for Orbital Science

In 1993 Marshall won the contract from Orbital Sciences Corporation (Orbital) of Washington, USA, to convert a Lockheed Tristar airliner into a carrier for their Pegasus satellite-launching rocket. The requirement was to suspend the Pegasus rocket, weighing 25 tonnes (55000 lbs) and about 17 m (56 feet) long, by a hook mechanism to the Tristar centre fuselage. Specialist control stations and inerting services were installed within the fuselage to monitor and maintain the Pegasus environment in carriage flight.

The operational requirement was for the combined Tristar/ Pegasus to be flown to high altitude/ high subsonic airspeed, followed by Pegasus release, rocket ignition and flight into orbit to release its satellite payload. The Pegasus carriage configuration, test flown with a dummy Pegasus, represented the most significant change of configuration and use of any Lockheed Tristar aircraft.

To assess the significant transient response of the Tristar upon Pegasus release, Marshall leased a Tristar full-motion simulator and Marshall Test Pilots, assisted by Marshall Flight Test engineers, 'flew' the manoeuvre to establish acceptable handling techniques.





Certification of the combined vehicles was by FAA, with Experimental Certificate flight testing conducted in UK airspace. This was authorised by UK Civil Aviation Authority (CAA) via an Exemption Order.

The Marshall Aerospace Flight Test team were supplemented by Orbital test personnel and FAA Designated Engineering Representatives.

The captive-carry flight test programme included:

- Aircraft handling qualities
- Flight envelope expansion
- Structural vibration monitoring (Tristar and Pegasus)
- Aircraft performance
- New systems assessment (Tristar and Pegasus)

In addition, during the flight tests, external flow tufting to visualise airflow directions was employed with still and video images captured by a photo-chase aircraft. This data was used to optimise design of the shape of the fairings between the Pegasus and the Tristar under-fuselage.

Following the successful conclusion of the captive-carry flight testing, the Tristar/ Pegasus aircraft was flown to the USA for live Pegasus releases.

As a result of the success of the Pegasus programme, Orbital contracted Marshall to adapt the Tristar attachments to allow carriage of the X-34 unmanned suborbital hypersonic research vehicle, a joint Orbital/ NASA project. Although significantly different in shape to the Pegasus, the X-34 vehicle was a similar weight and size. Certification testing tasks were required similar to those performed on the Pegasus, and whilst all testing had progressed successfully into the flight test phase, the project was terminated due to a change of NASA's financial priorities.

For Further information on this case study please contact Marshall Aerospace.

MARSHALL
AEROSPACE
www.marshallaerospace.com