CASE STUDY

Implementing a Structural Health Monitoring Program on an EH101

CURTISS-WRIGHT

DEFENSE SOLUTIONS

Challenge

- The Portuguese Air Force implements a Structural Health Monitoring (SHM) system on an AgustaWestland EH101 to evaluate the improvements to safety and maintenance costs.

Solution

- Critical Materials S.A. worked with the PAoF to accurately model two key components and optimally install vibration and temperature sensors. A Curtiss-Wright SSR-500 multi-role recorder was used to provide data for their PRODDIA® AERO® SHM software which can identify and locate any damage.

Results

- Rapidly deployed and easily qualified solution, able to meet tight deadlines
- Future proof solution, with growth capability for system expansion and update
- Low solution cost and future savings in operational and maintenance expenditure

Challenge

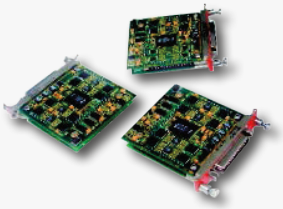
The Portuguese Air Force (PoAF) have operated a fleet of EH101s since 2004 to conduct transport, SAR and surveillance missions. The EH101's range and endurance capabilities make it an ideal aircraft as the PoAF have the largest area of SAR responsibility in Europe. In the first five years of operation alone, the fleet conducted hundreds of SAR missions saving over 600 lives, allowing it to be distinguished with the Sikorsky Humanitarian Service award. The aircraft are subject to structural damage both due to long term stresses to the airframe and encounters with debris and in some cases wildlife.

The PoAF wanted to evaluate the transition to a system of continuous structural health assessment of critical components. They have routine maintenance plans but these are based on periodic inspections with no access to continuous data. A Structural Health Monitoring (SHM) system would reduce the number of routine inspections and add information to alert the team when any damage occurs, saving time and money while increasing safety.

Critical Materials S.A. took the lead in producing an integrated solution consisting of software and hardware and providing consultancy. Curtiss-Wright provided continuous support for the SSR-500 data acquisition and recording system integration and certification performed by the PoAF.

Solution

The final system consists of two instrumented components, a data acquisition system and post flight analysis software. It was required that the system would not interfere with



Modular Data Acquisition Cards

any critical systems, avoid any structural modification and that any cabling and sensors would be located away from rotating or moving systems. The equipment also needed to be compatible with available rack specifications and survive a minor crash.

The first step was to develop virtual models of the instrumented components and the material's properties. The components in question were quite complex and detailed information was not available thus it was necessary to 're-engineer' this information using experimental data and modeling techniques.

Critical Materials S.A balanced sensor cost against data requirements through methods (developed internally) that can optimize the sensor placement. Each component was instrumented with three uniaxial accelerometers and a temperature sensor. This provided vibration data and information about the thermal properties of the material that affect the dynamic response of the components which could be compared to a baseline model.

The data acquisition system consisted of an SSR-500 chassis with a multi-channel analog acquisition module occupying one of its four available slots. Data is stored on a CompactFlash card and at the end of a flight, it is removed and the data is transferred into a database for analysis.

The PRODDIA AERO software performs signal processing operations which are used for analyzing the structural integrity of the components. It has the ability to locate any damage on the components by aggregating experimental data from the sensors and virtual data (from models) that, when manipulated in a 'global optimization framework, are able to produce a structural damage map. Maintenance crew can then quickly locate and further investigate the damage.

As part of the system qualification, the model was validated by placing mass on the components to simulate damage. This 'damage' was correctly detected and its location identified by the software. At the time of writing, baseline models have been established and damage detection and location validated. Future planned system enhancements include using a processing module in the SSR-500s to perform data reduction, built-in tests and real-time flagging of exceedance events.

Results

Rapidly deployed and easily qualified solution met tight deadlines

Meeting tight deadlines was achieved through the use of COTS hardware and software and through Critical Material's S.A expertise. The COTS hardware removed the need for development and the mature hardware and software facilitated the system working 100% when it was installed. The hardware's MIL-STD qualifications were very important - having a system without aeronautical qualifications would have added a huge amount of extra work and risk to show compliance with the airworthiness certification requirements.

Future proof solution that facilitates anticipated future expansion of the system

The system is capable of meeting future program requirements, through fleet expansion and adding further components or features to the system. PRODDIA AERO manages a large number of assets at fleet, system and component level so the PoAF have an easy migration path to expand the project across the EH101 and other fleets. The SSR-500 is a flexible and modular system that allows the hardware to evolve to meet customer requirements quickly and easily.

Low solution cost and future savings in operational and maintenance expenditure

The SHM method has been developed and validated using data from the data acquisition system. While this approach provides a certain level of confidence that there is no damage, it doesn't remove the requirement for routine checks, but it can extend the period between them. This saves time and money and increases the availability of the fleet. It also provides the PoAF with an early warning system as any damage sustained can be quickly identified post flight rather than at a set maintenance interval.

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