U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – GROUND VEHICLE SYSTEMS CENTER

Model Based Logistics Engineering (MBLE)

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Supervisor – Team Lead

Ground Vehicle Systems Center

SPECIALTY ENGINEERING

Specialty Engineering Mission

- Provide specialty engineering (DfR, DfM, DfL, CBM+, LE) expertise and knowledge to reduce the Army Operational & Support costs through proactive practices and analyses.
- Specialty Engineering improves system design, system sustainment, and system life cycle management through a wide range of specialty engineering capabilities and supportability analyses that leverage more complete, accurate, and available life cycle data.

Specialty Engineering Vision

- To be the Specialty Engineering Center of Excellence for S&T and Acquisition Program of Records within the Army ground and sea domain thru providing innovative supportability model based logistics engineering support, analyses, and services that ensure the most *reliable*, *maintainable and sustainable* technologies and systems are developed for use by the Warfighter.

MODEL-BASED LOGISTICS ENGINEERING SUPPORT (MBLE)

Advantages of MBLE

- Efficiency
  - ✓ Model can be used and updated throughout the project and lifecycle
  - ✓ Reports and analysis are available with the push of a button
- Consistency
  - ✓ Downstream effects of failure modes can easily be identified automatically using the functional model
- Repeatability
  - ✓ Subjectivity is removed, as model forces a certain level of detail and accuracy

Focus Areas

- Data Requirements
  - ✓ Accurate data packages and drawings are needed up front in order to build a complete functional model
- Contractual Language
  - ✓ Adding specific contracting language earlier in the design process allows for delivery of the correct reliability data, TDPs, electrical schematics, system layout drawings and subsystem details which allow a complete and accurate model to be built.

TOOL REVIEW – MADE BY PHM TECHNOLOGY, INC.

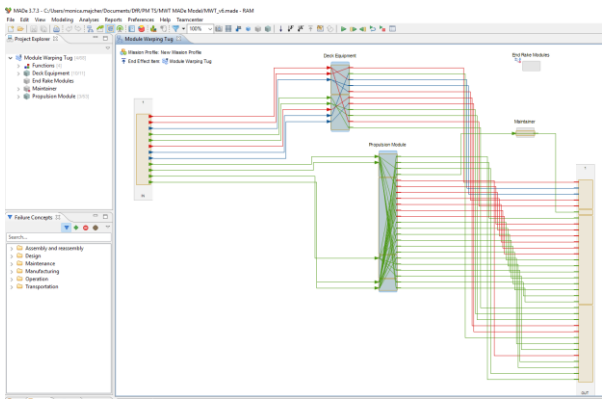
Maintenance Aware Design (MADe)

What MADe does:

- ✓ Enables better decisions about the design and support of safety/mission critical equipment at each stage of the product lifecycle.
- ✓ Maintenance Optimization of legacy systems
- ✓ Helps to Establish Life Cycle Costs
- ✓ Design for CBM
- ✓ Optimizes cost of ownership, system reliability and system availability

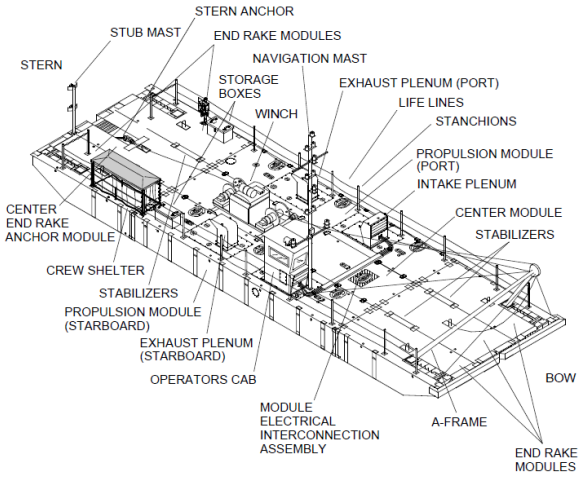
Advantages of Using MADe

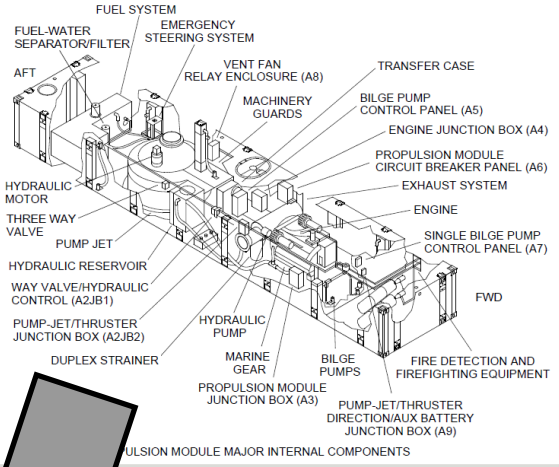
- ✓ Accounts for complexity and large number of moving parts by starting with a functional model
- ✓ Dependency modelling (or mapping) is achieved ‘automatically’ throughout the system, rather than relying on the engineer
- ✓ Introduces standardization into the design process to
  - ✓ improve quality and analysis capabilities
- ✓ Model can be shared across competencies and
  - ✓ organizations for different purposes/analyses
- ✓ Provides traceability of analysis across the product lifecycle

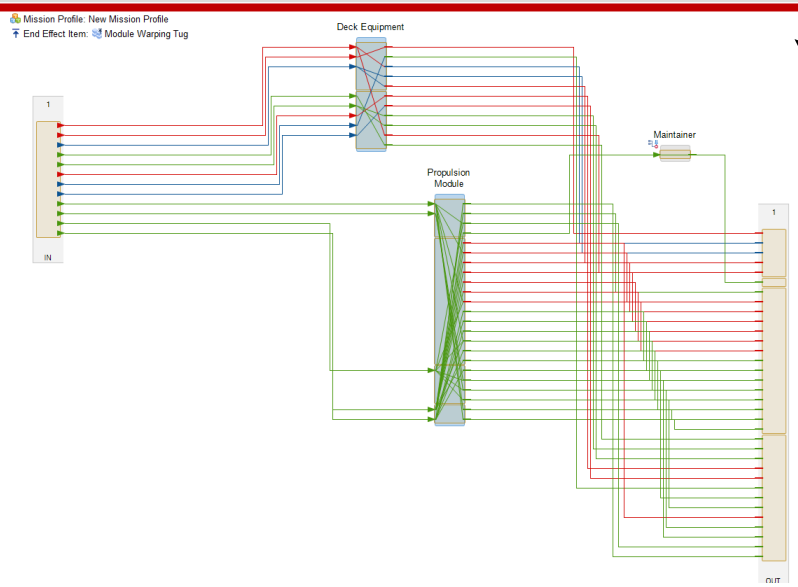


MADE – MAINTENANCE AWARE DESIGN ENVIRONMENT

System Diagrams/ Architecture Drawings

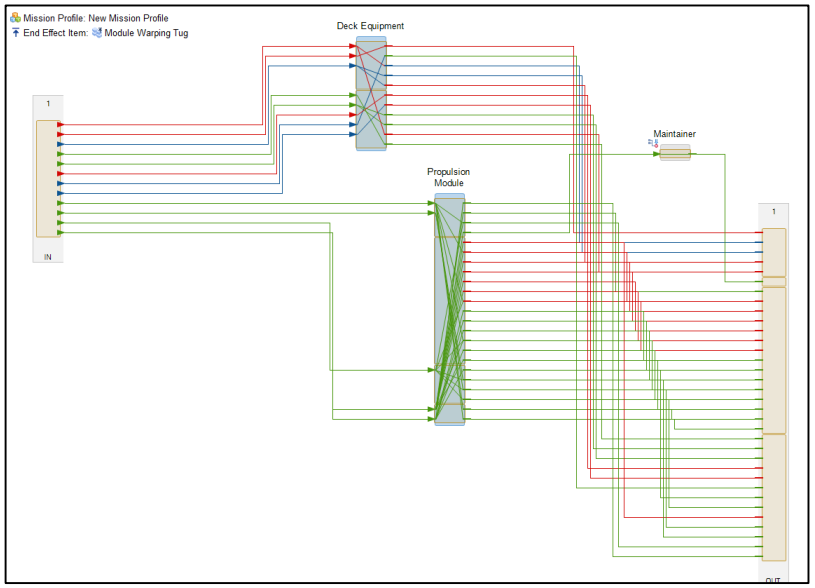




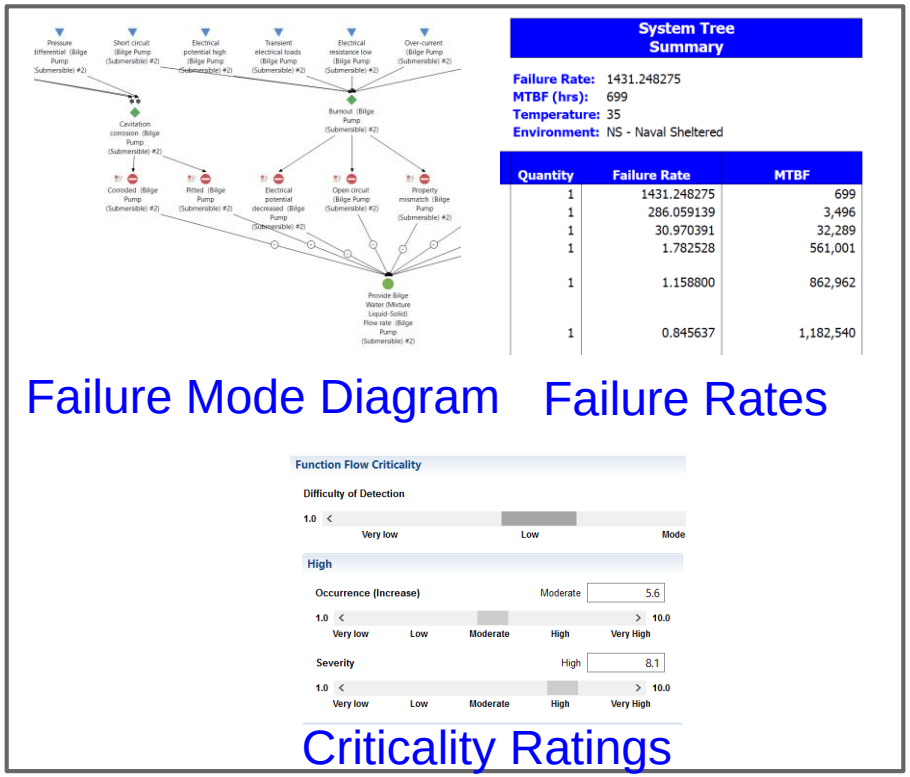


MADe System Functional Model

HIGH LEVEL MODELING PROCESS



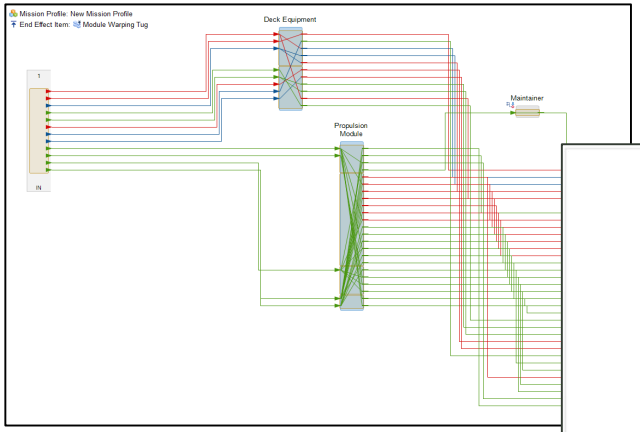
MADe System Functional Model



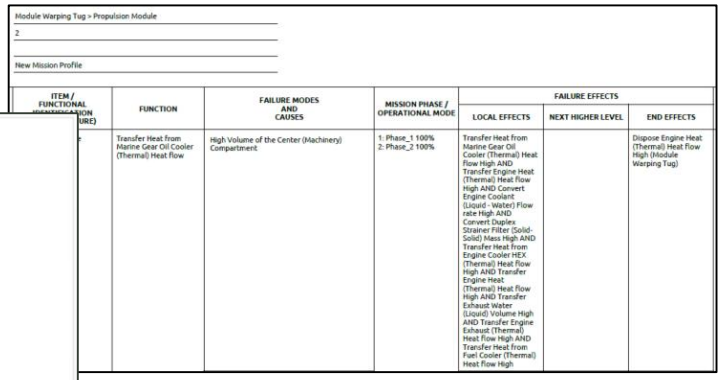
Failure Mode Diagram Failure Rates

Criticality Ratings

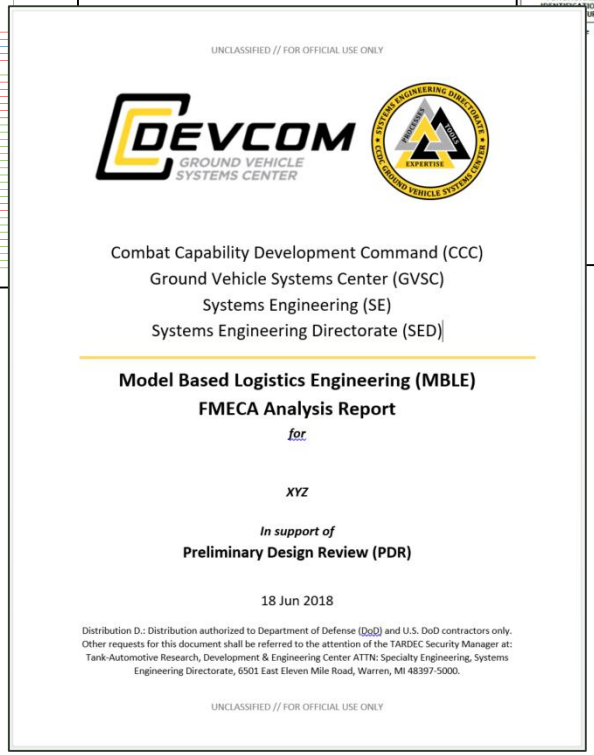
OPTION #1 – INDEPENDENT ASSESSOR DELIVERABLES



System Functional Model



Model Based FMECA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DEVCOM GROUND VEHICLE SYSTEMS CENTER

Combat Capability Development Command (CCC)
Ground Vehicle Systems Center (GVSC)
Systems Engineering (SE)
Systems Engineering Directorate (SED)

Model Based Logistics Engineering (MBLE)
FMECA Analysis Report
for

XYZ

In support of
Preliminary Design Review (PDR)

18 Jun 2018

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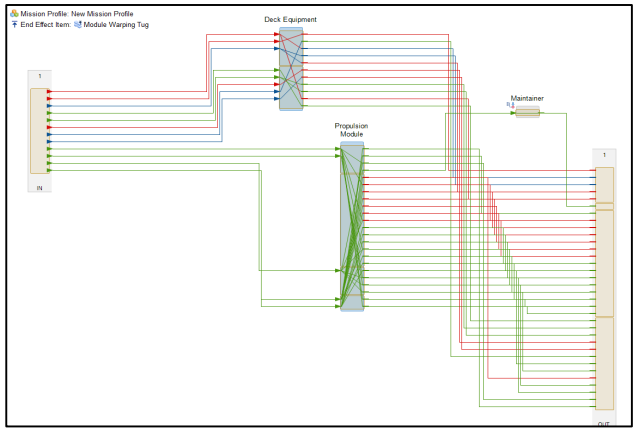
FMECA Analysis Report

Risk Reduction:

- Verifying deliverables from contractors are thorough and in accordance with technical standards
- Providing a baseline that can be used for traceability of improvements
- Identification of key failure areas that may need an updated maintenance strategy/schedule

OPTION #2 ORGANIC MODEL BASED FMECA



System Functional Model

Module Warping Tug > Propulsion Module

2

New Mission Profile

ITEM / FUNCTIONAL IDENTIFICATION (NOMENCLATURE)	FUNCTION	FAILURE MODES AND CAUSES	MISSION PHASE / OPERATIONAL MODE	FAILURE EFFECTS		
				LOCAL EFFECTS	NEXT HIGHER LEVEL	END EFFECTS
Propulsion Module	Transfer Heat from Marine Gear Oil Cooler (Thermal) Heat flow	High Volume of the Center (Machinery) Compartment	1: Phase_1 100% 2: Phase_2 100%	Transfer Heat from Marine Gear Oil Cooler (Thermal) Heat flow High AND Transfer Engine Heat (Thermal) Heat flow High AND Convert Engine Coolant (Liquid - Water) Flow rate High AND Convert Duplex Strainer Filter (Solid-Solid) Mass High AND Transfer Heat from Engine Cooler HEX (Thermal) Heat flow High AND Transfer Engine Heat (Thermal) Heat flow High AND Transfer Exhaust Water (Liquid) Volume High AND Transfer Engine Exhaust (Thermal) Heat flow High AND Transfer Heat from Fuel Cooler (Thermal) Heat flow High		Dispose Engine Heat (Thermal) Heat flow High (Module Warping Tug)

Model Based FMECA

DoD Digital Engineering Strategy

Ms. Philomena Zimmerman
Deputy Director, Engineering Tools and Environments
Office of the Deputy Assistant Secretary of Defense
for Systems Engineering

INCOSE IW
Jacksonville, FL | January 19, 2018

Digital Engineering Strategy: Five Goals

1. Formalize the **development, integration and use of models** to inform enterprise and program decision making
2. Provide an enduring **authoritative source of truth**
3. Incorporate **technological innovation** to improve the engineering practice
4. Establish supporting **infrastructure and environments** to perform activities, collaborate, and communicate across stakeholders
5. Transform a **culture and workforce** that adopts and supports Digital Engineering across the lifecycle

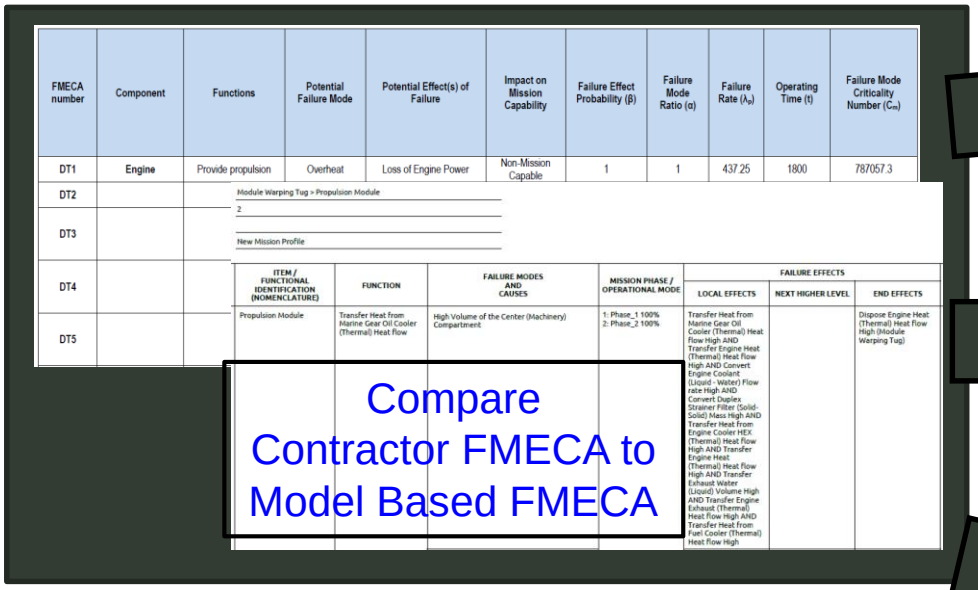
Drives the engineering practice towards improved agility, quality, and efficiency, which results in improvements in acquisition

Goal #1: Formalize Development, Integration & Use of Models

Models as the cohesive element across a system's lifecycle

QUESTIONS?

OPTION #1 – INDEPENDENT ASSESSOR DELIVERABLES cont.



FMECA number	Component	Functions	Potential Failure Mode	Potential Effect(s) of Failure	Impact on Mission Capability	Failure Effect Probability (β)	Failure Mode Ratio (α)	Failure Rate (λ_p)	Operating Time (t)	Failure Mode Criticality Number (C_m)
DT1	Engine	Provide propulsion	Overheat	Loss of Engine Power	Non-Mission Capable	1	1	437.25	1800	787057.3
DT2										
DT3										
DT4										
DT5										

Module Warping Tug > Propulsion Module

2

New Mission Profile

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Compare Contractor FMECA to Model Based FMECA

Identify difference and deficiencies

Identify missing failure modes

Provide guidance on critical failure maintenance strategy

Risk Reduction through:

- Verifying deliverables from contractors are thorough and in accordance with technical standards
- Providing a baseline that can be used for traceability of improvements
- Identification of key failure areas that may need an updated maintenance strategy/schedule