SIXTH FRAMEWORK PROGRAMME

FP6-2003-Aero-1

Strengthening the competitiveness

Final Publishable Activity Report

Project acronym: SMIST

Project full title: Structural Monitoring with Advanced Integrated Sensor Technologies

Proposal/Contract no.: 516103

Publishable Executive Summary

Background

The continued growth in air traffic has placed an increasing demand on the aerospace industry to manufacture aircraft at lower costs, while, at the same time, ensuring the products are efficient to operate, environmentally friendly and maintain the required level of safety. The primary objective of the aero-space industry is to offer products that not only meet the operational criteria, in terms of pay-loads and range, but also in terms of significantly reduced direct operating costs, which is to the benefit of their customers, the airlines.

Project Objectives

The objective of the project is to allow the best and most advanced sensing technologies to become an integral part of the aircraft structure and thus implement Structural Health Monitoring (SHM) into aircraft structural design with respect to maintenance cost reduction, increased aircraft availability and significant weight savings (see Figure 0.1).

The main project target is to develop and validate monitoring technologies that are able to deliver the expected cost savings for maintenance and enable innovative structural design for metals and composites.

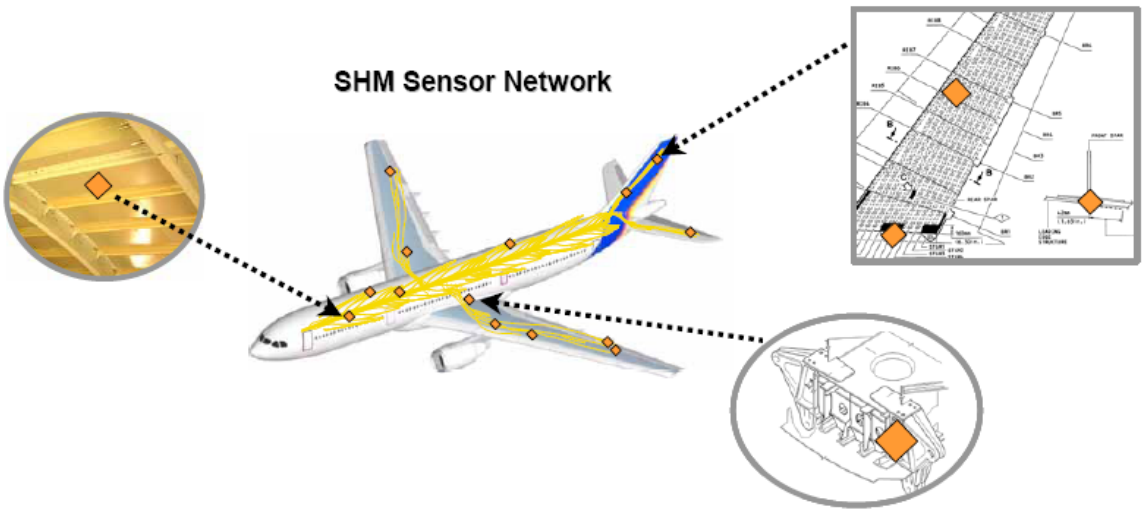

Figure 0.1: Illustration of a sensor network, monitoring the aircraft structure

Description of the Work

The project itself is split into three parts (workpackages), of which workpackage 1 deals with the specifications, workpackage 2 with the technology development, and workpackage 3 with the application and validation tests. The project includes nine sensor and monitoring technologies of different natures, which, at the end of the project, have to prove their applicability with regard to the objectives and specifications set. Due to

their different natures, not all the technologies will meet all of the objectives and specifications.

However, all the objectives will be addressed and hopefully met by the different technologies involved. Providing different solutions to meeting the objectives will guarantee that the merging of different technologies into one system will still be possible in the end, and that this will lead to a system meeting all of the objectives being addressed. It is possible that none of the technologies presented are able to meet the objectives set at this stage. The monitoring technologies to be proved are:

- Fibre Optic Bragg Gratings
- Sensitive Coatings
- Environmental Degradation Monitoring Sensors
- µ-wave Antennas
- Acousto-Ultrasonics
- Comparative Vacuum Measurement
- Acoustic Emission
- Imaging Ultrasonics
- Eddy Current Foil Systems

SMIST Contractors

The following partners participate directly in the SMIST project:

- Airbus Deutschland GmbH
- Airbus España, S.L.
- Airbus UK Ltd.
- Alenia Aeronautica S.p.A.
- ARC Seibersdorf Research GmbH
- BAE Systems(Operations) Ltd.
- DASSAULT AVIATION
- EADS CCR
- EADS Corporate Research Centre - part of EADS Deutschland GmbH
- EADS-Military Aircraft- part of EADS Deutschland GmbH
- Integrated Aerospace Sciences Corporation (INASCO)
- NDT Expert
- University of Sheffield
- KT Systems GmbH

The project is coordinated by Airbus Deutschland GmbH, respectively Holger Spec mann and Clemens Bockenheimer, the responsible project coordinators. The project structure is shown in Figure 0.2.

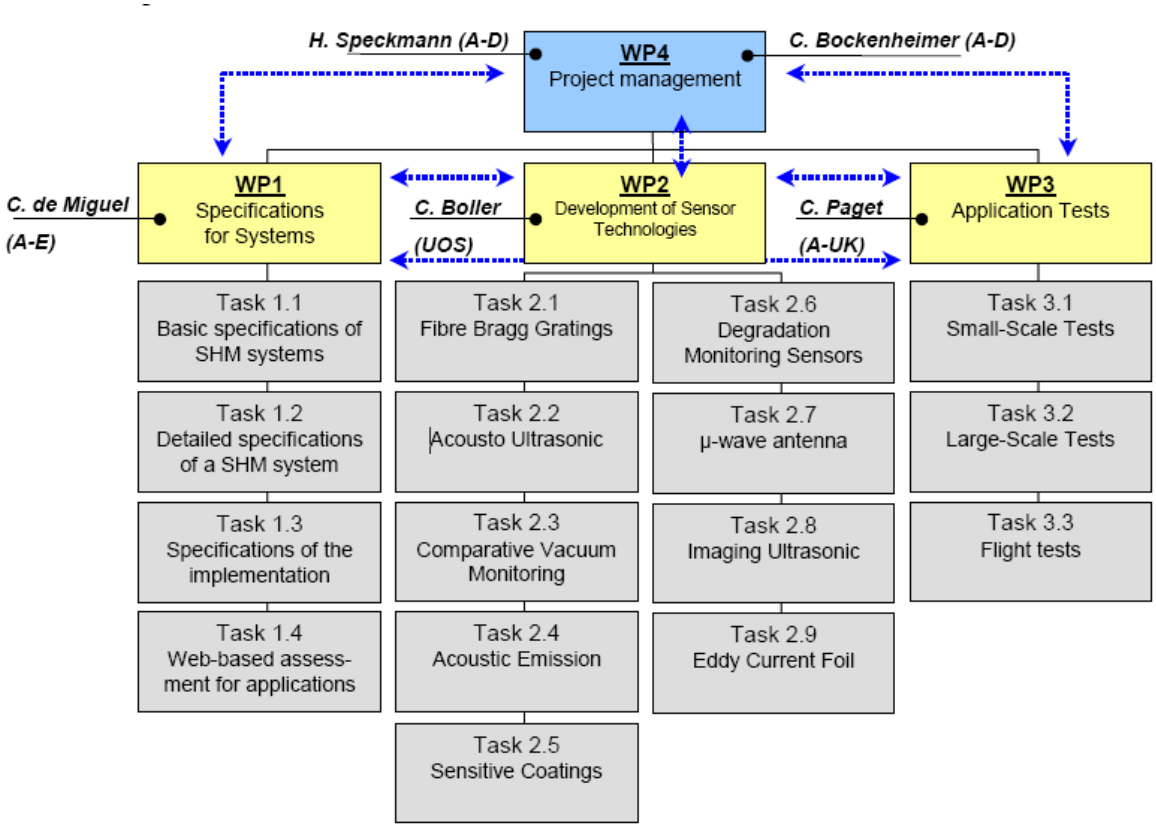

Figure 0.2: Project structure

Achievements

- Successful establishment of Cooperation with 6FP EU-Project ALCAS
- Successful accomplishment of several Technology Workshops

Under technology aspects the following overall project achievements were reached:

- Installation of CVM and AE Sensors in A380 Full Scale Fatigue Tests
- First FBG, AU, CVM and AE Sensors installed on Flight Test Aircraft

Technology related the following achievements were reached:

• For Fibre Bragg Gratings (FBGs)

- application procedure using patches was established and filed for patenting.
- As well connectors for embedding FO Sensors have been developed.

- panels for damage monitoring on composite structures are being manufactured and tests will start in the last year of the project.
- Corresponding finite element analysis has been performed and now be verified by small scale tests.

• For Acousto Ultrasonic (AU) technologies

- the damage detection capability in metal structures was shown and a better understanding of signal processing achieved. This will lead to a further emphasis in simulation within the last year of the project.
- hardware with regard to transducers was investigated and new sensors have been developed cross-linking work together with WP2.4/2.6 using laser printing technology. A corresponding patent has been filed.
- first environmental tests have been successfully finalised.
- first common testing on composite structures has been performed and build a basis for the work on this topic in the last year of the project.

• For Comparative Vacuum Monitoring (CVM) - Systems

- an application procedure has been established and an installation sheet compiled.
- tailored sensors for several applications were developed.
- a Service Bulletin was published allowing the use of these sensors on inservice Aircraft.
- first environmental and mechanical durability tests were successfully performed.
- a Probability of Detection (PoD) was achieved.
- first detection capability tests on composite panels were successfully performed.

• For Acoustic Emission (AE) Systems

- Two patents have been filed, one as mentioned above on new types of transducers and one on the testing procedure for the damage assessment of small CFRP coupon specimens subject to AE-monitored fatigue loading including the algorithms for processing AE-data.
- prototype multi-frequency sensors have been manufactured and will be tested.
- the AE BALRUE software has been improved.
- work has been completed to develop AE analysis for complex 3D structures.
- a study on the use of FBG-Sensors for AE has been completed.

• For Sensitive Coatings (SC) and Environmental Degradation Monitoring Systems (EDMS)

- Direct Write (DW) RFID, Strain Gauge (SG), Crack Wire (CW) and Micro environmental sensors have been developed and tested under mechanical and environmental conditions.
- one new Sensor System for Crack Detection has been filed for patenting.
- a study on environmental degradation monitoring systems has been completed.

• For Micro-Wave Antennas (MWA)

- new antennas have been designed and tested and an improvement of transmission achieved.
- signal modelling has been almost completed and is going to be verified during the last year of the project.

• For Imaging Ultrasonics (IU)

- IU-System has been improved, reduced in costs.
- cross-link between SME technology-provider and industrial partner established with potential application scenario. Test are being performed in last year of the project.

• For Eddy Current Foil Sensors (ETFS)

- numerical modelling has been performed and partly finished.
- new improved sensors have been developed and planned to be used in flight test within the forthcoming period as flight test request has been approved.