

## Demonstrate seaworthiness using integrated engineering analysis

### Key benefits

- ▶ Model based simulation
- ▶ Integrated analysis
- ▶ Automation of failure identification
- ▶ Traceability of risk identification
- ▶ Knowledge capture / transfer – GUI based

### Key features

- ▶ Comprehensive failure concept taxonomy
- ▶ Graphical representation of failure progression
- ▶ Consistency of failure concept descriptions

**The Problem:** Maritime certification for Seaworthiness is an important milestone. However the accuracy and legibility of the records are not always linked or derived from the engineering analyses used for the ship design and maintenance planning – which can have significant technical and schedule consequences.

**The Solution:** The MADe software is an integrated analysis solution that generates the artefacts required for Seaworthiness certification. Analysis generated concurrently with design leads to improvements in the certification process. MADe automatically tracks the source of all parameters used in an analysis to provides a means of assessing the quality of data used to support engineering decisions and analysis.



## Which analyses can be generated by MADe?

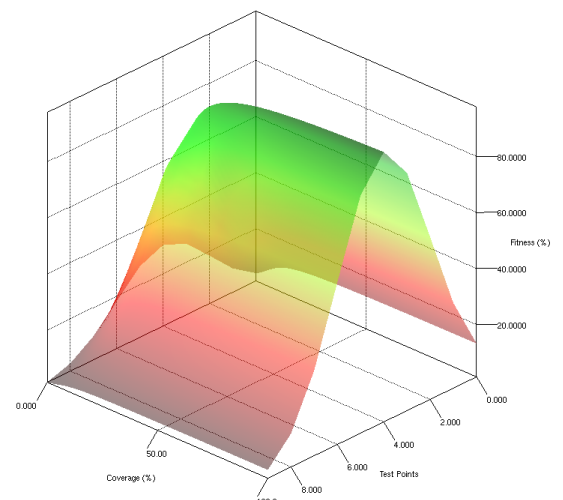
Engineering analyses can be generated on-demand from the MADe model built during design, a key benefit being the artefacts used to improve the design can also be leveraged to document and demonstrate Seaworthiness

- ▶ Mission profile – identifying the typical use-cases and operation of the design
- ▶ FMEA – Identifying the failures and how they progress through the system
- ▶ FTA – Performing root cause analysis to find the initiating cause of any failure
- ▶ RCM – Develop the maintenance plan to be applied consistent with current industry standards

## How do Annotations demonstrate analysis quality?

The ability to generate analyses is important, so is the ability to document, trace and demonstrate the quality and integrity of the model or analyses, Annotations demonstrate quality by documenting:

- ▶ Justification – List each decision/parameter and the reasoning to support the change or decision
- ▶ Configuration Management – who made the decision and when it was made
- ▶ Data source and quality - the integrity of the data including the quality of the data source



Physical failure modelling utilizing the Failure Concepts taxonomy

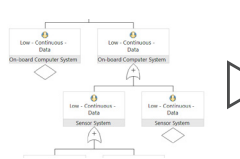
# How MADE supports Seaworthiness

## Generate Engineering Analyses


**FMEA**

FAILURE MODES AND CAUSES	I OF
High Contamination due to blocking of the Air Filter as a result of siltling caused by contaminated input flow and input flow too slow (resulting in Low Torque and high Force)	1: P 2: LI 3: P
Low Mass Flow rate due to blocking of the Air Filter as a result of siltling caused by contaminated input flow and input flow too slow	1: P 2: LI 3: P

**FTA**



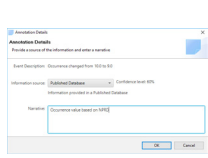
**RCM Analysis**



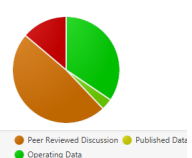
- 1) FMEA is generated based on the model
- 2) FTA can be generated from the FTA that provides cut-sets of failures
- 3) RCM analysis can be used to generate appropriate maintenance plan in response to the system

## Demonstrate Analysis Quality

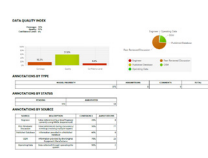
Annotate Decisions



Review Model Quality



Document Annotations



- 1) Each parameter decision is tracked and annotated
- 2) Model or Analysis quality assessment (confidence level)
- 3) Reports generated to document quality of the analyses

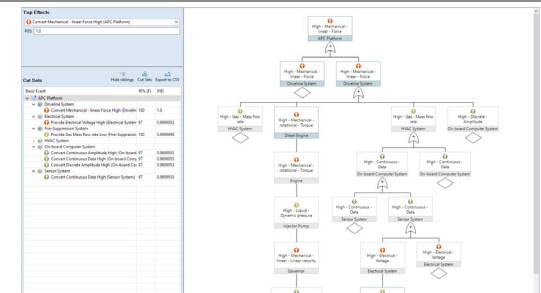
## Key Seaworthiness Analyses

**FMEA/FMECA**

IDENTIFICATION NUMBER	ITEM / FUNCTIONAL IDENTIFICATION (NOMENCLATURE)	FUNCTION	FAILURE MODES AND CAUSES	MISSION PHASE / OPERATIONAL MODE	LOCAL EFFECTS	SYSTEM EFFECTS
air filter	As air purifying device, removing particles contaminants from the air.	High Contamination due to blocking of the air filter as a result of siltling caused by contaminated input flow and input flow too slow (resulting in Low Torque and high Force)	1: Part 1 2: Lubrication 1 2: Part 2	High Contamination High Loss of output	Connect mechanical rotational Torque (Diesel engine)	Loss of output
air filter	As air purifying device, removing particles contaminants from the air.	Low Mass Flow rate due to blocking of the air filter as a result of siltling caused by contaminated input flow and input flow too slow (resulting in Low Torque and high Force)	1: Part 1 2: Lubrication 1 2: Part 2	High Mass Flow rate Low Loss of output	Connect mechanical rotational Torque (Diesel engine)	Loss of output
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FMEA/FMECA leverage the functional and physical model to track failures

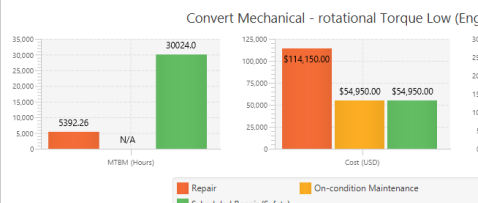
**Fault Tree Analysis**




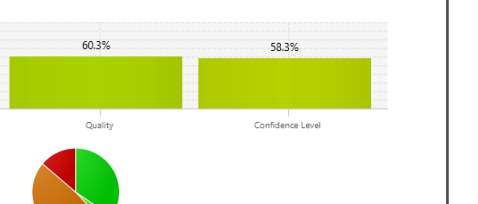
Root cause analysis from failure cause to end-effect in the FTA

**Classic RCM/Maintenance Plan**

Convert Mechanical - rotational Torque Low (Engine)







Classic RCM to provide a maintenance plan in response to system failures

**Annotations/Analysis Quality**

Coverage

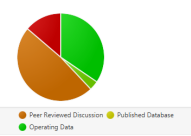
96.7%

Quality

60.3%

Confidence Level

58.3%



An Model Quality Index and report to support any generated analyses