FUTURE REPAIR AND MAINTENANCE FOR AEROSPACE INDUSTRY

Deliverable 4.1 **Test rig requirement document**

Suresh Perinpanayagam, Manuel Esperon Miguez, Adrián Cubillo Sastre
IVHM Centre (Cranfield University)
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Project Coordinator
Prof. Dr.-Ing. Rainer Koch (University of Paderborn)

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Further contributors		*Jeppe Byskov-Nielsen, Danish Technological Insitute, Quality Assurance (QA) Officer*		
Authors		*Suresh Perinpanayagam, Cranfield University* *Manuel Esperon Miguez, Cranfield University* *Adrián Cubillo Sastre, Cranfield University*		
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EXECUTIVE SUMMARY

1. Introduction

The main objective of the WP4 is to develop a Fault Detection Tool (FDT) for the part selected, that requires gathering data of the part using a test rig designed specifically to monitor different failure modes (FMs). The design, assembly, and operation of the test rig must accomplish all the desired goals of the RepAIR project. It should generate all the information to devise a reliable algorithm that relates the measured signals of the component with the most critical failure modes of the system, generating a diagnosis and/or prognosis of the health of the system automatically. The purpose of this document is therefore to establish a reasonable list of requirements that will be used as a reference during the following task: T4.2 Construction of a test rig for condition monitoring of sample parts.

2. Methodology

This general methodology for the development of condition monitoring systems has been devised at the IVHM Centre in Cranfield University (CU) and has been proven successful in the development of an end-to-end IVHM system for condition-monitoring of an Unmanned Aerial Vehicle (UAV) fuel system. The selected part is a component of a larger system and many of the Failure Modes (FMs) of the part are due to failures in other components of the system or due to external causes. Therefore, the analysis must include the whole system and not the component alone.

The main steps of this methodology are:

1. Failure Modes Analysis: This consists of a) Identifying and understanding the FMs; and b) define a functional model of the system. This analysis provides engineers with the following information:
    - Description and importance of the FMs
    - Causes and effects of the FMs
    - Mechanisms of the FMs
    - Possible symptoms
    - Functional failures
2. Construction of test rig
3. Conduct tests on critical FMs
4. Correlate data from test rig with FMs indicators
5. Find optimal set of sensors considering cost, coverage, reliability, and weight.

3. Requirements

<u>General requirements</u>

Safety requirements:

1. Safety of the operators and observers as high as possible during the operation of the test rig. Based on “Health and Safety at Work etc. Act 1974”.
2. Safety of the operators and observers as high as possible during the assembly and disassembly of the test rig. Based on “Health and Safety at Work etc. Act 1974”.
3. Fulfillment of the normative in terms of Health and Safety (H&S), environmental, and security policy.

Operational requirements:

Data acquisition requirements:

4. The data acquisition system must provide data of the signals in real time.
5. The data acquisition system must store all the data in an organized format.
6. Configuration parameters and auxiliary data must be recorded in every test.
7. All the sensor and auxiliary signals must by synchronized.
8. The data acquisition system must be able to read as many signals as necessary to conduct the experiments.
9. The format of every signal must be compatible with the data acquisition system.
10. The data acquisition sample rate must be high enough to acquire data at the frequency required to develop a FDT.

Other operational requirements

11. Any manual operation must be able to be carried out in compliance with the health and safety standards. Based on "The Manual Handling Operations Regulations 1992".
12. The test procedures must assure repeatability and minimize errors.
13. The test rig must be able of stop instantaneously during the realization of a test.
14. The precision of sensors/actuators must be high enough to develop a reliable FDT.
15. As many sensors as needed must be used to assure a good understanding of the system's behaviour.

Functional requirements:

16. Nominal operational conditions of the part must be reachable in the test rig.
17. Specific operational conditions needed to simulate a FM must be reachable in the test rig.
18. All the relevant parameters of a FM must be measured in the test rig.
19. It must be possible to make the part fail due to the most critical FMs.

<u>Specific requirements for the part selected</u>

After deliberation with the partner of project RepAIR, the decision was made to focus WP4 on the differential of an Integrated Drive Generator (IDG). The purpose of the IDG is to provide primary electric power for the aircraft electrical system by converting variable engine input speed to a constant output speed, which enables the generator portion of the IDG to produce alternating current (AC) electrical power which is used by different systems of the aircraft. Those factors considered in this decision were: complexity of the geometry, complexity of the failure modes, economic interest in developing a FDT for the part assessed, cost of the test rig, safety of the test rig, dimensions, and material.

Specific requirements have been defined to monitor different relevant failure modes:

I. Pitting:
   A. There must be access to the tools required to simulate pitting along the gear tooth surface.
   B. Accelerometers are required to analyse the vibration spectrum of the system.
II. Overheating:
   A. Temperature sensors are required to control the temperature of the lubricant
III. Scuffing:

A. Accelerometers are required to analyse the vibration spectrum of the system.
B. Temperature sensors are required to detect an increase of the temperature.
C. There must be access to the tools required to simulate scuffing along the gear tooth surface.

IV. Cracks:
A. Accelerometers are required to analyse the vibration spectrum of the system.
B. There must be access to the tools required to simulate a crack along the surface of a tooth

V. Tooth Breakage:
A. Accelerometers are required to analyse the vibration spectrum of the system.
B. There must be access to the machines required to break off a tooth of the gear