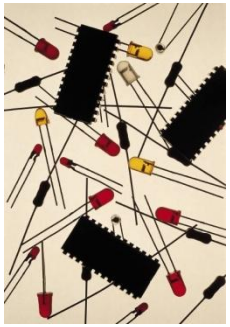
Obsolescence Issues for LHC Electronics

Vincent M. Spellane
DMSMS Subject Matter Expert
Lockheed Martin Co.

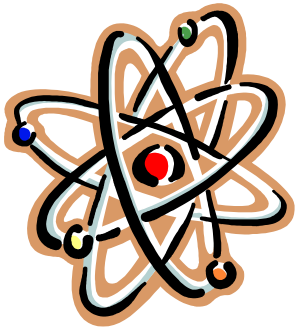


LOCKHEED MARTIN

How do you prevent valuable experiments from getting delayed or worse yet cancelled due to parts obsolescence of equipment ?

End of Life (EOL)

Parts Obsolescence

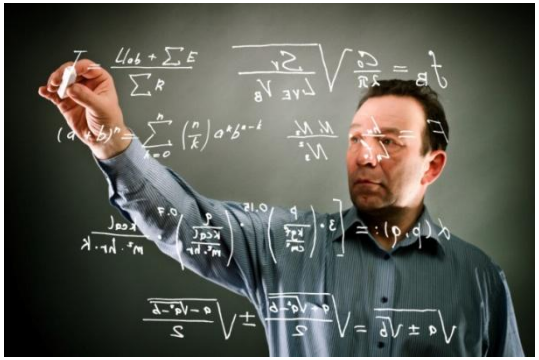


Diminishing Manufacturing Sources and Material Shortages (DMSMS)

Can you afford to shut the LHC down unnecessarily ?

How do you focus your brain power on LHC discoveries , and avoid one of the traps of end of life issues:

The DMSMS problem consumes more valuable resources as time goes on and equipment ages; Taking away time from more valuable work by the engineers and scientists.



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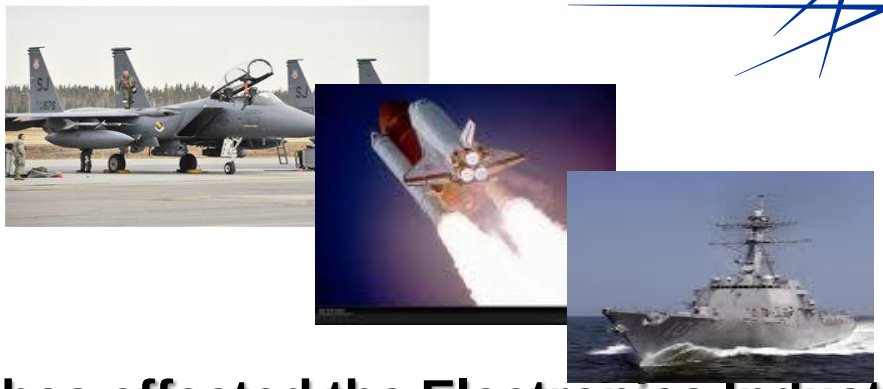
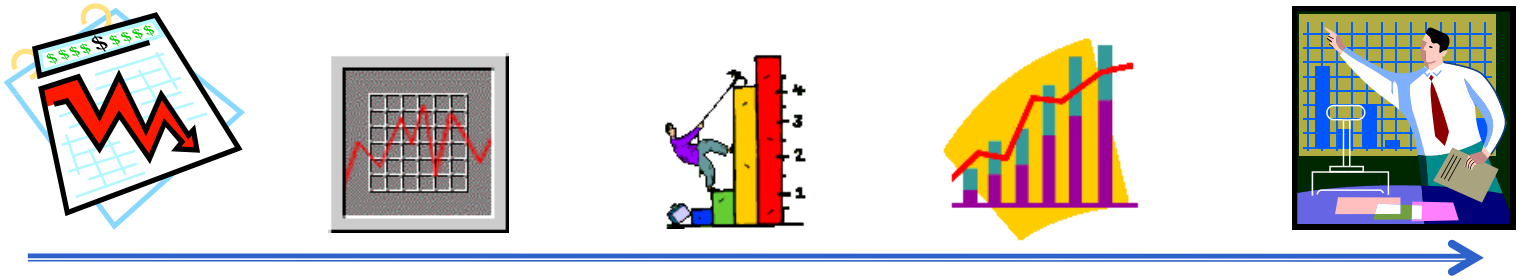
My presentation will:



Describe the problem and how it has effected the Electronics Industry and Lockheed Martin

Give a historical perspective on the development of DMSMS management and how solutions for DMSMS problems have advanced over time



Advise I would pass along from my experience in DMSMS Management

What Can Lockheed Martin Can do for you

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Vince Spellane
DMSMS Subject Matter Expert
Lockheed Martin
Global Sustainment

25 years of aerospace industry experience as an Analog Design Engineer, Systems Engineer and DMSMS Engineer.

I have published 9 papers on DMSMS, presented at 7 national conferences, and have 12 years DMSMS Engineer and DMSMS management experience

I've worked on military flight controls, military and commercial engine controls, military and commercial cockpits, mission systems equipment and also have experience in aircraft power and hybrid vehicle power generation systems .

I was the technical lead for 2 major supply chain purchase agreements with microcircuit and semiconductor technology companies in excess of $400 million each.

I was a communications instructor for 5 years and I am also a high school football referee

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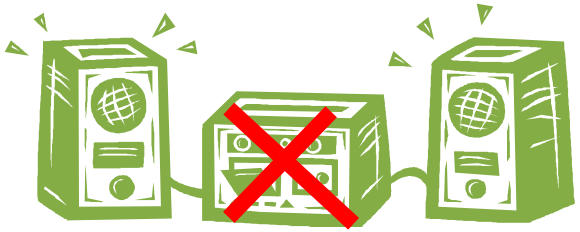
The DMSMS Problem



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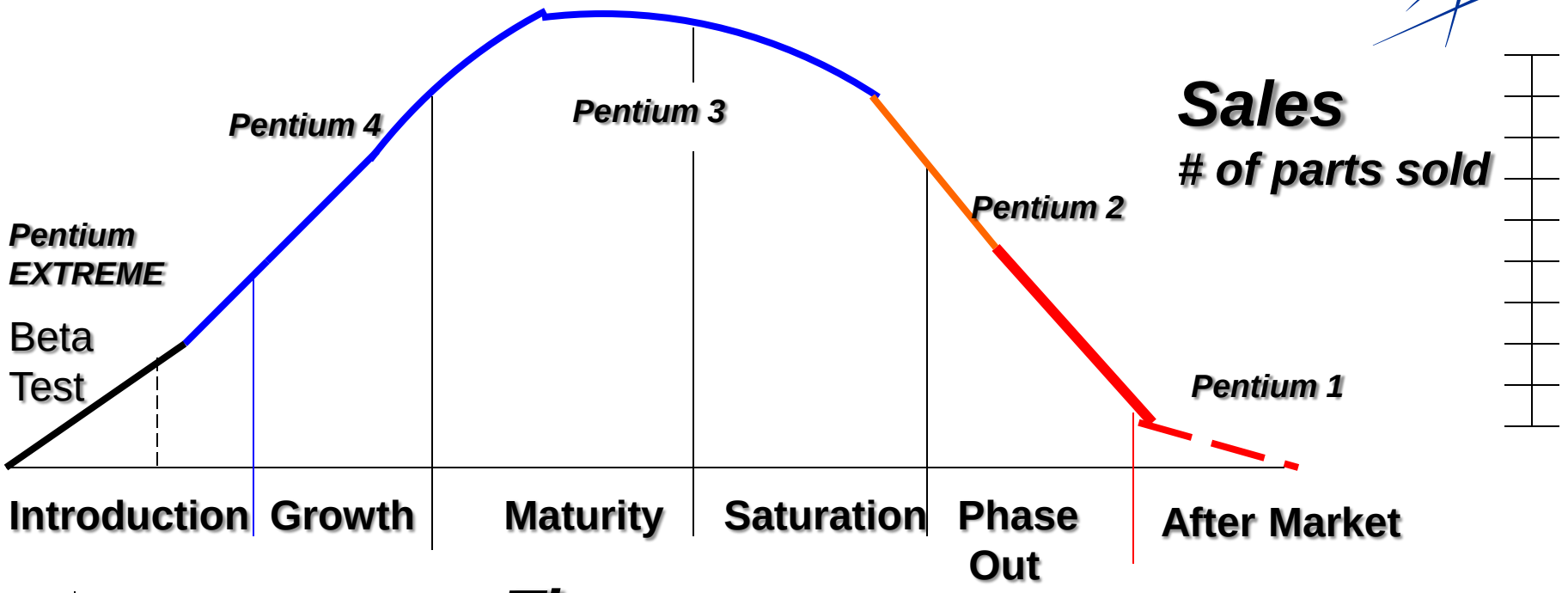
Electronic Component Life Cycle



Memory Devices	3 years
Digital Logic Devices	7 years
Analog Devices	10 years

Intel® Pentium®

Helicopter Aircraft  20 – 25 years

This Electronic Component life cycle is driven by Technology and Market factors

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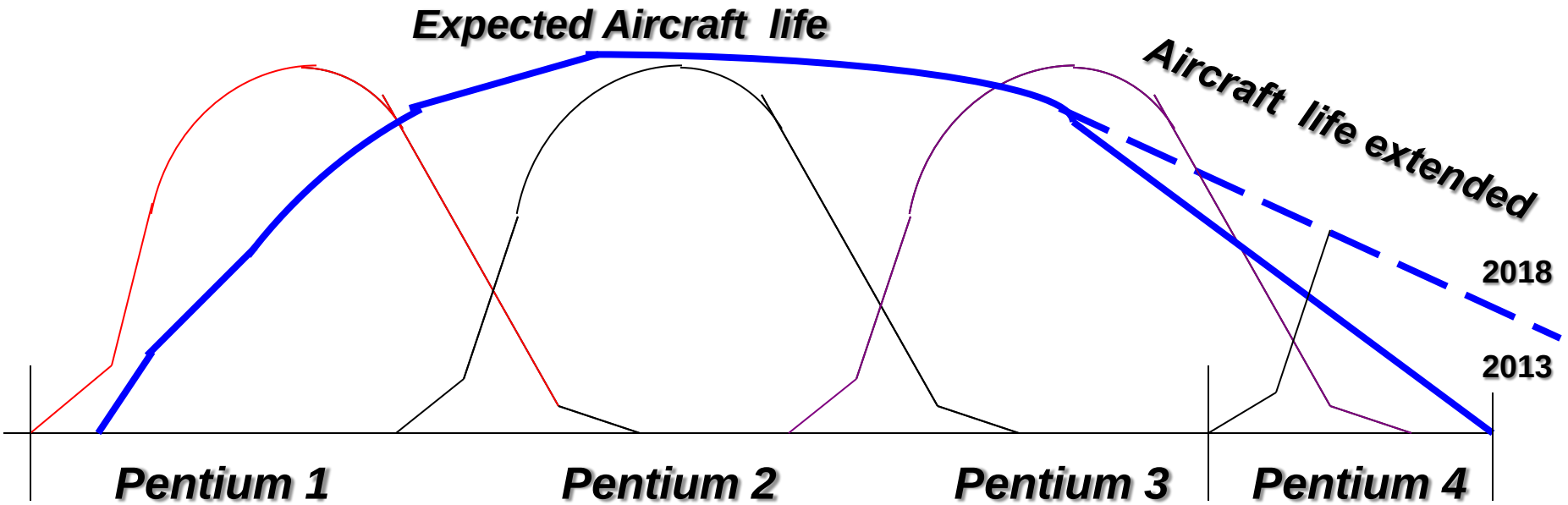
Magnitude of the Problem



1993
Pentium 1 introduced

2005
Pentium 4 introduced

Actual dates for Pentium family introductions resulted in 3 microprocessor upgrades over 12 years of aircraft life.

Microprocessors require a large amounts of hardware and software qualification.

Intel® Pentium®

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DMSMS Problem for Lockheed Martin

- **Lockheed Martin Co. demands the highest mission capabilities of its products**
- **Achieved by using the latest technologies available on the market**
- **Many of these technologies are designed for commercial use applications**
- **Life cycle of the piece parts we use do not match the lifecycle of the aircraft, ships, trucks or electronic equipment we supply**

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DMSMS Problem for Lockheed Martin

- Creates a problem when piece parts are not available, or no longer manufactured
- Referred to as a Diminishing Manufacturing Sources and Material Shortages (DMSMS) Issues
    - Parts Obsolescence Issues
    - End of Life (EOL)
- Requires continuous management for cost effectively dealing with these issues, for meeting fleet sustainability, and availability requirements
- Lockheed Martin cannot have gaps in the availability of equipment we supply to the US military, lives are dependant upon the equipment being ready for use when called upon
- A commercial Aircraft (i.e. Boeing 777) waiting for a part, for the build to be complete and then to be delivered to an Airline, could costs over a $1 million in penalties for everyday it is delivered late

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Where are we today?

Electronic Content on everything the DOD purchases is on the rise
<u>This magnifies the Risk</u>

The Focus is shifting from solving DMSMS problems to adding Mission Capability to the systems while managing DMSMS problems

Budgets are constrained due to DMSMS problems increasing

COT's equipment content & the average system's age are increasing

Short and Long Term Solutions must be engaged with each other

Modernization and Sustainment Plans developed for equipment

You need a tool set, experienced DMSMS Engineers to properly solve DMSMS (it is an information game)

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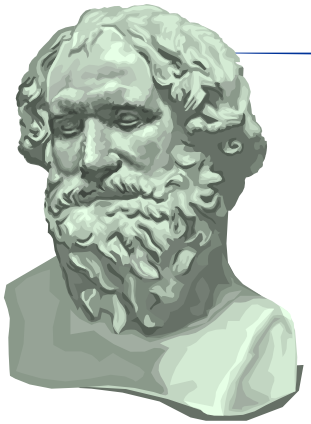


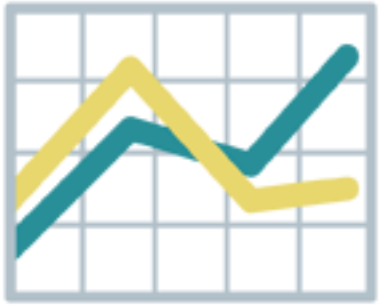
Some Historical Perspective

How we perform DMSMS Management

Tasks to Perform

DMSMS Management Theory

Analysis that helps us



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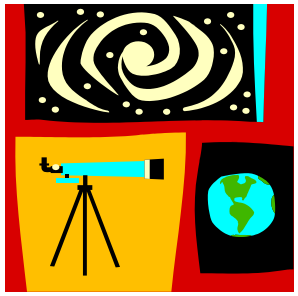
DMSMS Management Approach

System includes these basic elements:

Proactive Management: **(Understanding DMSMS risks)**

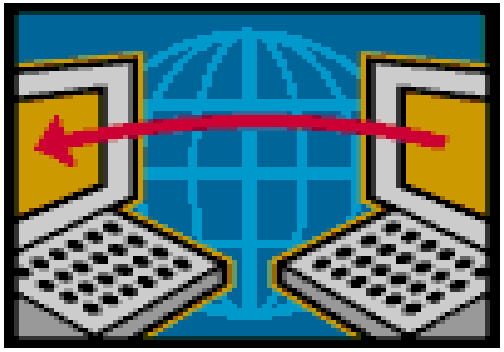


- Predicting Risks
- Budgeting or scheduling for DMSMS
- High risk items identified
- Management of Supplier DMSMS information
- Mitigation set of solutions

Technology Roadmap

Reactive System: **(respond to issues)**

- Capable of responding quickly
- Items should be easily replaced



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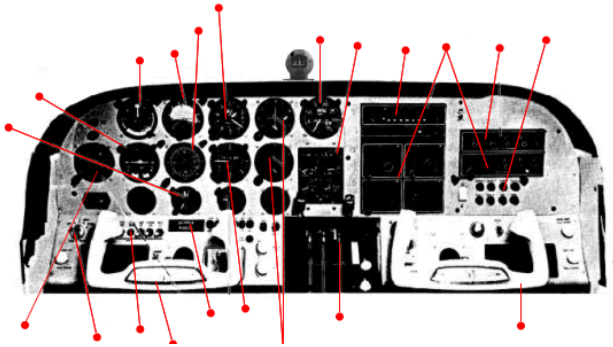
Equipment Evaluation

"One sizes doesn't fit all."



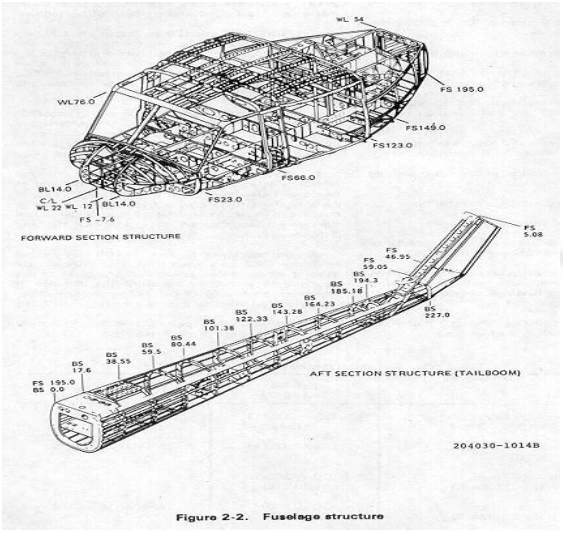
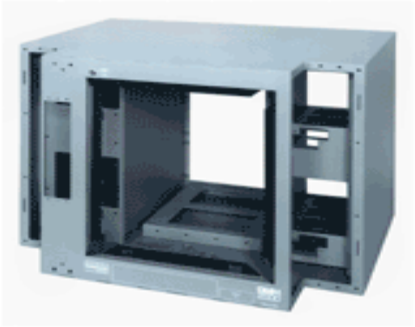


Figure 2-2. Fuselage structure



Different Levels of DMSMS management must be applied to different types of equipment.

An analysis and approach should be chosen for each piece of equipment (Line item) based on several factors:

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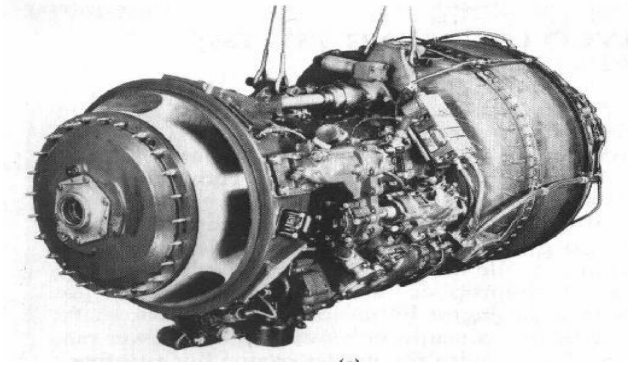
Equipment Evaluation

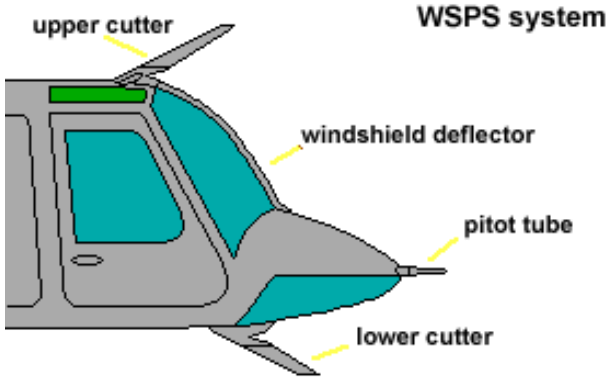
A more rigorous DMSMS management approach should be considered for:

- **Flight or Mission critical equipment**
- **Potential consequences of a failure**
  - **If loss of life could occur if equipment malfunctions**
  - **If potentially the mission would have to be aborted**

Main Computer



Engine



Cockpit exterior

Must understand ”the Mission” to properly protect against DMSMS, work with the buyer to understand the mission.

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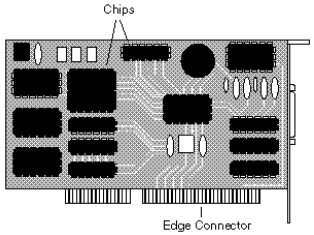
Equipment Evaluation

A more rigorous DMSMS management approach should be considered for:

- **Equipment with high electronics content**
- **Equipment with high DMSMS risks**
- **Equipment with high DMSMS consequence**



Determine where your DMSMS risks are and focus your program setup strategy to mitigate these risks

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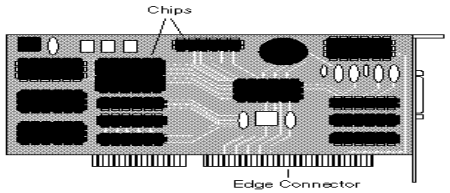
Equipment Evaluation



If applying a Robust DMSMS management strategy at the system or WRA level, less robust DMSMS management may be adequate at the board or piece part level.

<u>For Example:</u>

If you have multiple cockpit displays that can be used, you may not need to spend a lot of money at the piece part or board level to solve DMSMS issues. Your DMSMS solution would be to use one of the other alternate displays; Rather then solve every piece part issue on the display,

Consult with the prime contractor to consolidated DMSMS risk avoidance strategies that minimize mitigation costs.

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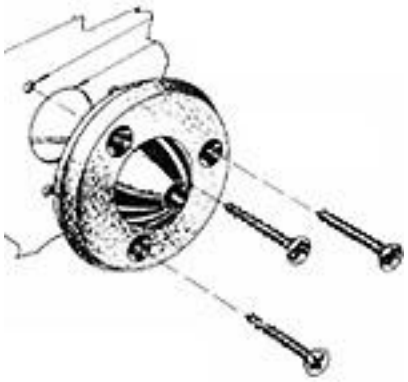
Equipment Evaluation

A Less rigorous approach can be used for non-active or non- critical equipment



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Your Reactive Approach

DMSMS System includes:

Process for finding DMSMS issues
Team member to verify that the issue exists
Determine what equipment is effected by the issue
Solution set for the issue (short and long term)
Analyze the cost of solutions
Resolution selected
Resolution enacted
DMSMS tools BOM's updated

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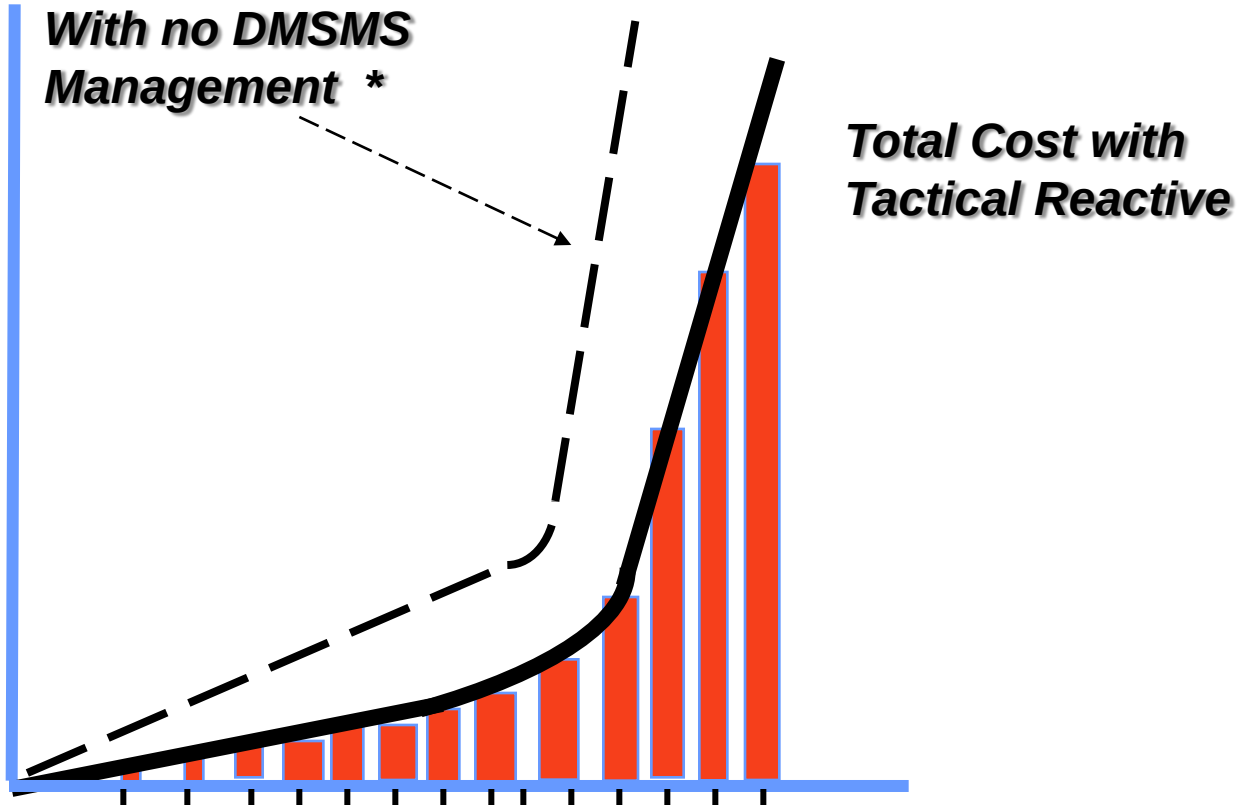
Why higher levels of Sustainment are needed?
Cost to Solve DMSMS Over Time



Add up Cost for each issue

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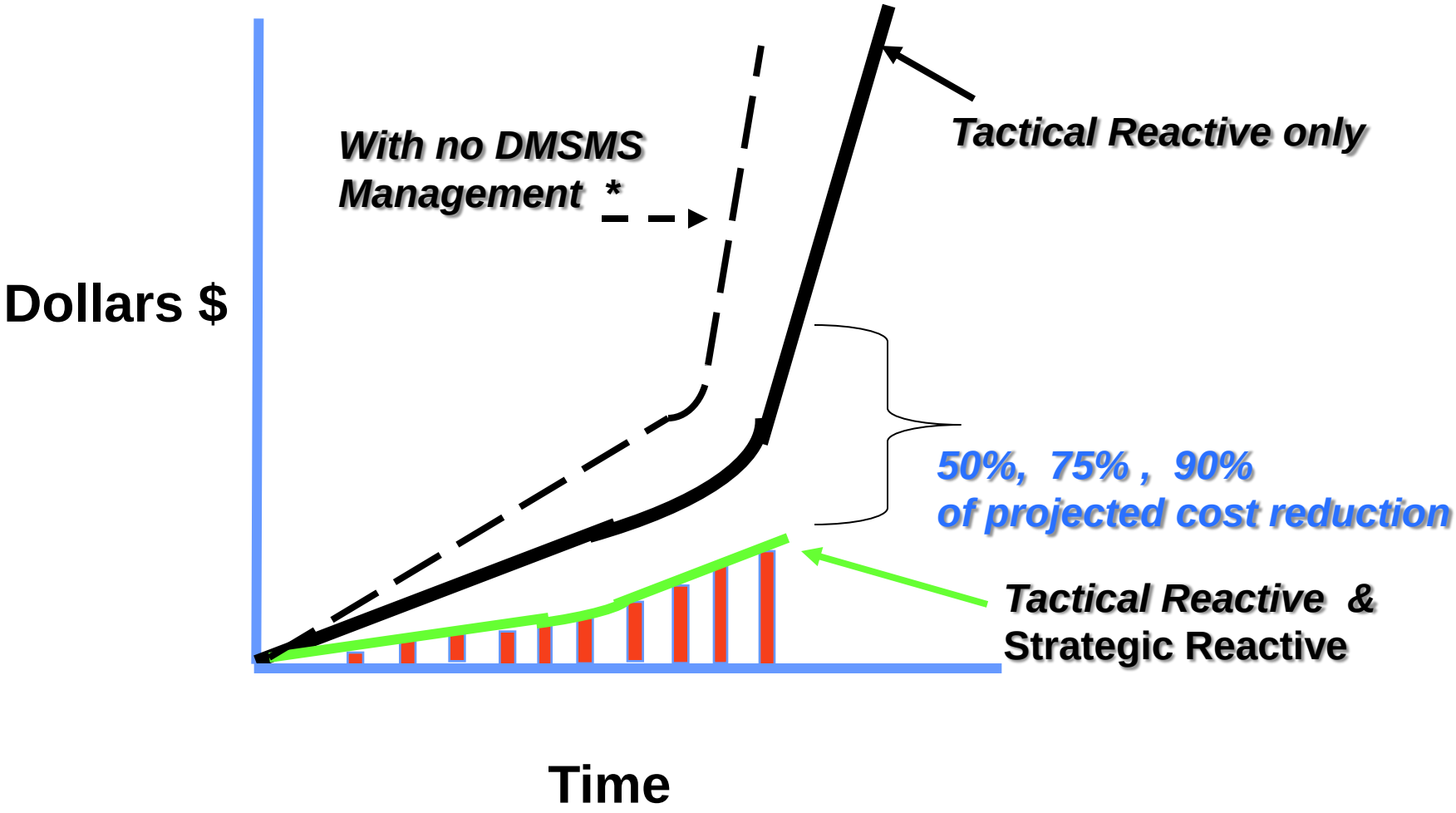
Cost to Solve DMSMS Over Time With strategic reactive



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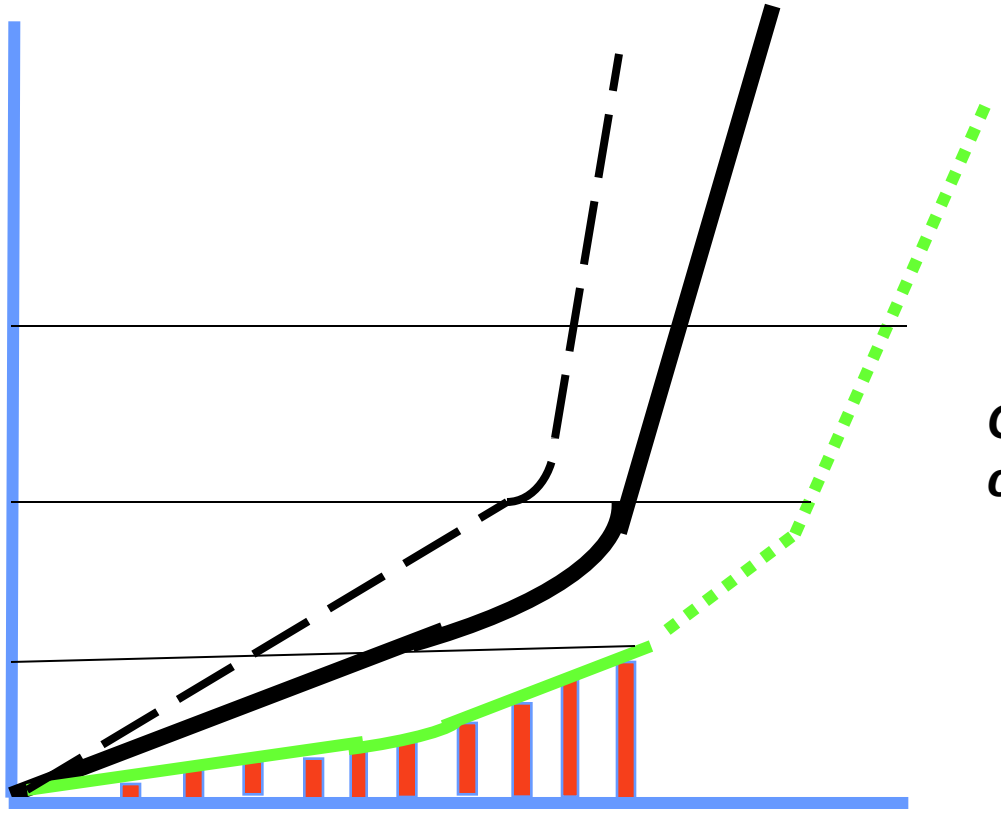
Cost to Solve DMSMS Over Time With strategic reactive



Cost will eventually climb

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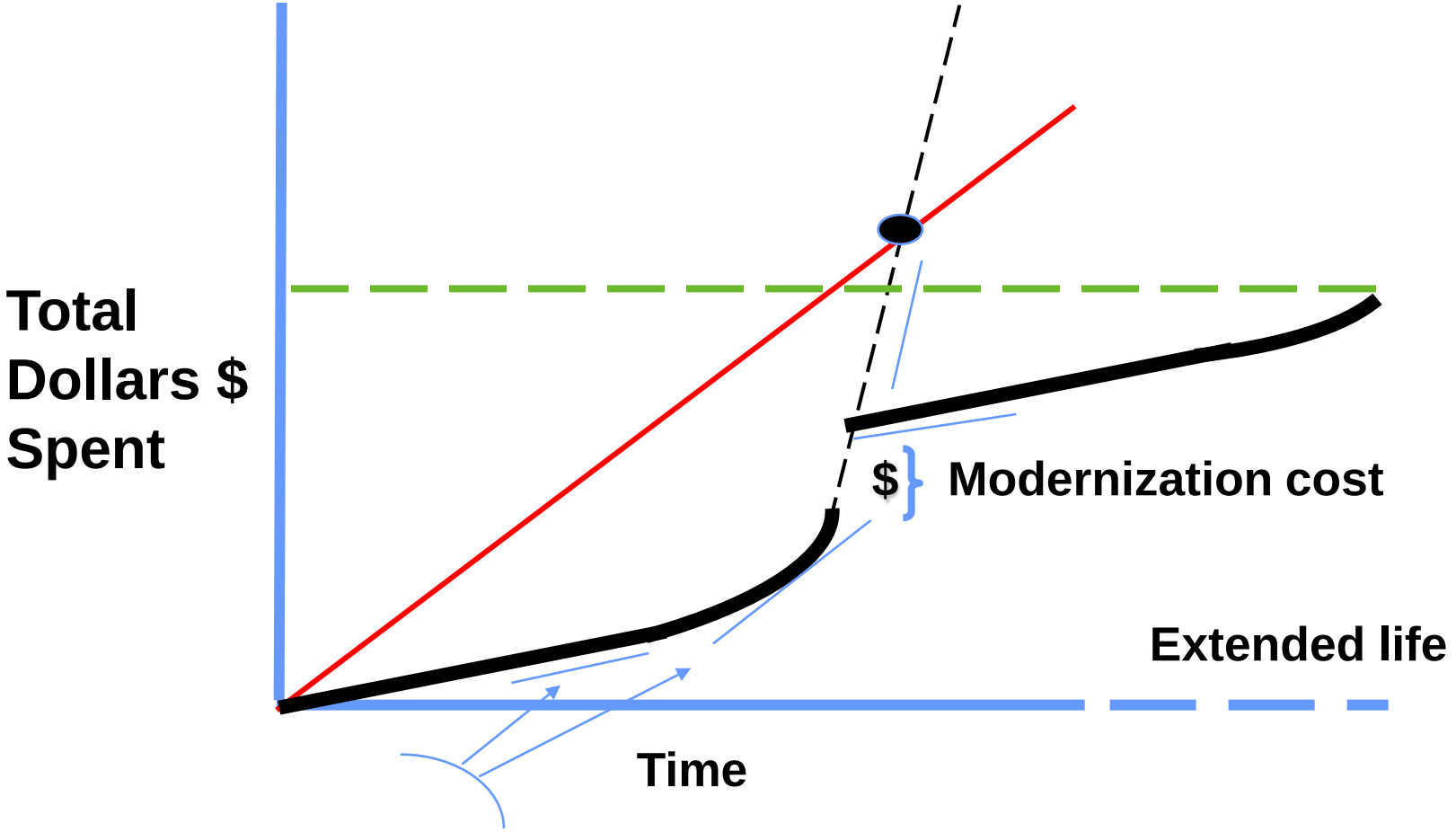
Sustainment vs. Modernization



The slope of these Curves help determine your best value solutions
(slope determined with Calculus equations for easy analysis)

Finding the right timing can reduce program cost and extend life.

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Proactive DMSMS Team

Over the last few years the whole scope of the DMSMS team has changed

Component Engineering Problem:
Originally the focus of solving DMSMS was at the piece part level.

Now it is a multi-team effort:
Components, Design, Systems, Software, ILS Engineering and Program Management
It is a comprehensive look at the entire subsystem, that includes technology insertion plans, program plans, budgets, desired additional mission capability, technology tracking.
Resolutions are defined at the part level, board Level (SRU), box level (WRA or LRU) and subsystem level.

Without a top to bottom look at resolutions you cannot guarantee you have solved it in the most economical, value added way that is best for the end user (Your Customer the most important person)

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Integrated DMSMS / Sustainment Team

Lockheed Martin Team

Manufacturers
- Notices
- New Products
- Contacts

Supplier Management
- Data Flow
- Plan Execution

Tools
- Q-Star MS2 Database
- Haystack
- Web Tools
- SE-flyfisher
- MS2 Tools Set

Component Engineering
- BOM Monitoring
- Identification Lead
- Supplier Contacts
- LTB Execution

Materials Engineering
- Resolutions Analysis
- Materials Analysis
- Technology Insertion Plans

Technology Team – SME's
- Technology Selection Review
- Road-mapping
- Technology Insertion Plans

D M S M S / Sustainment Knowledge

ILS DMSMS Team

Reporting
DMSMS Prediction
DMSMS Plans

DMSMS Lead

Resolution Costs
DMSMS Issues
DMSMS Training

Program Analyst
Manufacturing
Systems Engineering
Hardware Engineering
Reliability Engineering

"Program Specific Solutions"

DMSMS Program Team

Program Manager
Associate Program Manager

Value

Customers

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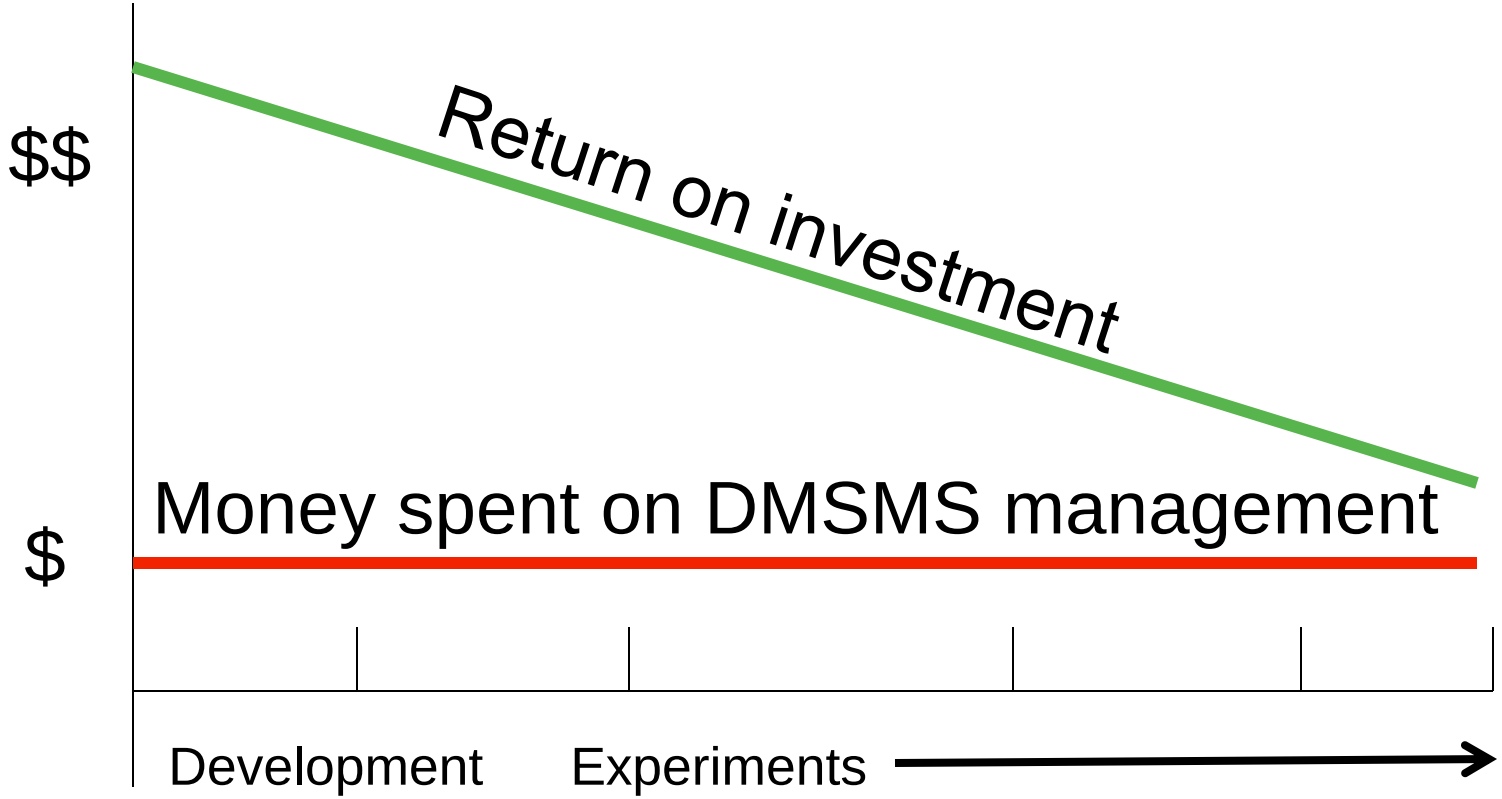
Why it's important to start in the process early



DMSMS proactive actions result in better value for the LHC

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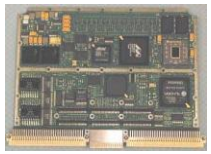
DMSMS management cross functional approach







Proposal | Development | Manufacturing | Field Service | Spares

Drive DMSMS management earlier in the process;
Involve more disciplines into the DMSMS management process

Demonstrated advantages in DMSMS management.

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DMSMS System Objectives

DMSMS System Inputs

- BOM
- DMSMS data
- Research
- Supply Chain
- Sustaining Engineering
- Contract & Funding Cycles

DMSMS Reports

BOM's

Issue's Tracking

CDRL's

Sustainment Analysis Tools

" Sustainment Options"

- Piece Part PEOL
- Health Out-Look
  - Sub-component / Box
  - Aftermarket Stock
  - Cost of EOL
- Mitigation Plans
- Sustainability Analysis

Decision Makers / Commanders

Best Value Decisions

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Analysis & Reporting

DMS Basic Analysis

Standard Reporting Structure

Lockheed Martin Part Number	Manufacturer Part number	Status	PEOL date	suppliers	Manufacturer	Assy or Piece Part	Part Type	Solution
Part 1	**CY28325-2**	**R**	**3/30/2006**	**0**	**Cypress**	**PP**	**Clock**	**LTB complete**
Part 2	OP210	Y	12/30/2006	1	Analog	PP	Analog Switch	Add Alternate to the drawing - in progress
Part 3	S25FL	Y	9/30/2008	1	AMD	PP	Flash Memory	1 alternate identified 10/17/06
Part 4	LM139A	G	3/30/2010	2	Analog	PP	Comparator	2 suppliers still active
Part 5	LM139A	G	3/30/2010	2	TI	PP	Comparator	2 suppliers still active

Predicted availability of each piece part

Strengths: **Low cost analysis, determines immediate or upcoming problems. Good for out of production and spare orders. Can be generated fairly quick Allows for budgeting for DMSMS issues. Should be available for all parts under consideration for selection.**

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This is what a DMSMS Analysis over time might look like

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Part 1	R	R	R	R	R	R	R	R	R
Part 2	Y	R	R	R	R	R	R	R	R
Part 3	G	Y	R	R	R	R	R	R	R
Part 4	G	G	Y	R	R	R	R	R	R
Part 5	G	G	Y	R	R	R	R	R	R
Part 6	G	G	G	Y	R	R	R	R	R
Part 7	G	G	G	Y	R	R	R	R	R
Part 8	G	G	G	G	Y	R	R	R	R
Part 9	G	G	G	G	Y	R	R	R	R
Part 10	G	G	G	G	Y	R	R	R	R
Part 11	G	G	G	G	G	Y	R	R	R
Part 12	G	G	G	G	G	Y	R	R	R
Part 13	G	G	G	G	G	Y	R	R	R
Part 14	G	G	G	G	G	Y	R	R	R
Part 15	G	G	G	G	G	Y	R	R	R
Part 16	G	G	G	G	G	Y	R	R	R
Part 17	G	G	G	G	G	Y	R	R	R
TOTAL EOL	1	2	3	5	7	10	17	> 17	>17

CPU, Memory component

Analog component

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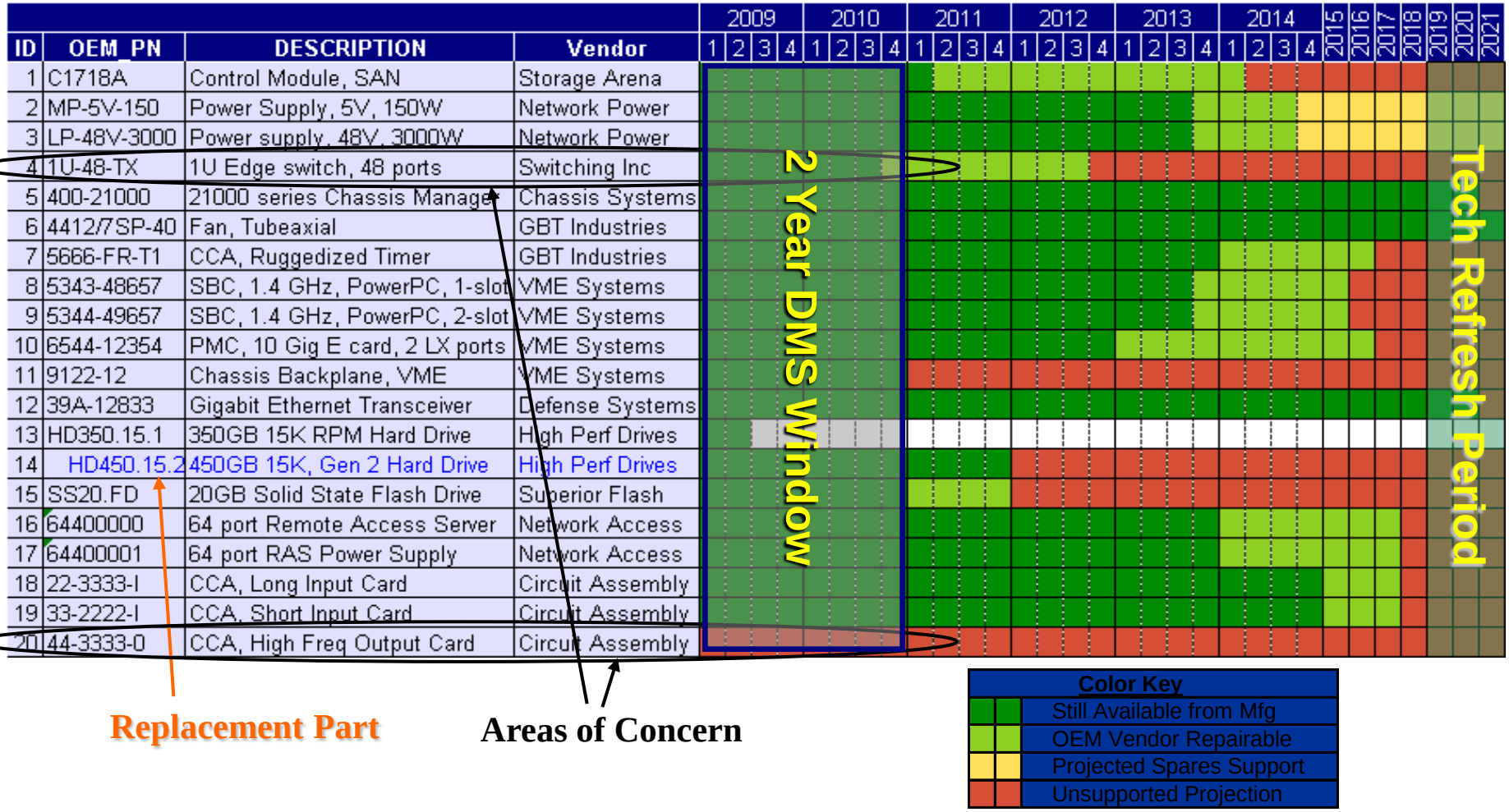
COTS2 – Reports: Health Chart Example



ID	OEM_PN	DESCRIPTION	Vendor
1	C1718A	Control Module, SAN	Storage Arena
2	MP-5V-150	Power Supply, 5V, 150W	Network Power
3	LP-48V-3000	Power supply, 48V, 3000W	Network Power
4	1U-48-TX	1U Edge switch, 48 ports	Switching Inc
5	400-21000	21000 series Chassis Manage	Chassis Systems
6	4412/7SP-40	Fan, Tubeaxial	GBT Industries
7	5666-FR-T1	CCA, Ruggedized Timer	GBT Industries
8	5343-48657	SBC, 1.4 GHz, PowerPC, 1-slot	VME Systems
9	5344-49657	SBC, 1.4 GHz, PowerPC, 2-slot	VME Systems
10	6544-12354	PMC, 10 Gig E card, 2 LX ports	VME Systems
11	9122-12	Chassis Backplane, VME	VME Systems
12	39A-12833	Gigabit Ethernet Transceiver	Defense Systems
13	HD350.15.1	350GB 15K RPM Hard Drive	High Perf Drives
14	HD450.15.2	450GB 15K, Gen 2 Hard Drive	High Perf Drives
15	SS20.FD	20GB Solid State Flash Drive	Superior Flash
16	64400000	64 port Remote Access Server	Network Access
17	64400001	64 port RAS Power Supply	Network Access
18	22-3333-I	CCA, Long Input Card	Circuit Assembly
19	33-2222-I	CCA, Short Input Card	Circuit Assembly
20	44-3333-0	CCA, High Freq Output Card	Circuit Assembly

Color Key

- Still Available from Mfg
- OEM Vendor Repairable
- Projected Spares Support
- Unsupported Projection

Replacement Part

Areas of Concern

Health charts display system "health" at a more granular level, providing information at the part level

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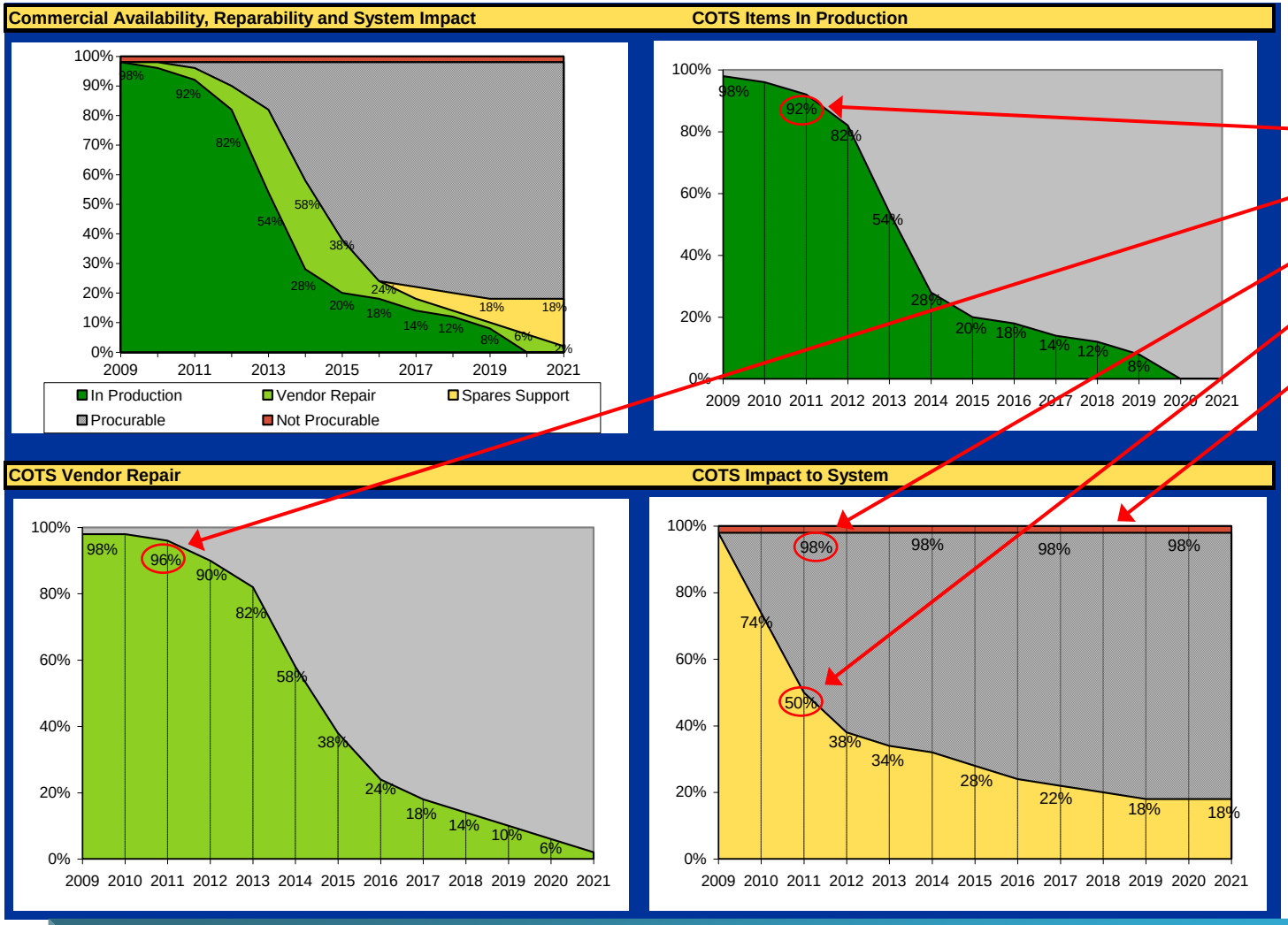
COTS2 – Reports: Obsolescence Curve Example



At the end of 2011,

In production: 92%

Repairable: 96%

Supportable: 98%

Spares Support: 50%

Not Supportable: 2% *

**** Parts that are DMS that need resolution ASAP***

COTS Obsolescence curves graphically display baseline health at a high level. Red and cross-hatched zones require action.

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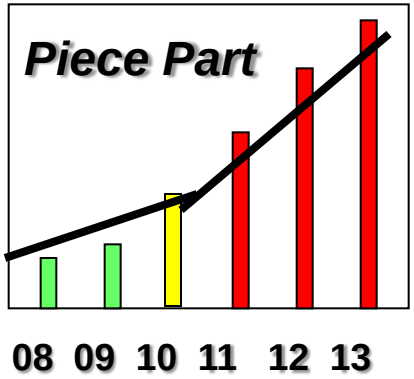
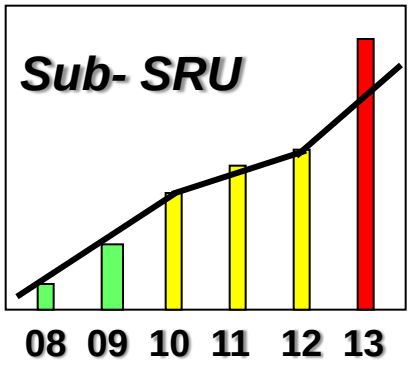
We develop multi-level sustainment data from piece part data for each piece of equipment

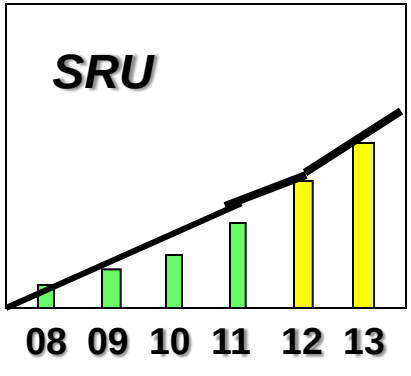
Sustainment Story

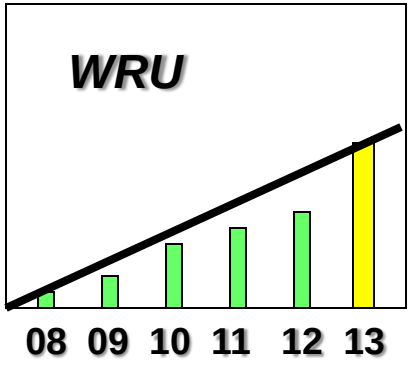
	2008	2009	2010	2011	2012
part 1					
part 2					
part 3					
part 4					

Availability Over time









Multi-level comparison

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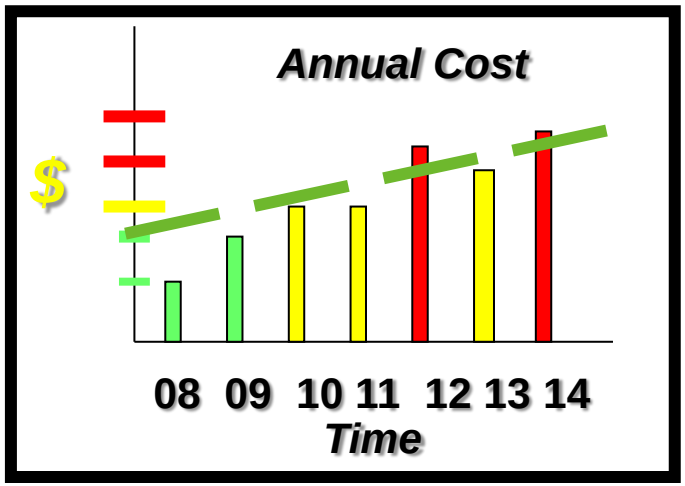
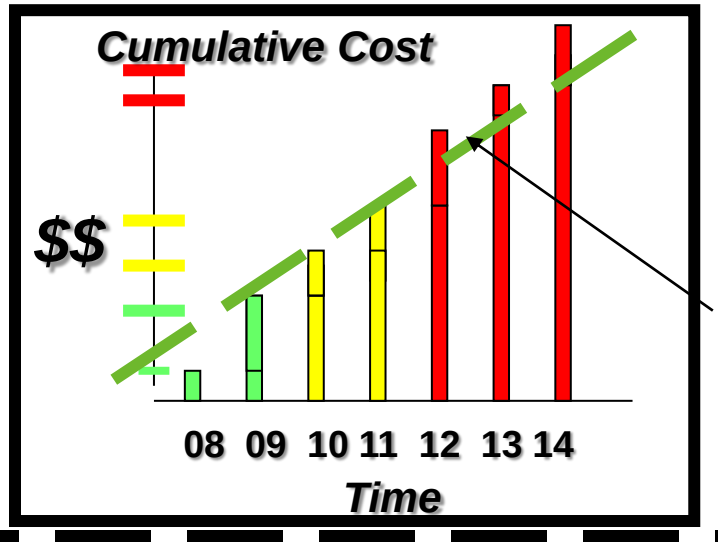
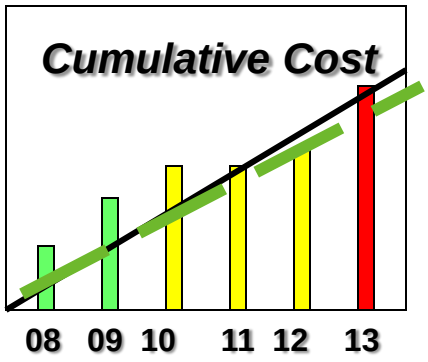
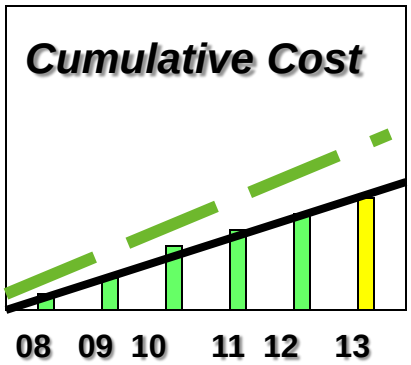
Cost Over Time

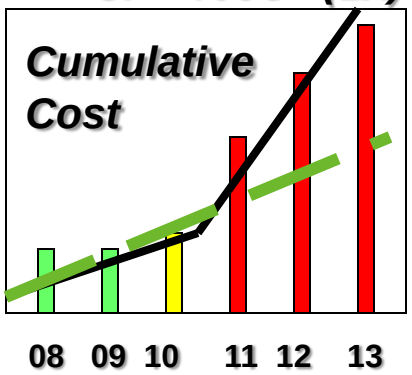


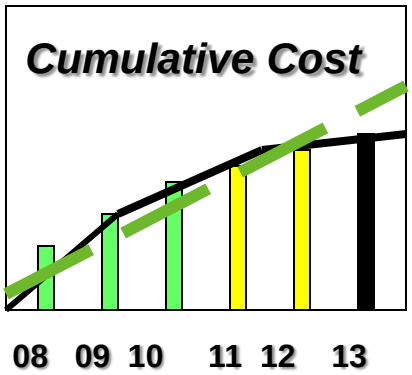


Expected Cost









Potential Candidate for modernization

Candidate for modernization

Mathematical Equations are applied to determine break points based on slope

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The DMSMS Myth:

DMSMS Approach:

Cost to solve a DMSMS issue depends on what level you solve it at

$ Low $ $$ Med $$ $$$ High $$$

Piece Part SRU LRU System

This is not true, we must find the right spot to resolve

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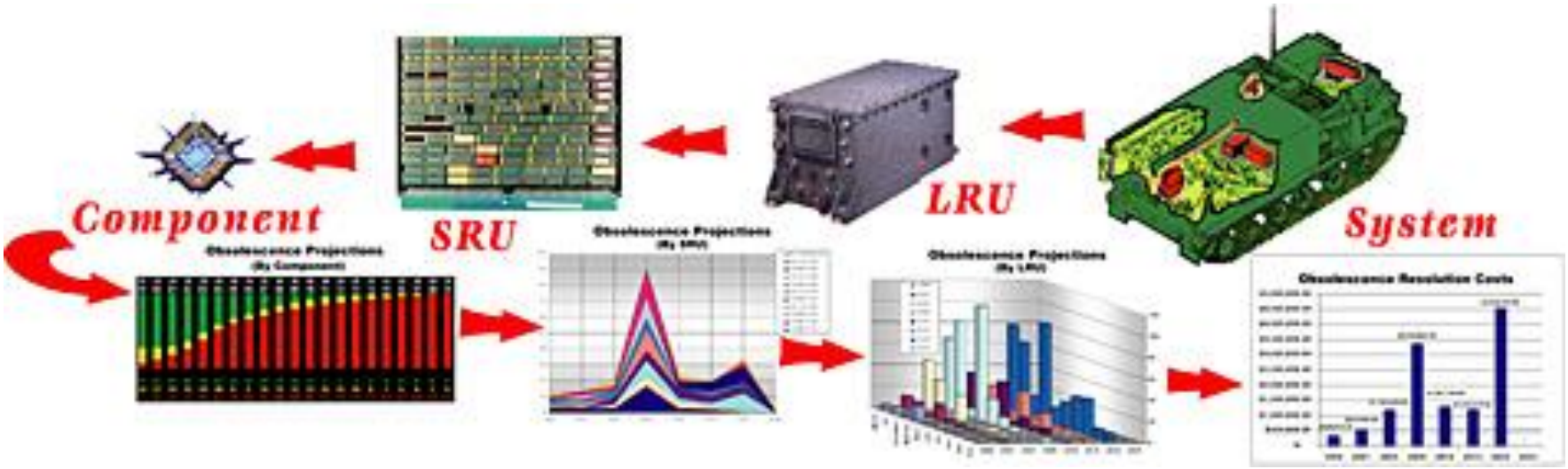
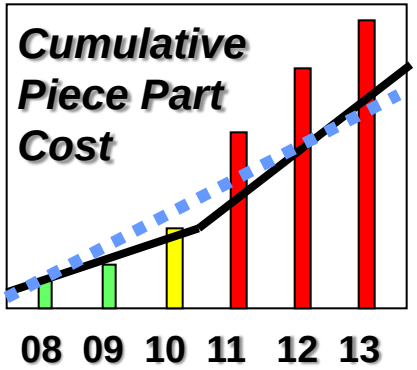
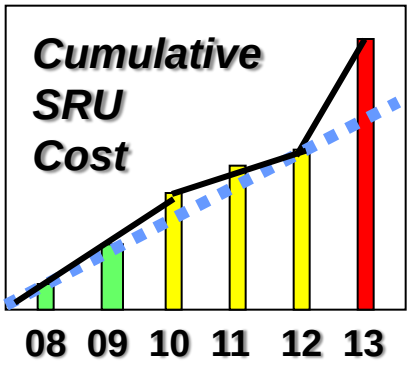
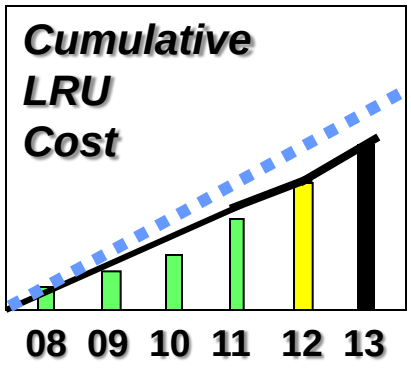
Find the Most Cost Effective Approach

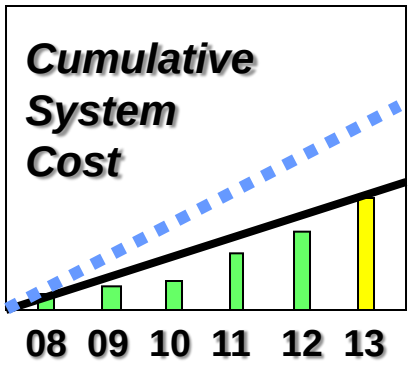
Evaluate your best option by analyzing DMSMS at different levels over different time periods (current and future)











Data indicates SRU replacement might be most cost effective approach

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DMSMS Risk Analysis Scoring

Probability						
	Certain (5)	5	15	25	35	45
	Highly Likely (4)	4	12	20	28	36
	Likely (3)	3	9	15	21	27
	Highly Unlikely (2)	2	6	10	14	18
	Remote (1)	1	3	5	7	9
		Low (1)	Minor (3)	Moderate (5)	Significant (7)	High (9)
		Impact				

The DMSMS Risk Score:
is the numerical product of the Impact Value and the Predicted Availability Score.
DMSMS Risk Score = (Impact Value) x (Probability / Availability Score)

Probability = Announced (5), 0-3 years PEOL (4) , possible 3-7 years (3) , > 7 years (2), validated by the manufacture to be > 10 years (1)
Impact = Redesign required (9), Minor Redesign required (7), some NRE maybe required (5), FFF replacement available (3), multiple Sources Available (1)

Each Component is scored and long term availability weakness are revealed
More effective way to gauge Sustainment Risk then PEOL only

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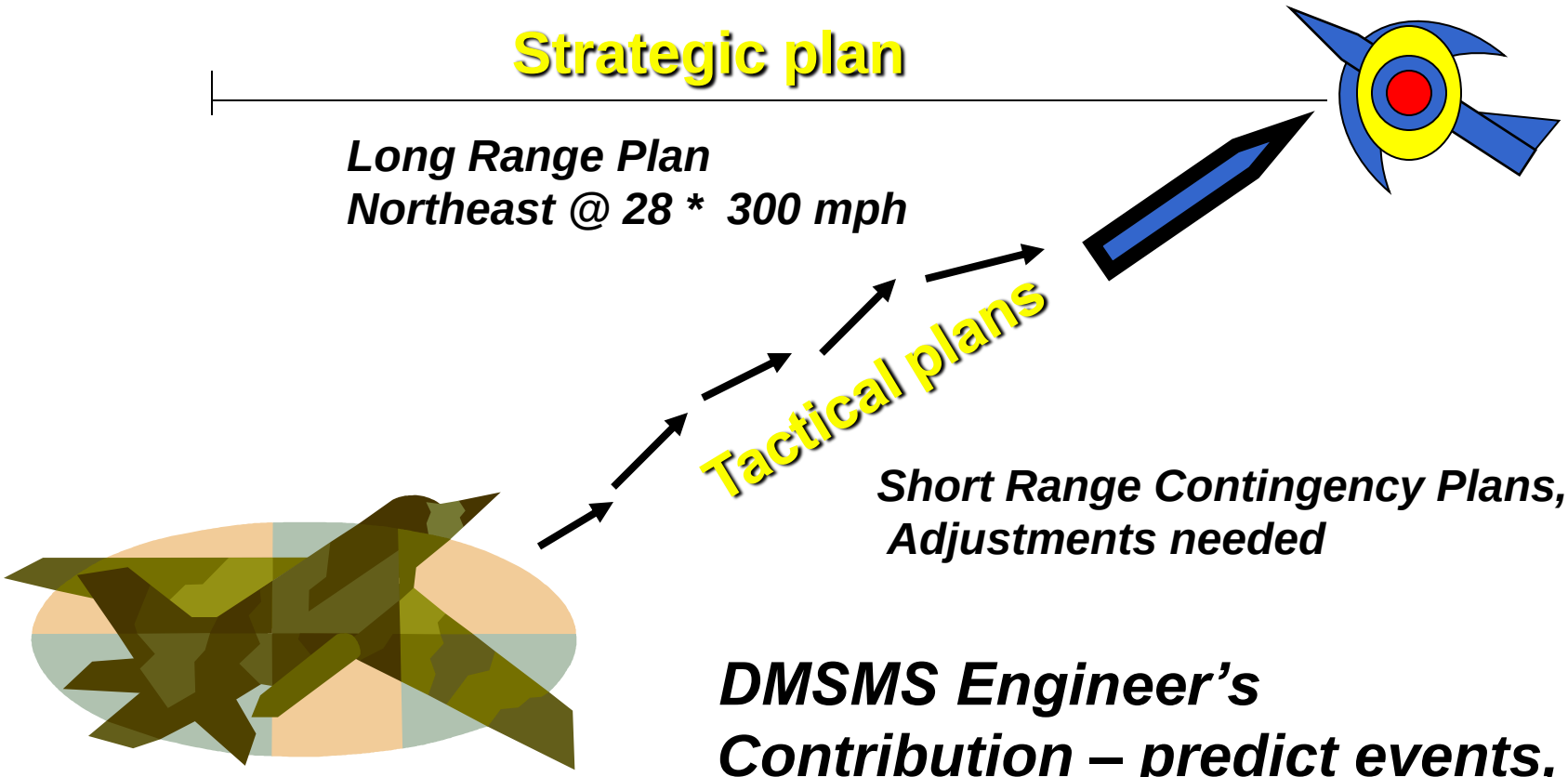
Technology Road-Maps Analogy

Purpose of the Map: to assure we succeed in our goals



DMSMS Engineer's Contribution – predict events, help develop tactical plans, input to the strategic plan

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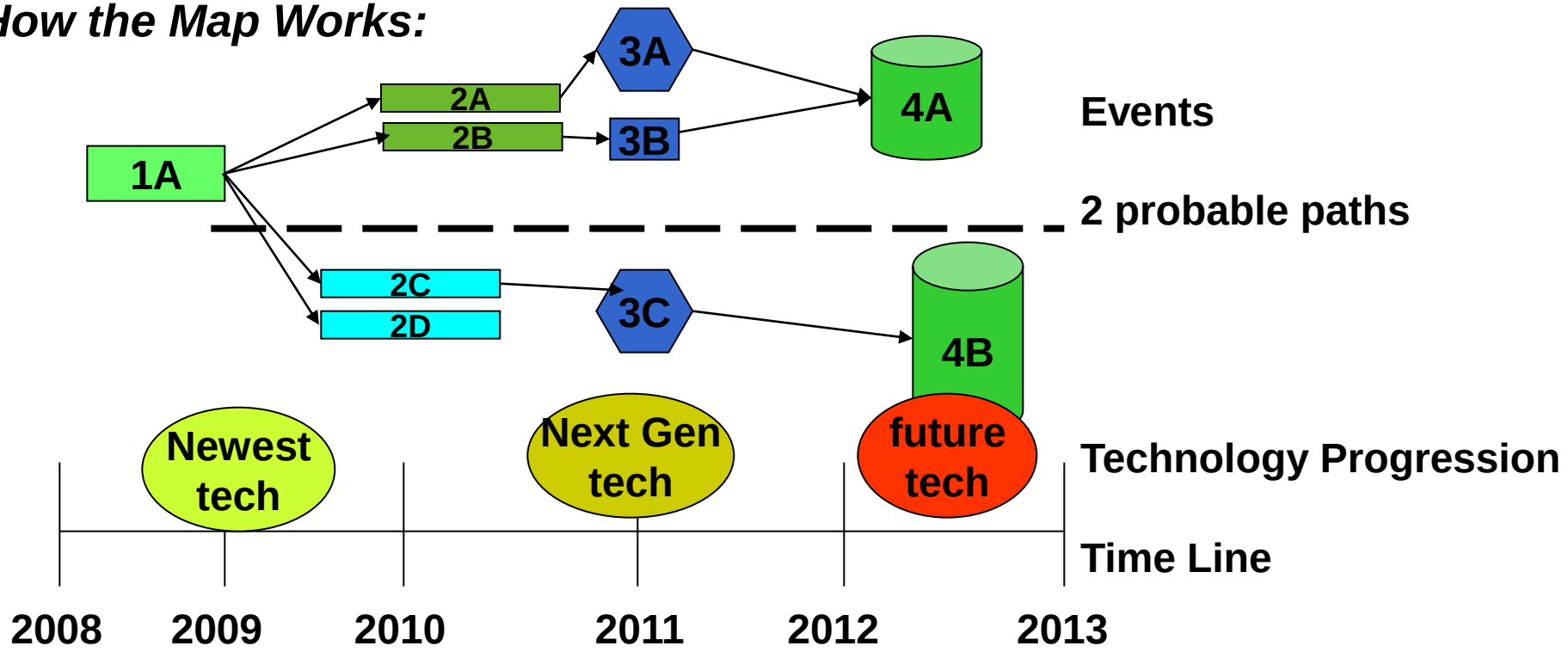
Technology Road-Maps

Goal: The most cost effective approach for the platform

How the Map Works:



Many Different Type Formats for Road-Maps
common elements are a timeline and events

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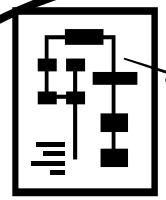
Technology Road-Map Ownership



Chief Engineer's Office

Business Instinct, Advanced Technology, Development History

<u>Chief Engineer Owns the Road-Map</u>

Many Stakeholders, *Systems, Software, Hardware, Programs, Product Support*

"Technology Insertion Road-Map "

IR&D Investment
Product Enhancements
Customer Desires

Sustainment Story

Business Intelligence

DMSMS Sustainment Team Data

ers

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Technology Road-Mapping & Sustainment Analysis

Platform Modernization and Sustainment Plan

Chief Eng. & Program Office

Combines All Maps

Programs:
New communications, new Threats & countermeasures, Desired Enhancements

Business Direction, Corporate Objectives

- ***Customer Road Map***
- ***Deviation, Waivers, Other changes***
- ***Marketing Road Map***
- ***Business Road Map***

Chief Engineers:
Where Product lines want to go

- ***Systems Engineering Road Map***
- ***Subcontractor Product Road Maps***

DMSMS Team Contribution

- ***Sustainability Road Map***
- ***Piece Part Technology Road Map***

How long will piece parts be around
How long can configurations be supported

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Tombstone/Graveyard Chart

"WRA Time-line" View Concept

FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
Lot 5	Lot 6	Lot 7	Lot 8	Lot 9	Lot 10	Lot 11	Lot 12	Lot 13	Lot 14	Lot 15	Lot 16	Lot 17	
MY X					MY XX								

Program 1

Lot 9	Lot 10	Lot 11	Lot 12	Lot 13	Lot 14	Lot 15	Lot 16
MY X			MY XX		MY XXX		

Program 2

Parts for SP-103C secured thru Lot 11  Box 1

Parts for Servo secured thru Lot 11  Box 2

Parts for SP-103C secured thru Lot 11  BOX 3

25 Other WRA's 

No known limiting parts at this time

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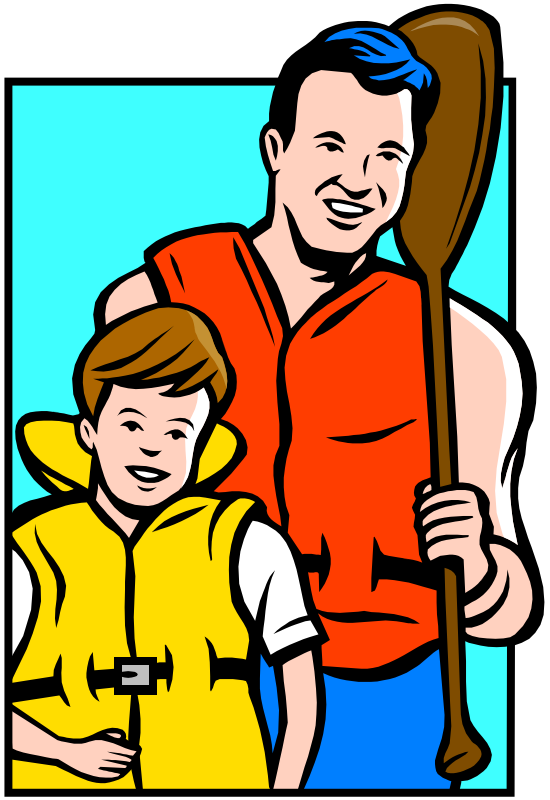
Some advice I would pass along



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DMSMS Management Program Set-Up

- **How do you go about setting up a DMSMS program for your Equipment?**

Things to consider

Tools needed ?

Budget needed ?

Who has ownership of DMSMS?

Who is on the team ?

Who do I interface with ?

Expected Outcomes ?

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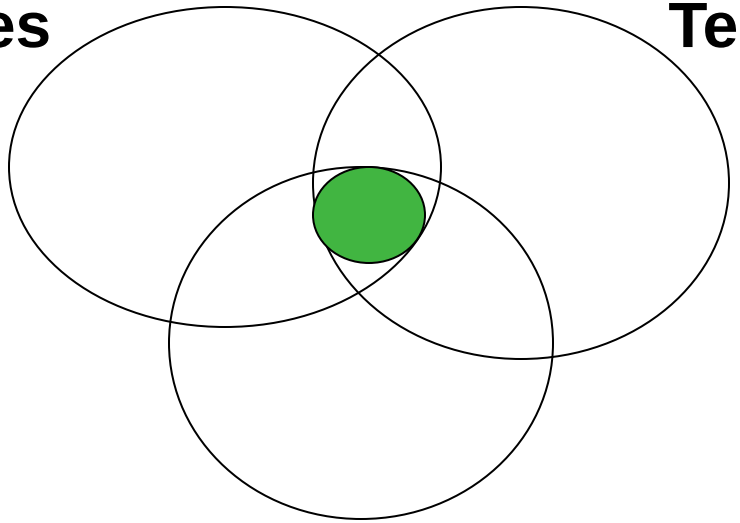
DMSMS Management optimization



Optimum Point for all 3 activities
Activities should be planned and coordinated

"Avoid Recovery Actions replace with planned actions"

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Engage with the customer on DMSMS:

- So they know you are using the most cost effective approaches to handling the problem
- Attend DOD sponsored conferences and workshops.
- Participate in working groups
- Increase customer comfort level with our DMSMS system

Engage with the suppliers on DMSMS:

- So we know their systems are effective in dealing with DMSMS
- Hold a one day workshop with our suppliers, detailing expectations, reinforce partnership on DMSMS management
- Increase DMSMS awareness among suppliers

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Successful DMSMS Program

- Takes some savvy to design the program correctly
  - Must be a plan that can be easily executed
  - Value added tasks and information gathering
  - Structured to meet the required end users goals
- Produces the desired outcome
  - Equipment availability
  - Reduced costs
  - Higher reliability
  - Less Down Time

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Continue to improve your process

- **Training for your DMSMS Team**

- **Participate in DMSMS Working Groups**
- **Participate in DMSMS conferences**

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What can Lockheed Martin do for you?

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Why Choose Lockheed Martin as a partner in DMSMS Management

Supplies some of the most sophisticated electronics for some of the toughest environments in the world

Radiation Hardness Part Experience

Large Supply Chain Leverage

Dedicated Global Sustainment work force

Highly Respect the Work LHC is performing

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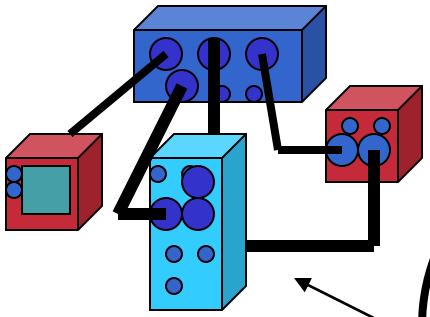
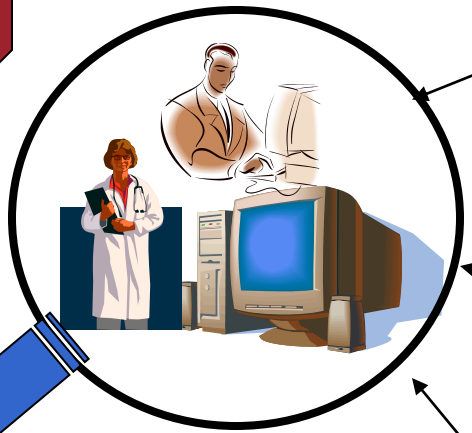
Lockheed Martin Integration across the Supply Chain

- **Reliable, credible relationships with the Supply Chain**
  Factory Engineers and Product Line Managers
- **Trusted DMSMS / Sustainment Information**
- **Buying Power, Capability with the Supply Chain**



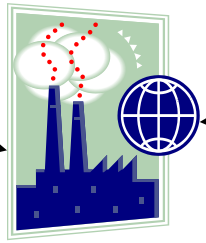
Integrators

Lockheed Martin

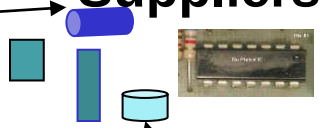


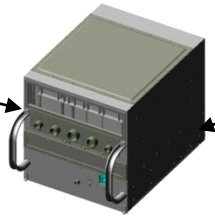
" Opportunities To Sustain"

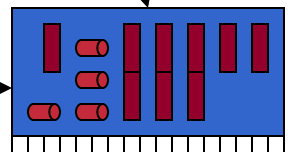
People, Processes & Tools

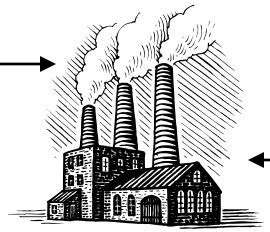


Parts Cots Widgets Suppliers









LRU Suppliers

Factories

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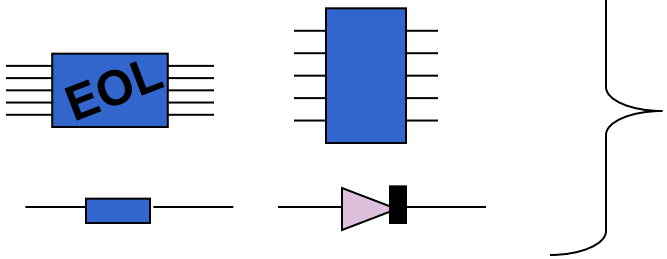
The Way it should be done

Manufacturers

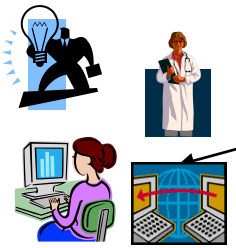
announce parts are end of life
Q-Star, purchasing, components
engineering notification to the system



From a business (site) level

Information,
Analysis & Solutions

Supplier contacts
LTB's
PEOL
Alternate parts
Aftermarket parts



Research
Done once

Databases

Over 40K COT's items (COTS2),
Piece Part level DMSMS data;

Multi-program benefit

Information
Dispersed to Programs

LHC

"Consolidated efforts for lowest cost"

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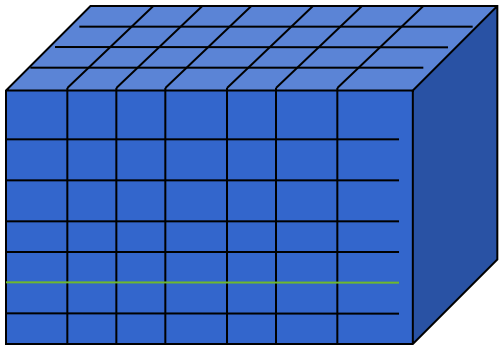
How LM could Achieve LHC Sustainment Objectives

LM DMSMS / Sustainment Database Warehouse

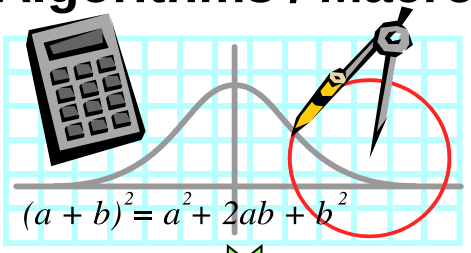
Inputs

- Prod BOM's, E-BOMs
- DMSMS info tool: Q-Star
- CE / Supplier EOL notices
- DMSMS Engineer's Research
- Sustaining Engineering Research
- Program Mitigation Plans
- Program Schedules and contract periods
- Part, SRU, LRU costs



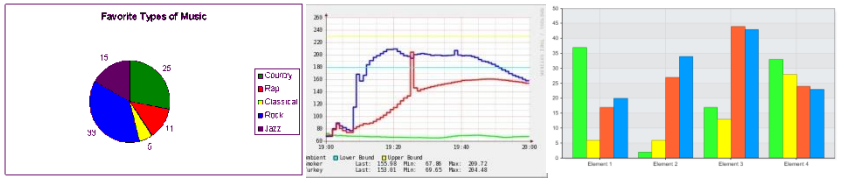
Data

Algorithms / Macros

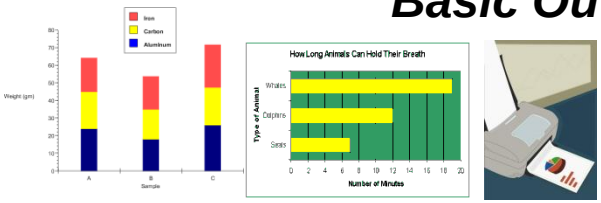


Macros

Advanced Outputs



Basic Outputs



Basic DMSMS Services

- DMSMS Reports
- Customer Formatted Reports
- Program Reports
- Monitoring Reports

Premium Sustainment Services

- Decision Trees
- Sustainment Analysis
- Cost Analysis
- Graveyard Charts
- Modernization and Sustainment plans
- Technology Road-mapping

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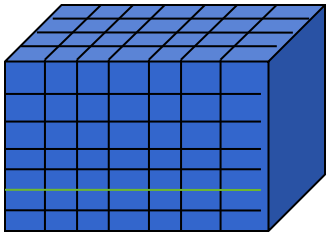
Premium DMSMS Services

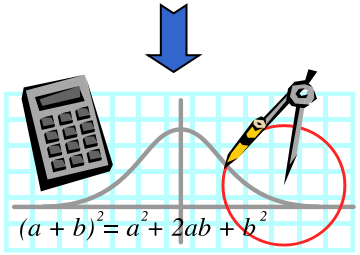
LM DMSMS Sustainment Database Warehouse (DBW) and Premium Sustainment Tools Set access

Plus:

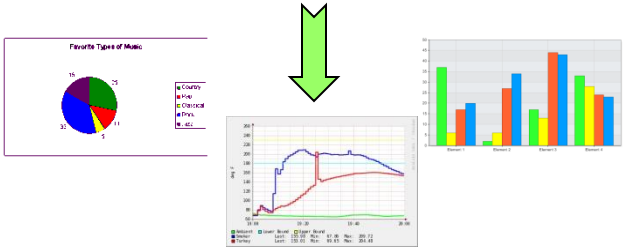
Premium Sustainment Analysis Tools Set *



DMSMS Risk Score (automatically calculated)
Decision Tree's
COTS 2 tool
Sustainability Analysis Reports
SRU & LRU Health Analysis Reports
Long Term Sustainment Solutions
Platform Graveyard Charts
Technology Road-mapping Support
Modernization and Sustainment Plans
Funding Cycle Planning
DMSMS Program Planning



Algorithms / Macros



Advanced Outputs

- **Program Schedules, contract periods, part cost, SRU cost, and LRU cost and redesign NRE estimates**
- **needed to be added to the DBW**

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Lockheed Martin MS2 Global Sustainment Services

We would be glad to help.

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Mark Hartnagel - DMSMS MS2 Enterprise Lead (315) 456-3116
Max DellaPia - Business Development Logistics and Sustainment
(607) 751- 6063

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Questions

Thank You