28th Annual INCOSE international symposium

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Integrating a Model-Based Systems Engineering and Model-Based Product Support Approach for Affordable System Sustainment

MBSE and MBPS

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Imagine the Following…

iconic Millennium Falcon.

The Resistance has limited resources to support development and operations of the new Rebel starfighter. They are preparing for an important battle against the evil First Order, and high operational availability is imperative.

The Systems Engineer must make smart design decisions to optimize system readiness and life cycle cost to support this vital mission for the Resistance…

Customer Feedback

“What a piece of junk!”
– Luke Skywalker on first seeing the Millennium Falcon (Star Wars: Episode IV A New Hope)

“For once, sir, the Millennium Falcon actually appears to be in good working order.”
– C-3PO during the Attack on Cymoon 1 (Star Wars 1 Skywalker Strikes)

Quotes from http://starwars.wikia.com/wiki/Millennium_Falcon. Photo by Darryl W. Moran Photography under https://creativecommons.org/licenses/by-sa/2.0/

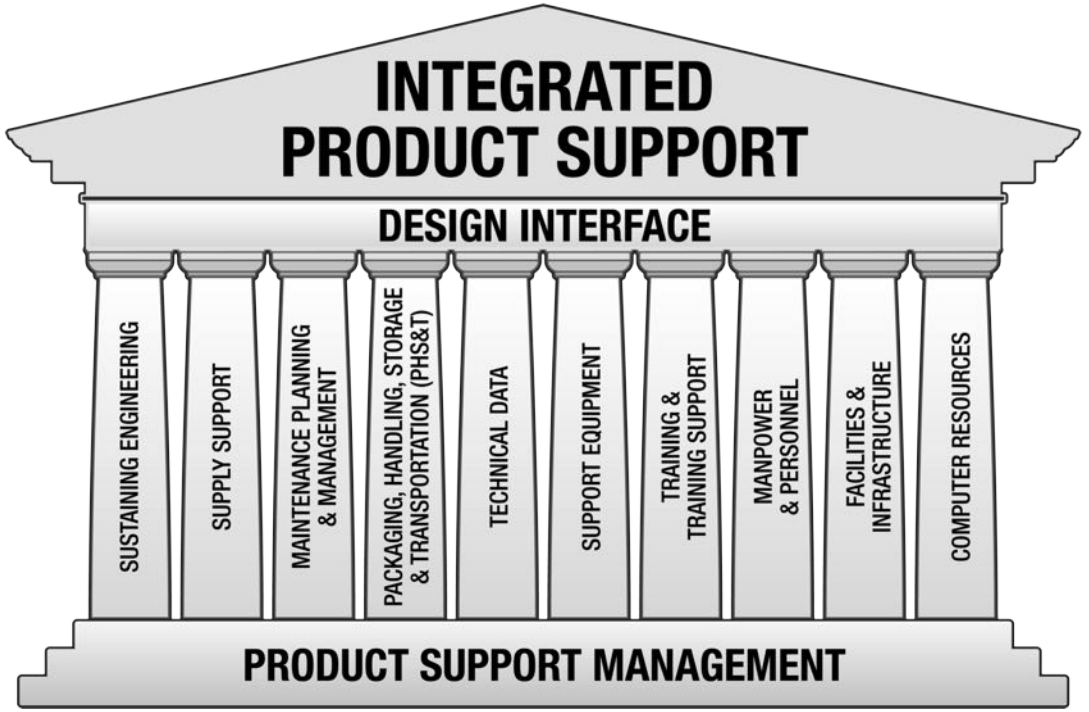
Affordable System Sustainment Challenges

- Millennium Falcon uses Girodyne SRB42 sublight engines. *How should new starfighter engines be designed to outrun the First Order's new Star Destroyer?*
- Current weapon systems include two CEC AG-2G quad laser cannons. *New mission requirements include longer travel time – what is the trade-off between inventory on the shelf and engineering design changes?*
- *How can we improve the reliability of the three deflector shield generators*?

What sustainment enablers should be designed <u>into</u> the system to optimize readiness and cost requirements?

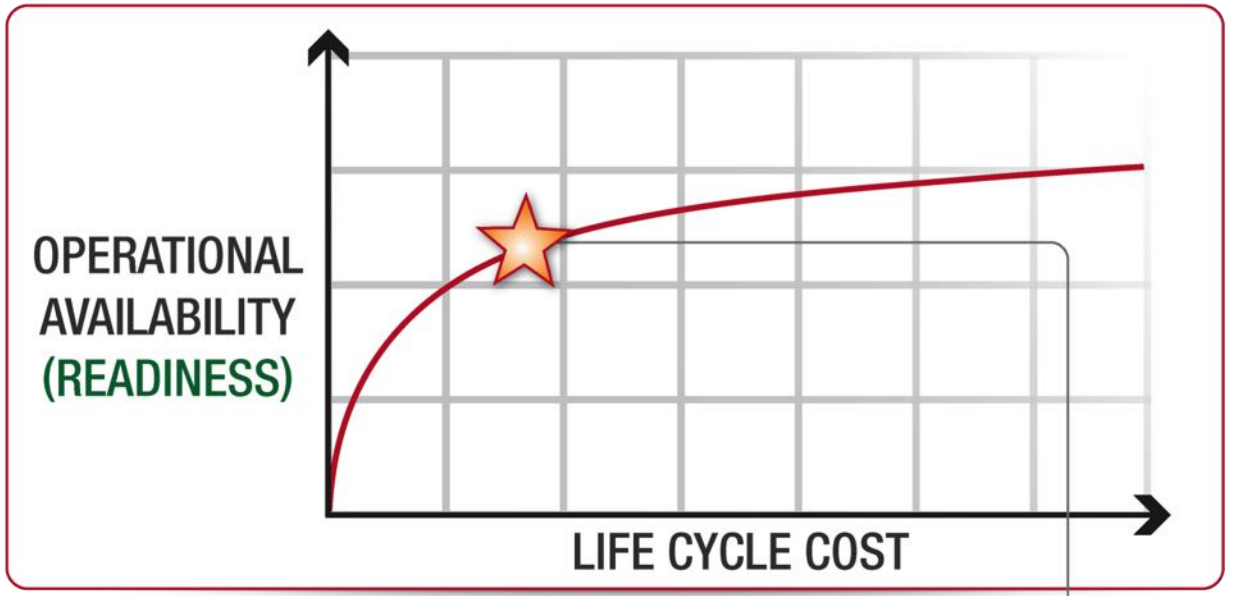
What is Product Support?

- **Product Support** is a key life cycle management enabler – it is the package of ***support functions required to deploy and maintain the readiness and operational capability*** of the product's systems, subsystems, and components, including all functions related to systems readiness
- **Integrated Product Support Elements** provide a structured framework for managing product support
  - ***Design Interface*** is the involvement of product support within the SE process to impact design through the life cycle, facilitating supportability to maximize system readiness at the lowest LCC



https://www.dau.mil/guidebooks/Shared%20Documents/IPS_Element_Guidebook.pdf

Primary Purpose of Product Support



85% of O&S costs are committed as a result of a program's early design decisions

KPP	Key Performance Parameter
KSA	Key System Attribute
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
MLDT	Mean Logistics Down Time

Enabling Affordable System Operational Effectiveness

Optimize System Readiness at Affordable Cost

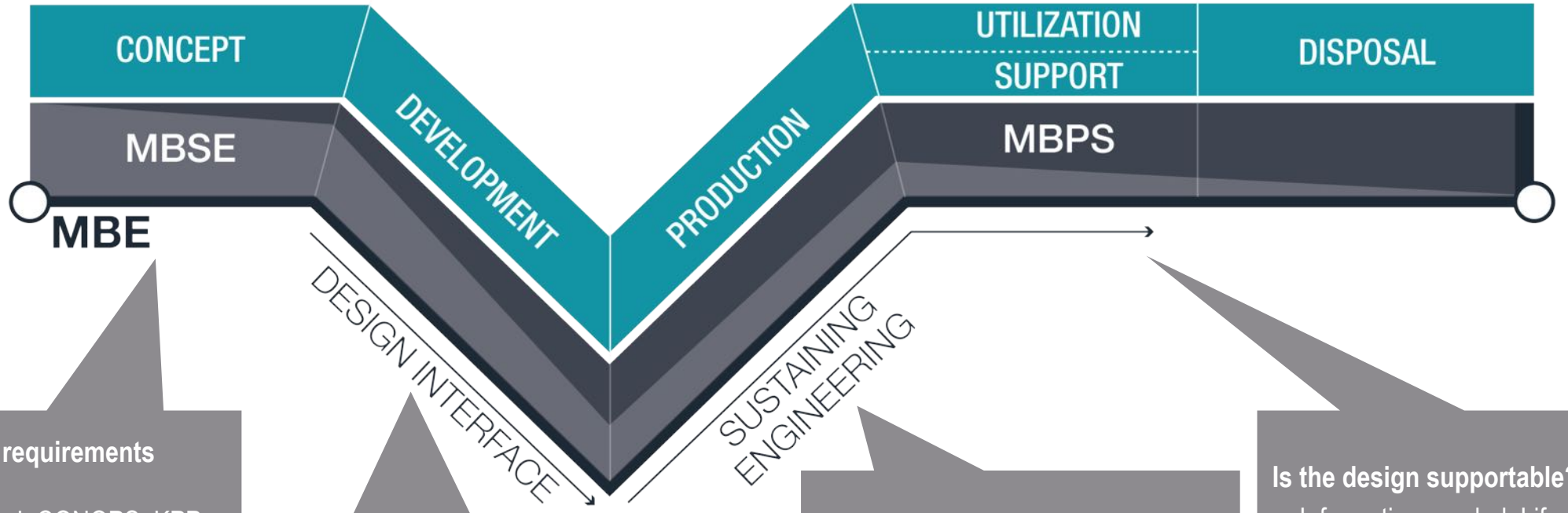
- Systems Engineers need to consider sustainment starting in early stage design
- Engage the Product Support community and integrate within SE processes

What Do We Mean by MBPS?

Model-Based Product Support (MBPS) is an approach to life cycle product support that uses models as an integral part of the system baseline to optimize supportability through requirements, analysis, design, verification, implementation, and sustainment of a capability, system or product throughout the system life cycle.

MBPS in Practice Across the Life Cycle

Design for Support - Design the Support - Support the Design



Are supportability requirements defined?

- Information needed: CONOPS, KPPs, KSAs, OSAs
- Information produced: Material Availability (Am), Operational Availability (Ao), Training, Material Reliability (Rm), O&S Cost, RTVM, SysML Model

Is the design feasible?

- Information needed: Design, Producibility Technology Maturity
- Information produced: Producibility Analysis, System, Production & Maintenance Models

Are risks mitigated?

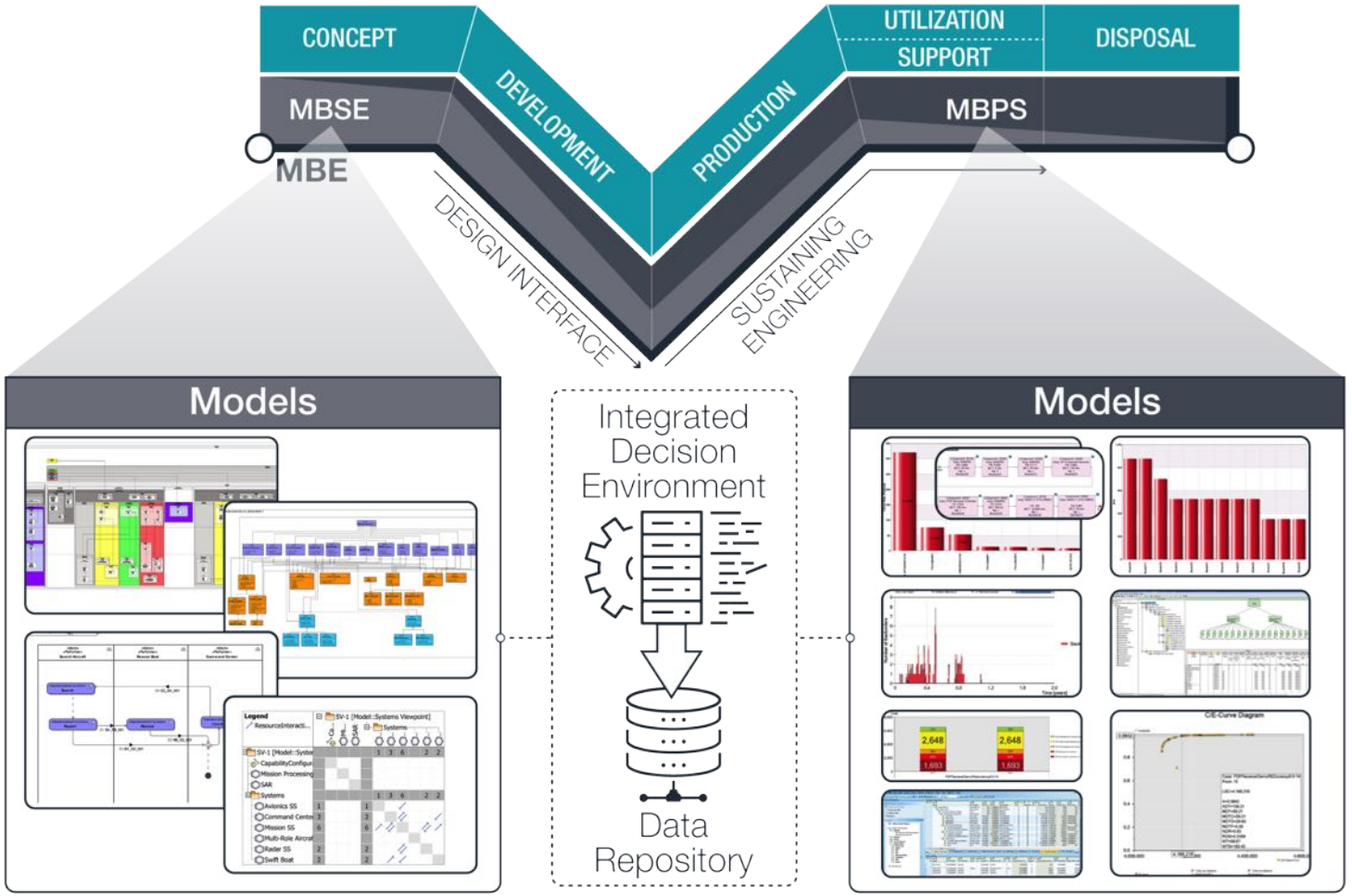
- Information needed: Risk Analysis; Test Plans
- Information produced: Risk Cubes pulled from SysML model and 3D model; Risk Analysis

Is the design supportable?

- Information needed: Lifecycle Cost Analysis; Spare/Repair Analysis
- Information produced: Cost Model, Logistics Support Model, Historical RAM data

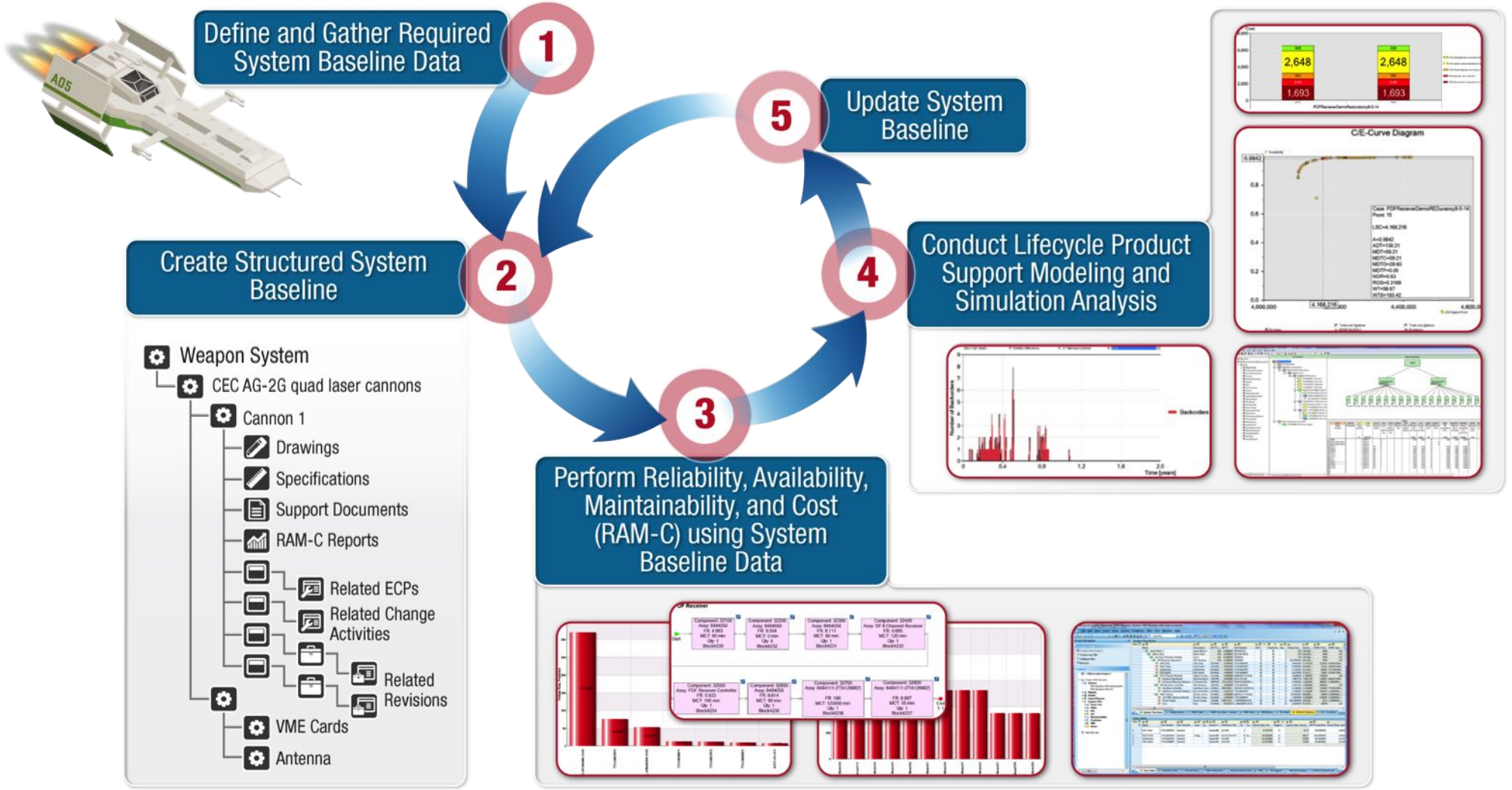
Bringing it Together: MBSE & MBPS

Using a Digital Twin with Digital Thread



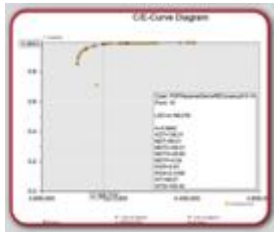
Both communities working from the digital twin within a collaborative environment to deliver affordable system capability

Applying MBPS to Starfighter Design



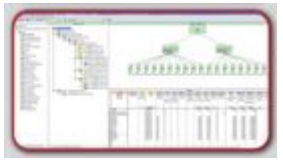
Enabling Affordable System Sustainment

How should new starfighter engines be designed to outrun the First Order's new Star Destroyer?



Create Ao vs cost models and compare designs using available product design data (drawings, 3D CAD models, technical manuals) to recommend using sublight engines modified with a higher reliability SLAM overdrive and hyperdrive capabilities to reach Class 0.5 drive and achieve higher MTBF

What is the trade-off between inventory on the shelf and engineering design changes for the quad laser cannons?



Create weapon system sparing models and conduct RAM-C analysis to determine that sparing levels do not require changes despite new mission requirements.

How can we improve the reliability of the three deflector shield generators?

Create RAM-C models and compare the reliability against operational availability, cost, and design considerations to determine that additional backup power generators will provide 90% reliability improvements.

Customer Feedback

This new starfighter has better weapons and shields, and still maintained full maneuverability!

This new design is affordable, dependable, and maintainable — the most reliable spacecraft in the Rebel fleet.

Summary

- Systems Engineers should engage the Product Support community in early stage design to optimize supportability and sustainment
- MBPS can be applied as an integrated approach with MBSE to define the system baseline
- Digital twin must support **both** MBSE and MBPS needs

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Kevin Weinstein, a Chief Engineer at Booz Allen Hamilton, is the Deputy Sector Director for the Americas having served as Assistant Sector Director for Chapter Relations since 2016, solving issues for chapters across the country. He has been a member of the INCOSE Washington Metro Area (WMA) chapter for over 10 years and was a member of the INCOSE WMA Board of Directors, serving twice as President and as Treasurer and Membership Chair. He holds a M.S. in Systems Architecture and Engineering from the University of Southern California, a B.S. in Systems Engineering with a second major in Economics from the University of Virginia, and relevant industry certifications (CSEP-Acq, OMG Certified Systems Modeling Professional – Model User, and PMP).

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