Measuring Supportability to Enhance Decision-Making

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A Method for Quantifying the Relative Benefits of Support System Improvement Alternatives

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Objective

- Introduce and Discuss a Method for Defining, Quantifying, Improving and Optimizing Supportability Throughout the Life Cycle of Physical Assets
- Present Results of an Actual Case Study for the Department of Defense

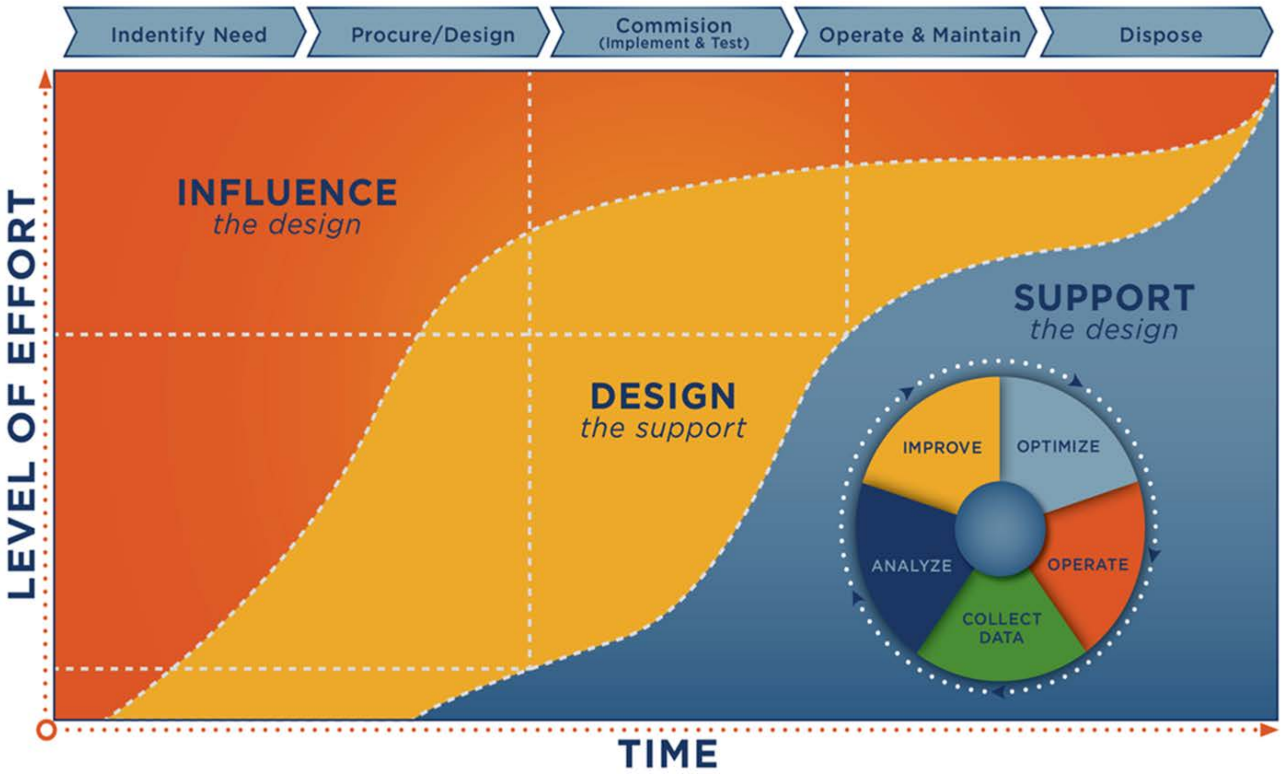
DoD Definition of Supportability

"Supportability : The inherent quality of a system - including design, technical support data, and maintenance procedures - to facilitate detection, isolation, and timely repair/replacement of system anomalies. This includes factors such as diagnostics, prognostics, real-time maintenance data collection, 'design for support' and 'support the design' aspects, corrosion protection and mitigation, reduced logistics footprint, and other factors that contribute to optimum environment for developing and sustaining a stable, operational system."

Designing and Assessing Supportability in DOD Weapon Systems: A Guide to Increased Reliability and Reduced Logistics Footprint - page 12.

Simplified Definition of Supportability

- Supportability is the ability and effectiveness of an asset, along with its support system, to achieve its desired performance over the life of the asset.
- Supportability is:
  - ➢ Influenced by both the design and of the asset and the design of the support system
  - ➢ Impacted by operating environment
  - ➢ A function of Reliability, Availability, Cost, and Safety

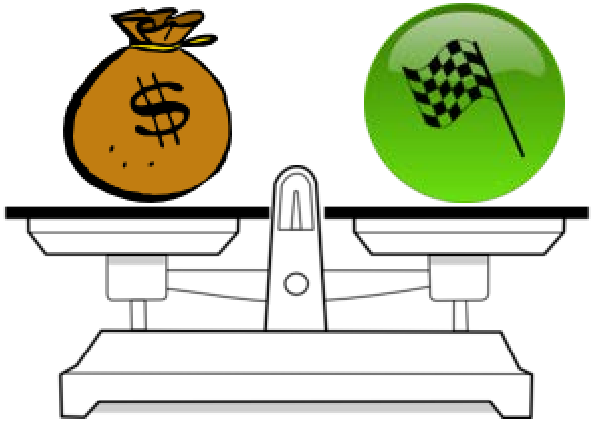


Problem Statement

- Currently, there is no quantitative measure of Supportability. Consequently, there is no method to evaluate the total impact to supportability for support system alternatives. Program Managers and Fleet Owners often make decisions that are sub-optimal, and fail to increase overall performance of the support system.

Today's Process

- Identifying top degraders and performing a root-cause analysis on selected components. For a given system in a finite time period, analysts:
  - **Dive into the Operational & Maintenance Data**
    - Understand which components were either the leading causes of system failure, or
    - Leading drivers of overall sustainment cost
  - **Analyze the Support System of these Components**
    - Identify the root causes that can be addressed
    - Obtain improvement in component metrics
  - **Analyze a Set of Viable Interventions Against the Root Causes**
    - Select the one that offers the best benefit to component performance
    - Perform Business Case Analyses



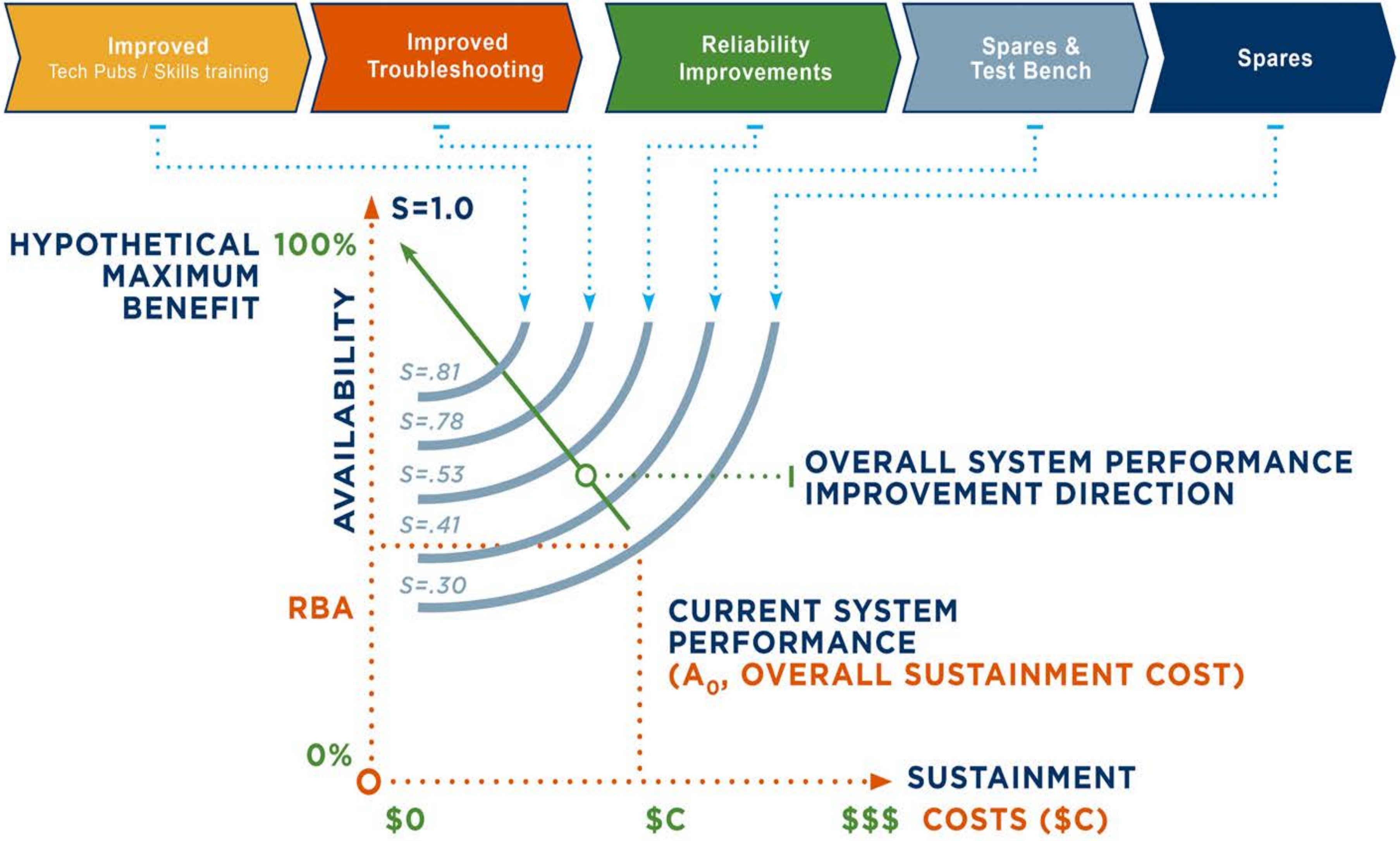
- ***Drawback.*** This is a constrained optimization problem and addresses a degrader which often involves shifting resources away from other components in the logistic system; thereby compounding the problem.

Current method to address the problem

- Currently Supportability is measured indirectly by using multiple discrete metrics
  - Reliability - Probability of no failures in a defined time period (R, MTBF etc..)
  - Availability – Percentage of time system available for use (Ao)
  - Maintainability – Time required to return an asset to service after failure (MTTR, EMT)
  - Cost – Life Cycle Costs, O&S Costs
- Because these metrics are not independent, using them to individually evaluate supportability will often not provide a complete picture
- In this presentation, we will present a method to measure supportability using an index - “S”

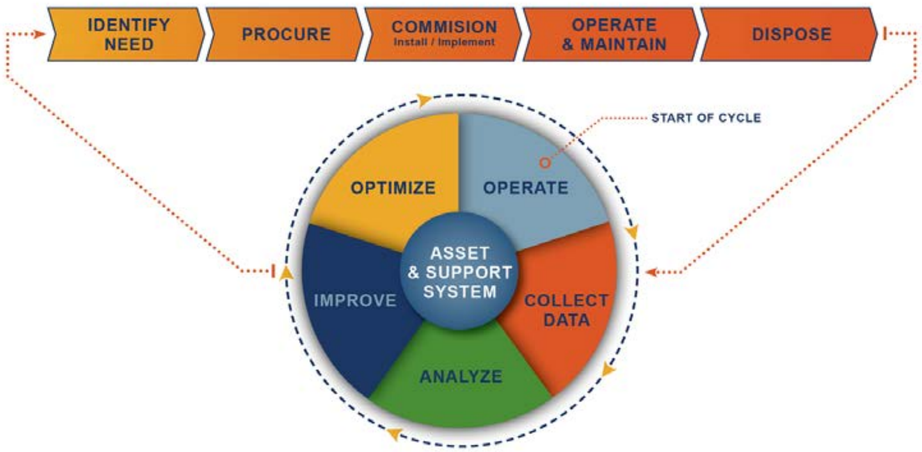
The “S” Concept

- *What changes to the logistics support structure can be cost-effectively implemented to move a weapons system from current performance to the targeted performance objective providing the highest possible supportability?*
- *Where is my Supportability dollar best spent?*

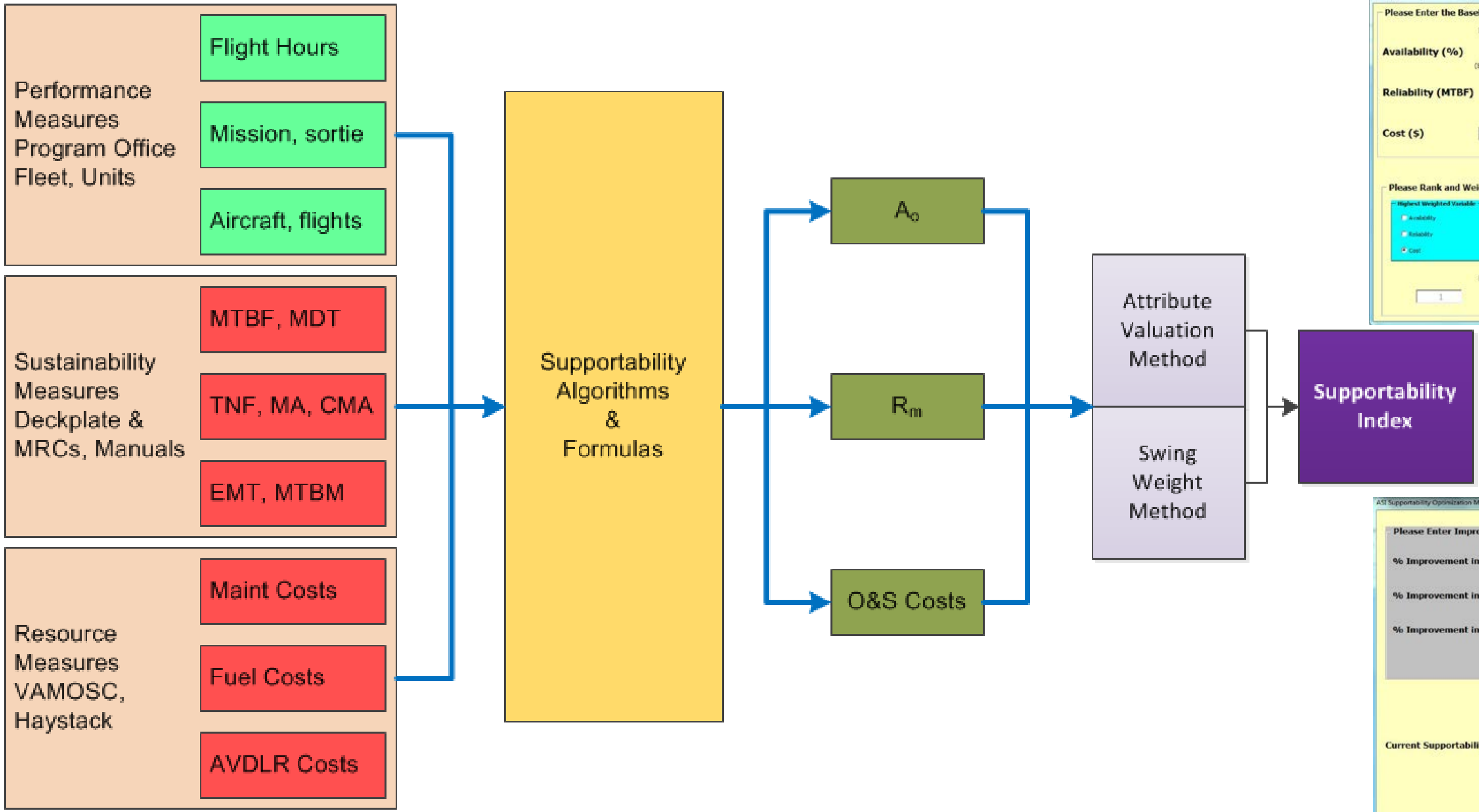


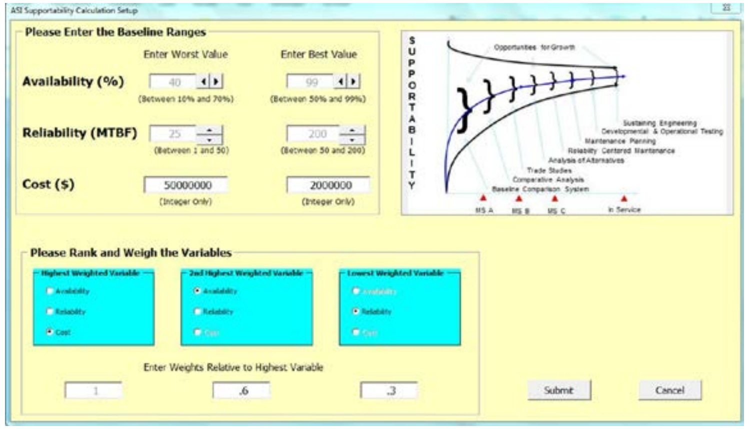
Calculating Supportability

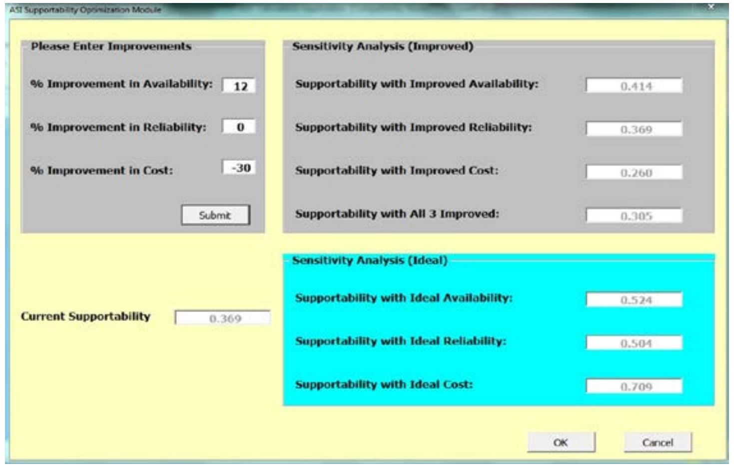
- $S = f\ (A_o, R_m,$ *& O&S Costs)*
- **Expressed** terms of PSE– *S > f } Maint Plan, Manpower, Supply, Supt Equip, Tech Pubs, Comp Resources, Facilities, etc…(mmssttcomfapad)*
- **Calculate** the contribution of PSE elements to *S*
  - *S = f } a(m)+ b(m)+ c(s)+ d(s)+ a(t)+ a(t)+ a(com)…*
- **Calculate** the contribution of S to KPPs and KPIs
  - *S = f } Ava, ME, Log Ft Print, FMC, NMC, PMC*



Supportability Computation Process

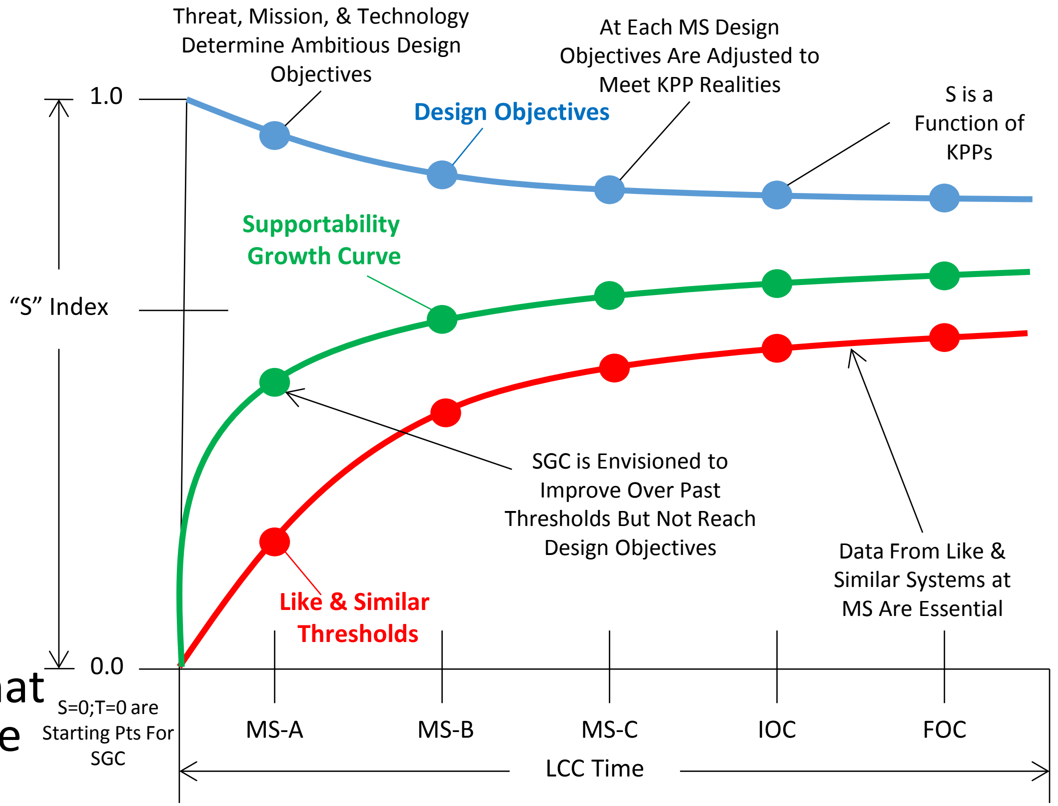






Improving Supportability ("S") – Supportability Growth Curve to:

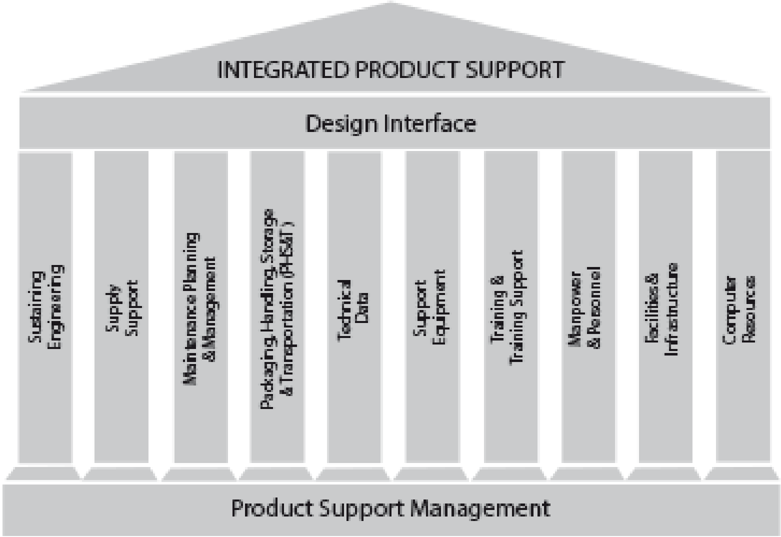
- ➢Understand How *Changes To Any Variable* In the Logistic Solution Affect the Performance Of the Entire Weapon System
- ➢Use This Capability To Find The Logistic System Variables That Have The *Greatest Impact* On Overall Weapon System Performance; Findings Include:
  - **Component-level Variables** such as Failure Rates, Spares Allocation, & Maintenance Turn-around Times
  - **Other Variables**, i.e. Labor Availability & Cost, Support Equipment Availability & Cost, Transportation Times & Cost at any of the Support Sites
  - **Analysis Results** In A Modified List Of "Top Degraders" That Point The Analyst In the Direction of Those Metrics Whose Change Would Yield the *Greatest Overall System Impact*
  - **Supportability Index Computations & SGC Plot**; see Figure



- ➢Interventions Must Be Evaluated Against This List Of "Top Degraders" By Taking Into Account the *Trade-offs* That Are Inherent & Understand How They Impact Other System Variables

Optimizing Supportability ("S")

Supportability Optimization is the process of maximizing the effectiveness of the support system in terms of asset performance and cost within given constraints. In other words, it is getting what you want out of your physical assets for the least cost over the long-haul, based on robust analytics, not just guesses. Supportability Optimization will answer the question: "Where will my next dollar provide the most impact on asset performance?"



Case Study

DoD's first prototype of utilizing the "S-Index" occurred when a DoD Program Office wanted to compare alternate maintenance concepts for the Armament Equipment

- Organizational Level to Original Equipment Manufacturer concept promised increased reliability, increased availability
- The prototype identified a Like and Similar (L&S) launcher that was being repaired at an Intermediate Level
  - Identified S-Index for both maintenance concepts, performing sensitivity analysis across multiple variables.
  - Provided recommendations based on quantifiable, defendable analysis that allowed Program Managers to clearly make decisions on the preferred maintenance concept.

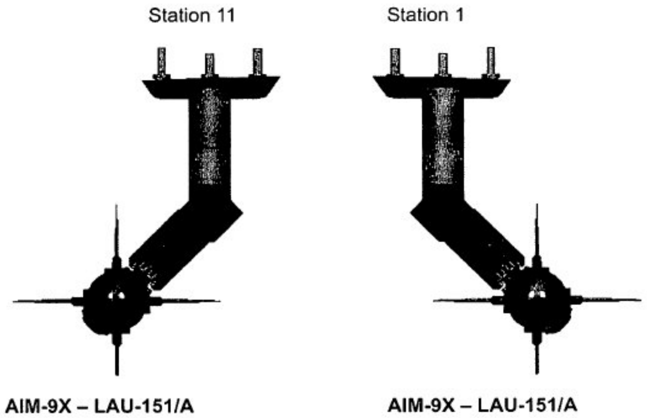
Performing Like and Similar Analysis

Our process for performing Like and Similar Analysis:

1. Photo comparisons
2. Drawing Comparisons
3. Feature Comparisons
4. Capabilities/Technology Comparisons
5. Parts Comparisons

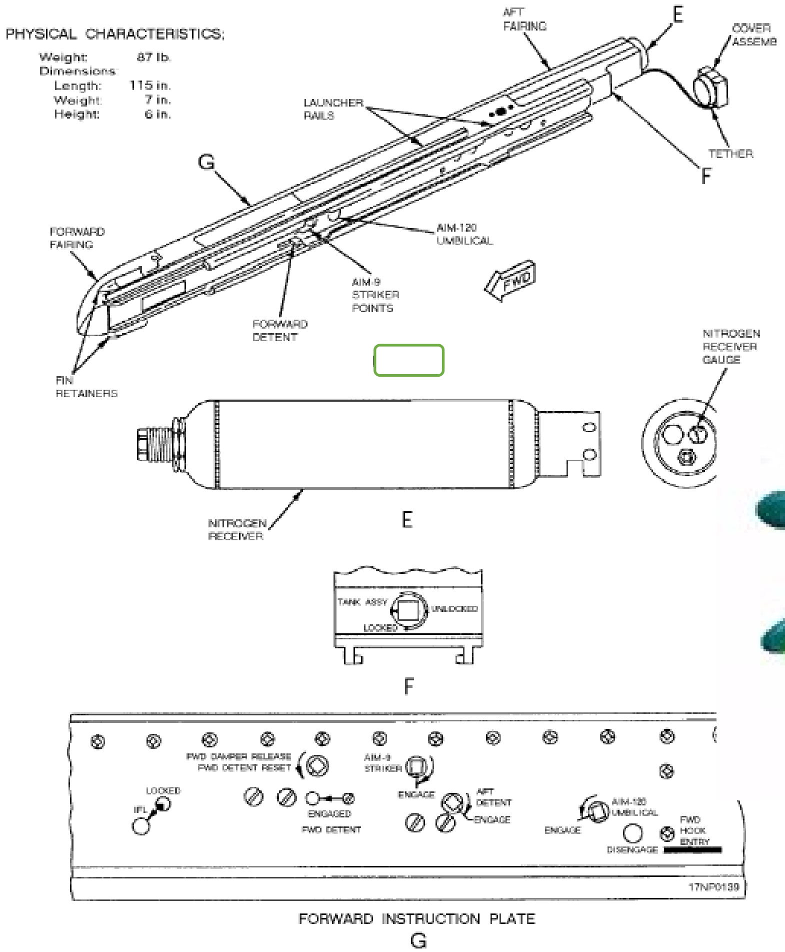
Photo Comparison

BCS Launcher

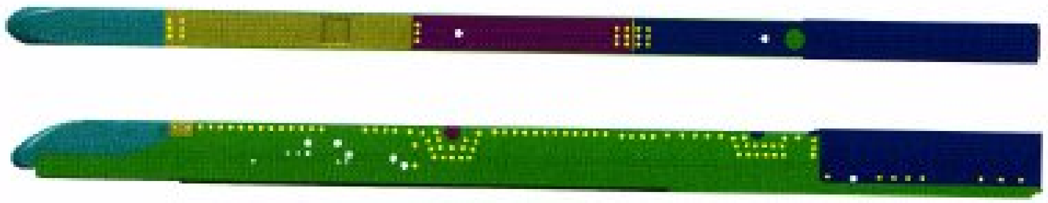


New Launcher

Drawing Comparison



BCS Launcher



New Launcher

Like & Similar Comparison

Feature Comparison

#	BCS	#	New
1	Electrical power system	1	Electrical power system with BIT
2	Non pyrotechnic	2	Non pyrotechnic
3	One rack per wing pylon	3	One rack per wing pylon
5	Rail structure, Actuator, Dampener, Detent Assemblies	5	Rail Structure, Actuator, Dampener, Detent Assemblies

Parts Comparison

#	BCS	#	New
1	Linear Electro-Mechanical Actuator	1	Linear Electro-Mechanical Actuator
2	Forward & Aft Detent Assembly	2	Forward & Aft Detent Assembly
3	Dampener Assembly	3	Dampener Assembly
4	Shoulder Shaft	4	Shoulder Shaft
5	Remote Control Lever	5	Remote Control Lever
6	Helical Compression Spring	6	Helical Compression Spring
7	Retainer Assembly	7	Retainer Parts & Pieces
8	Bell Crank Assembly	8	Bell Crank Assembly
9	Missile umbilical interface	9	Missile umbilical interface
10	D.C. Solenoid	10	D.C. Solenoid
11	Forward & Aft Fairing Assemblies	11	Forward & Aft Fairing parts & pieces

Comparison Results

Comparison	Check	%
Look & feel from photo comparison	✓	90%
Design & technology from drawing comparison	✓	85%
Capabilities from feature comparison	✓	90%
Similarity from sub-assembly comparison	✓	90%
Parts comparison	✓	80%
Summary (average of comparisons)	✓	87%

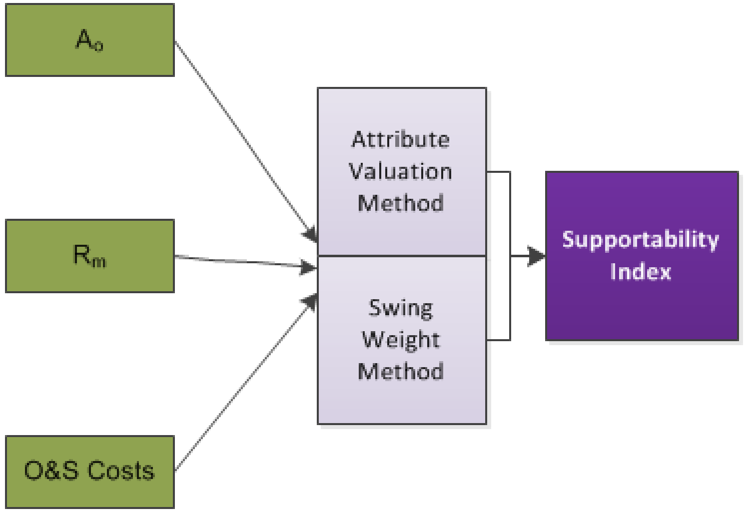
Supportability Metrics

BCS		New	
Metric	Value	Metric	Value
Fiscal Year	FY-2010	Fiscal Year	One year
Aircraft		Aircraft	
# of Aircraft	339	# of Aircraft	339
Flight Hours (0.75)	92,359	Flight Hours (0.75)	76,275
Flights (0.75)	57,831	Flights (0.75)	38,137
Replacement Cost	$ 79,400	Replacement Cost	$ 85,400
# of Removals	363	# of Removals	76,275/74=1,030
O-level CMA	5,054	O-level	N/A
I-level CMA	80	I-level CMA	N/A
Net repair cost	$ 31,760	Net repair cost	$ 34,160
AVDLR Costs	$ 4,986,320	AVDLR Costs	$ 35,210,189
# of BCMs	157	# of BCMs /R&R	1,030

Supportability Analysis BCS

$$S_{index} = \int(A_o, R_m, \text{O\&S Costs})$$

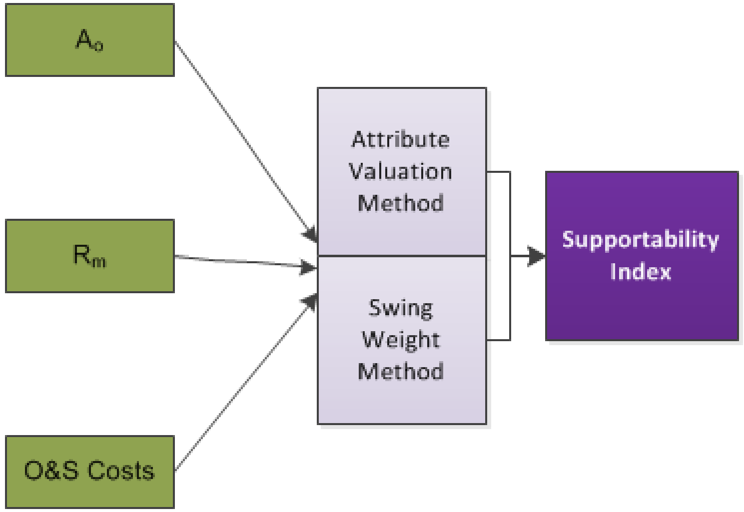
#	Variable	Calculation
1	A_o	0.819
2	R_m	67.61 FHs
3	O&S Costs	$ 6,420,640



Supportability Analysis New

$$S_{index} = \text{∫}(A_o, R_m, \text{O\&S Costs})$$

#	Variable	Calculation
1	A_o	0.919
2	R_m	74.05 FHs
3	O&S Costs	$ 35,481,008



Summary Comparison

BCS		New	
Variable	Calculation	Variable	Calculation
Availability	0.819	Availability	0.919
Reliability (MTBF)	67.61 FHs	Reliability (MTBF)	74.05 FHs
O&S Costs	$6,420,640	O&S Costs	$35,481,008
Cost/Flight Hour	$69.52	Cost/Flight Hour	$465.17
Cost/Aircraft	$18,940	Cost/Aircraft	$104,664
Supportability	0.589	Supportability	0.368

New System projected 10% improvement in Availability, at an increase of $29 Million (yearly estimate) in Sustainment Costs

Level of Repair Analysis Inputs

ITEM NAME	IND	UNIT COST	MTBF	Q/NHA
100 WRA	**1**	**$85,400**	**8,000**	**2**
201 launcher subassy	2	$10,736	60,267	1
202 forward fairing	2	$488	328,727	1
203 aft fairing	2	$2,928	241,067	1
204 forward cover	2	$1,952	361,600	1
205 center cover	2	$1,952	361,600	1
206 door assy w/ box and slide	2	$976	328,727	1
207 detent assy	2	$24,400	28,928	1
208 actuator assy	2	$11,712	60,267	1
209 MRIU	2	$14,640	90,400	1
210 wiring harness	2	$3,904	72,320	1
211 forward dampening assy	2	$11,712	60,267	1
212 aft dampening assy	2	$11,712	60,267	1
213 HMM	2	$9,760	60,267	1

Summarized Life Cycle Cost Estimates

ALT	WRA	SRAs	LCC	COMMENTS
A	O+	O+	$5,623,000	
B	O+	D_{ORG}	$5,977,000	
C	O+	D_{COMM}	$14,572,000	
D	D_{ORG}	D_{ORG}	$61,445,000	WRA repair cost = $34,160, that is, 40% of unit cost of $85,400
E	D_{COMM}	D_{COMM}	$42,772,000	WRA repair cost = 28% of unit cost
F	D_{COMM}	D_{COMM}	$66,926,000	WRA repair cost = 45% of unit cost (more likely, if not higher)
OPT	O+	O+	$5,623,000	fully optimized WRA and SRA LOR code assignments - same as ALT A
SA_{8000}	O+	O+	$5,623,000	8,000 WRA MTBF Baseline
SA_{6000}	O+	O+	$7,533,000	6,000 WRA MTBF - no changes to Baseline optimized LOR code assignments
SA_{4000}	O+	O+	$10,906,000	4,000 WRA MTBF - no changes to Baseline optimized LOR code assignments

Note 1: New Launcher– Based on 8000 hour MTBF and planned flight operations
Analysis based on Mil Std 1390D & NAVSUP RIMAIR / ARROWS sparing process

Level of Repair Analysis Recomendations

ITEM NAME	IND	LOR
100 WRA	1	O+
201 launcher subassy	2	O+
202 forward fairing	2	O+
203 aft fairing	2	O+
204 forward cover	2	O+
205 center cover	2	O+
206 door assy w/ box and slide	2	O+
207 detent assy	2	O+
208 actuator assy	2	O+
209 MRIU	2	O+
210 wiring harness	2	O+
211 forward dampening assy	2	O+
212 aft dampening assy	2	O+
213 HMM	2	O+

Recommendations & Options

- Complete a maintenance task analysis (MTA) on all AME
- MTA should be driven and traced to FMECA/RCM Analysis
- Consider O-plus as an option to mitigate costs and improve Supportability
- Adopt BCS maintenance concept
- Conduct Sensitivity Analysis to evaluate various scenarios and impact to Readiness and Supportability

Questions