MADe - Automated Dependency Mapping (ADM)

made
decisions better MADe...

Instantly identify how failures propagate acrosss a system.

Key benefits

- Rapid failure identification for complex systems (cost and schedule impact)
- Consistency of failure analysis process (objective method with significant technical advantages)
- Usability – directly supports various engineering analysis
- Traceability - knowledge of the domain / system experts is captured in the MADe FBD
- Extensibility of system (configuration management across platform lifecycle)

Key features

- Automated process
- Environmental Factors – environmental variables that impact system performance
- Dynamic, iterative process (vs. static documentation derived from a traditional 'brainstorming' process that is recorded in spreadsheets)

The Problem: with increasingly complex platforms that can combine electronic, hydraulic, mechanical and pneumatic systems it is difficult to accurately identify how a failure will propagate across a system using traditional 'brainstorming' methods – but without dependency mapping it is not possible to understand the engineering, financial or operational risks associated with a potential failure mode.

The Solution: generate dependency mapping for a system automatically based on the MADe Functional Block Diagram (FBD). MADe ADM will automatically identify and capture the effects of a loss of function (failure) based on fundamental engineering concepts (physics of failure) both 'upstream' and 'downstream' in the platform.

The MADe FBD enables rapid updates / changes to a system configuration in the model to support the failure analysis required to optimise design / RAM / diagnostic activities at each stage of the product lifecycle (from concept to operations).

Identify the consequences of physical / functional failures and effects on the system.

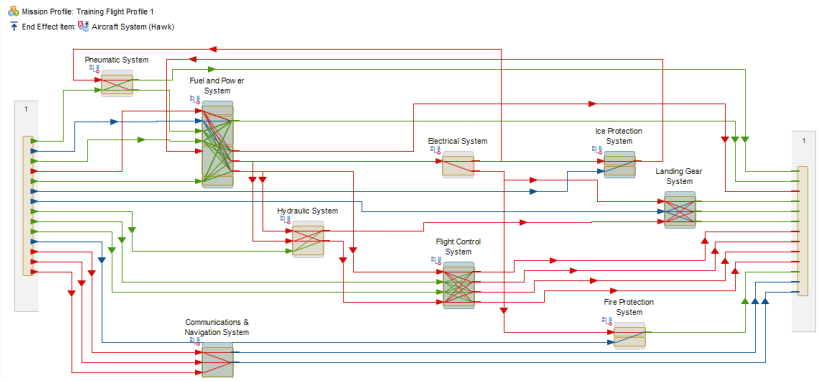

Figure 1: Automated Dependency Mapping in a Driveline System Model

How does MADe generate ADM?

ADM is derived automatically from the MADe FBD (system model) – the functional definitions of each element in the system and their connections to other model elements are used to identify the causal relationships. Using a model of the system generated based on fundamental engineering principles (e.g. functional analysis, physics of failure) ensures that system integrity can be assured for certification.

Why is MADe Automated Dependency Mapping important?

If you don't identify a potential failure, it cannot be understood or mitigated. Being able to objectively identify all of the potential failures in a system is essential to the design process:

- Failure Analysis – understanding how the system can fail (and what causes the failure).
- Criticality Analysis – establishing which failures are important (cost / operations).
- Safety Analysis – ensuring that all potential failures and their effects are considered.
- RAM Analysis –establishing appropriate countermeasures for identified failures.
- Diagnostic Analysis – understanding which failures need to be monitored.

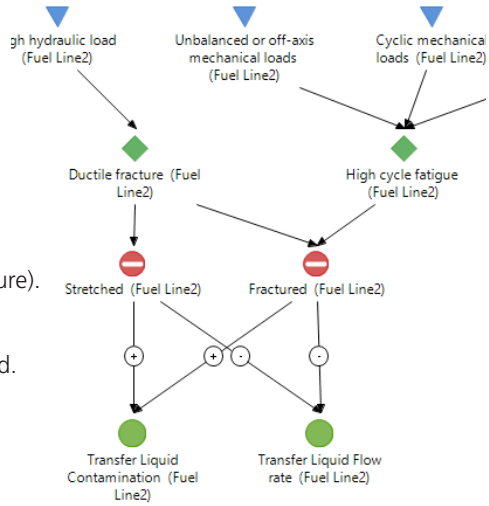

Figure 2: Failure Diagram of a Fuel Line

What benefits does MADe ADM have over traditional failure analysis?

MADe ADM means that the user can maximize the consistency and effectiveness of the failure analysis process. The MADe GUI provides visualisation of the ADM on the model to maximise knowledge capture / transfer - and the FBD can be configuration managed (MADe Annotation).

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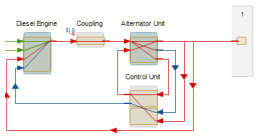
How MADe performs Automated Dependency Mapping

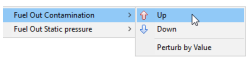
What is required to conduct Dependency Mapping?

Functional Model



Causal Strengths

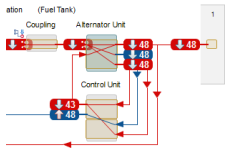
Fault Injection



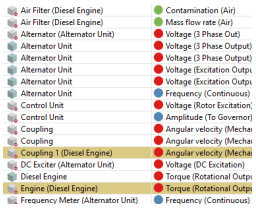
1) MADe Functional Block Diagram (FBD) model is used for ADM failure simulation.
2) Effects of flow properties are set based on causal strength settings.
3) A model item is injected with a perturbation (failure) to simulate failure propagation.

What does Dependency Mapping provide?

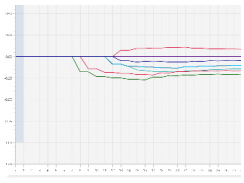
Automated Failure Propagation (Multi-Domain)



Step Table



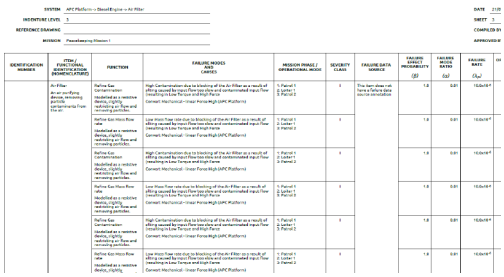
Response Simulation



1) Failure propagation is visualized in model – intermediate Failure Response can also be viewed.
2) Step table shows the extent of flow property perturbations for each component failure mode.
3) Perturbations are represented in response simulation graph.

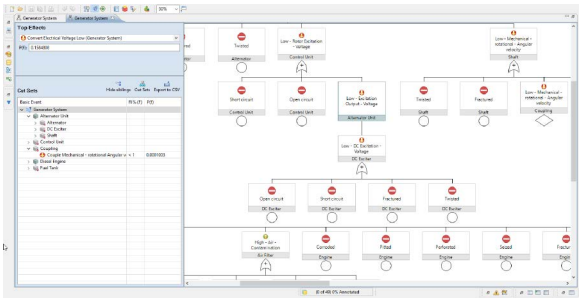
How are the results of Automated Dependency Mapping used?

FMEA/FMECA



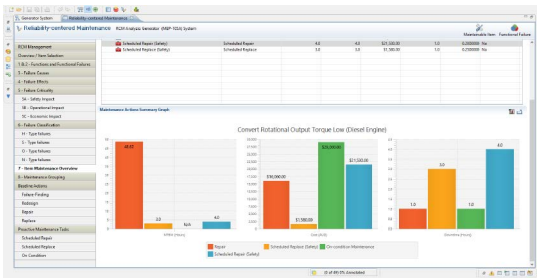
ADM enables automated production of FMECA based on a MADe FBD Model

Maintenance Actions



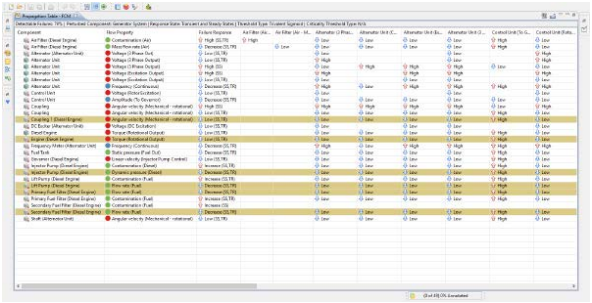
Failure paths between components are captured in FTA

RCM



ADM is used to identify specific end effects of system failures

Sensor Diagnostics / Fault Detection & Isolation (FDI)



ADM is used to identify combinations of diagnostic test points to enable FDI

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