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BOEING

A Framework for Aerospace Vehicle Reasoning (FAVER)

Dr. Cordelia Mattuvarkuzhali Ezhilarasu*, Prof. Ian Jennions

Integrated Vehicle Health Management (IVHM) Centre, Cranfield University

*c.m.Ezhilarasu@cranfield.ac.uk

Motivation of the research

Sustainable Aviation

✈ **Long-term measures**: Disruptive technologies like developing electric/ hydrogen/ alternate fuel powered aircrafts.

✈ **Immediate measures**: To reduce carbon footprint and emissions from existing flights.

Unscheduled Maintenance

✈ It is one of the primary reasons behind **flight delays** and **air traffic congestion**, leading to unnecessarily burnt fuel and exhaust gases and adding to the carbon footprint as well as costing airliners time, money and reputation.

Integrated Vehicle Health Management (IVHM) technology provides **health status, diagnostic and prognostic** information of aircraft systems to ensure operational efficiency with economical and environmental benefits.

Problem Statement
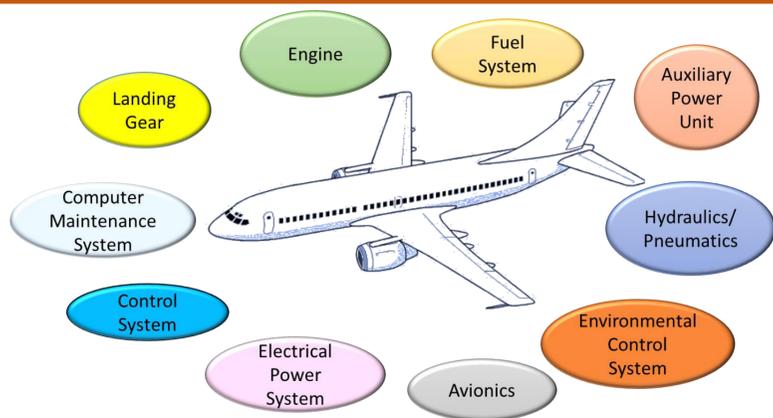
Health Management at Vehicle Level

✈ The **interactions** between aircraft systems can lead to unexpected fault propagation resulting in prolonged downtime and unscheduled maintenance.

✈ This problem requires system level knowledge as well as a **holistic view** of the vehicle.

✈ **FAVER** is an IVHM framework that paves way for exploring cascading faults among interacting systems to isolate faults and their root causes and predict their cascading effects.

Building blocks of FAVER

✈ FAVER comprises of a
  ✈ **Digital Twin layer** that contains virtual representations of aircraft systems,
  ✈ a **Reasoning layer** with knowledge, and algorithms, and
  ✈ a supporting **communication layer** that connects the other layers to user interface.

✈ The architecture of FAVER is **modular**, enabling the use of different types and levels of system representations and various diagnostic methods for demonstrations.

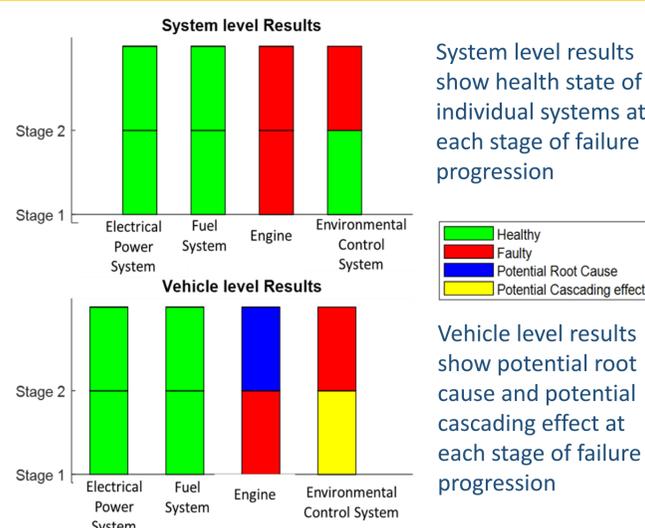✈ The framework is also **expandable,** to include more onboard and ground systems for the vehicle level analysis.
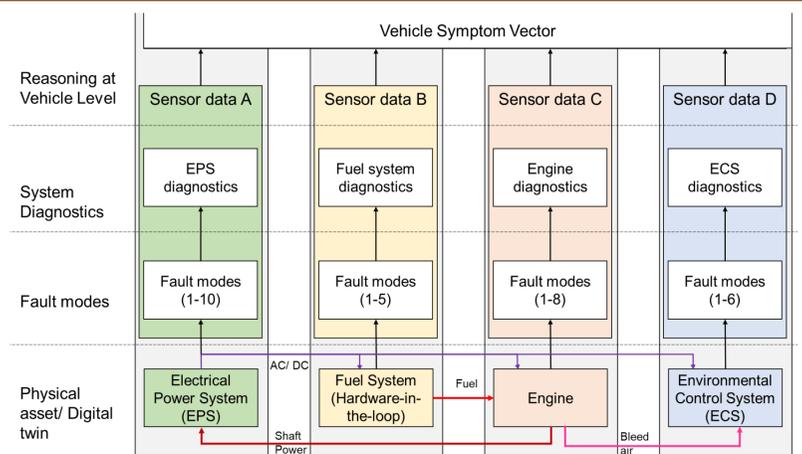
Working schematic of FAVER

Use case scenario
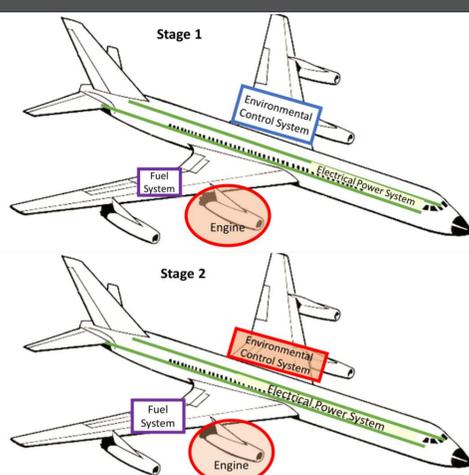
Example of fault in the engine affecting the Environmental Control system in two stages

Results by FAVER

System level results show health state of individual systems at each stage of failure progression

Vehicle level results show potential root cause and potential cascading effect at each stage of failure progression

Benefits of FAVER

✈ FAVER's results are **easily interpretable,** helping users to prevent cascading faults from causing unscheduled maintenance, thus saving time, cost, and ensuring on-time flying.

✈ FAVER is **system agnostic**, enabling adaptation to the new generation of aircrafts, thus capable of evolving into the future.

✈ FAVER is a building block for IVHM Centre's aspirational **Conscious Aircraft** to provide step changes in operational efficiency and sustainable flying.

Reference: 1. Ezhilarasu CM., Jennions IK. Development and Implementation of a Framework for Aerospace Vehicle Reasoning (FAVER). IEEE Access. 2021; 9: 108028–108048.
2. Angus J., Maggiore J. Environmental benefits of Integrated Vehicle Health Management (IVHM). Cranfield University Blogs. 2022.
3. Jennions I., Angus J. Opinion: Are Aircraft Going To Become 'Conscious'? Aviation Week. February 2022.

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