



Need for Affordability Analysis in Systems Engineering

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Outline

- **Problem Statement** *(Mark)*
- **Affordability Background** *(Mike)*
 - **Definitions**
 - **Recent Defense Acquisition Reform**
 - **Aerospace Industry Affordability Practices**
- **Affordability Practice Solutions**
 - **Affordability Analysis Capabilities Summary** *(Mark)*
 - **Best Value Analysis**
 - **Cost-performance**
 - **Best Practice Systems Engineering Practices** *(Mike)*
 - **Cost As an Independent Variable (CAIV)**
 - **Target Costing**
 - **Value Engineering**
- **Summary**

Recent Defense Acquisition Reform and Cost Accountability

Public Law No. 111-23 (May 2009)

- Establishes within the Department of Defense (DOD) a Director of Cost Assessment and Program Evaluation.
- Requires the Secretary of the military department concerned to disclose the confidence level used in establishing a baseline estimate.
- Requires the rationale for selecting such confidence level, and, if such confidence level is less than 80 percent, the justification for selecting a confidence level of less than 80 percent.
- Requires tracking and assessing Major System operating and support costs.

***Intent of Law is to Hold DoD Program Managers Accountable for
Program Cost-Risk Estimates***

Problem Statement

- **Increased pressure to control DoD Program Cost Growth:**
(GAO-09-326SP, March 2009:“Assessments of Selected Weapon Programs”)
 - \$300 Billion Growth in FY 08 Acquisition Cost (top 96 programs)
 - 25% increased Acquisition Cost from First Cost Estimate
 - 42% increased R&D Cost from First Cost Estimate
 - “Early system engineering, stable requirements, and disciplined software management on programs...experienced less cost growth”
 - “...Dec '08 Revised Acquisition policy...places more emphasis on acquiring knowledge about requirements, technology, and design before programs start...recommends holding early system engineering reviews..”

Need “Up-Front” Affordability & Cost-Performance Analyses

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- Affordability Practice Solutions
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Affordability Definitions

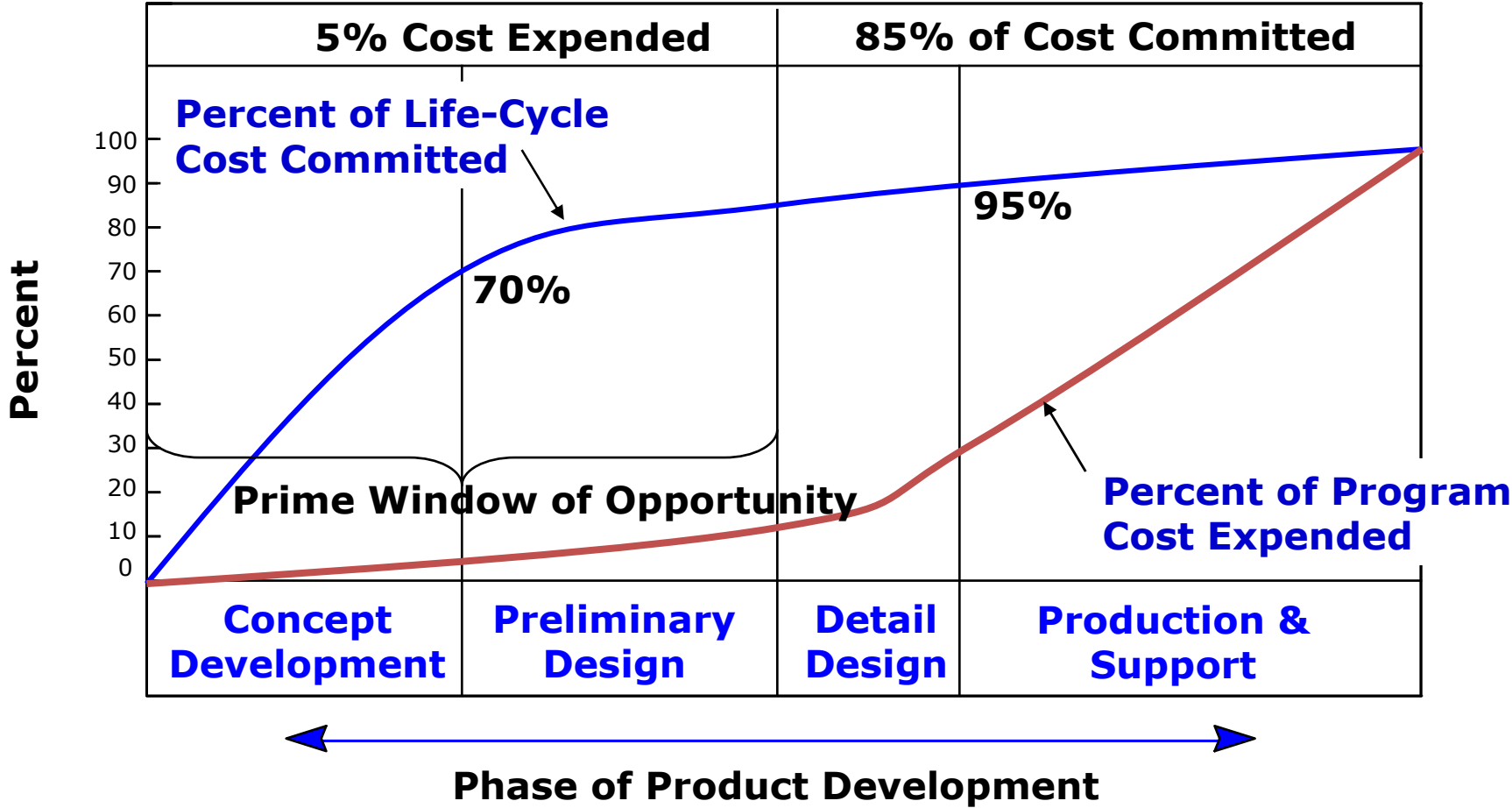
“...Affordability is a Systems Engineering process used during all phases of the product life cycle where cost is balanced with performance and schedule to define and deliver best value solutions to the customer.”

“...Affordability deals with...how much the marketplace is willing or able to pay for the program or product.”

Defense Acquisition University Guidebook:

“Affordability...the degree to which the Lifecycle cost...is in consonance with the long-range modernization, force structure, and manpower plans...”

Design Influence on Life Cycle Cost



Best Opportunity to Influence System Cost is Early in Design

Selections from ISPA/SCEA Joint Conference 2009, St. Louis

Cost Analysis Impact in Systems Engineering

- **Raytheon**
 - **“Weapon System Design Trade Offs Using Life Cycle Cost”**
 - Cost Estimating Methods to Perform CAIV & cost-performance
- **Sikorsky:**
 - **“Complex Hardware Models”**
 - Integrated Cost Performance with Model Center©
 - Affordability Analysis group for conceptual rotorcraft
- **Air Force Cost Analysis Agency:**
 - **“Excessive Project Cost – Where Does it Come From?”**
 - Tool that relates program risk mitigation to cost-risk

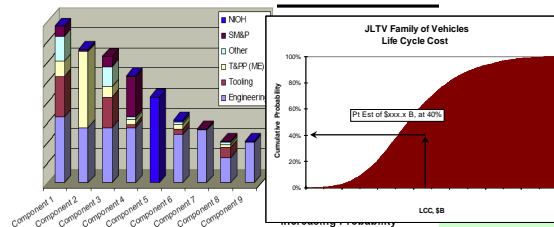
Conference highlighted Affordability best-practices

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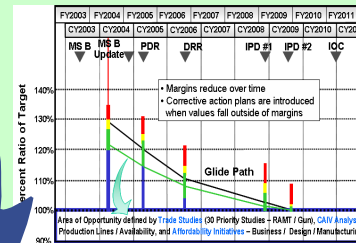
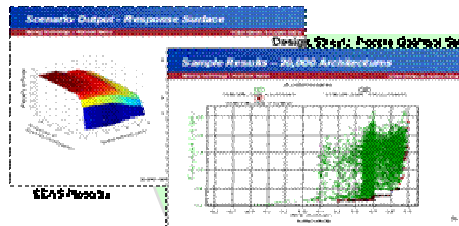
Affordability Practices in Boeing

Life Cycle Cost & Uncertainty Analysis



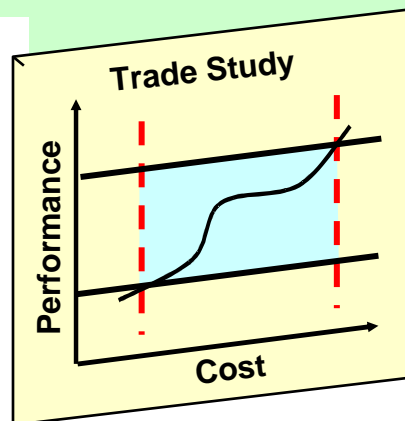
Affordability Training

Trade Studies & Affordability Initiatives

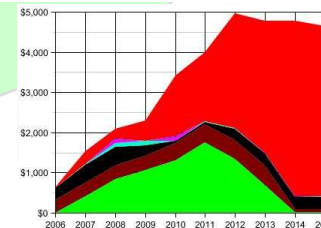


Target Cost Allocation & Tracking

**Best Value Analysis
(Cost vs. performance)**



Market & Competitive Analysis



Trade Study Implementation of Affordability (sample CAIV Analysis Results)

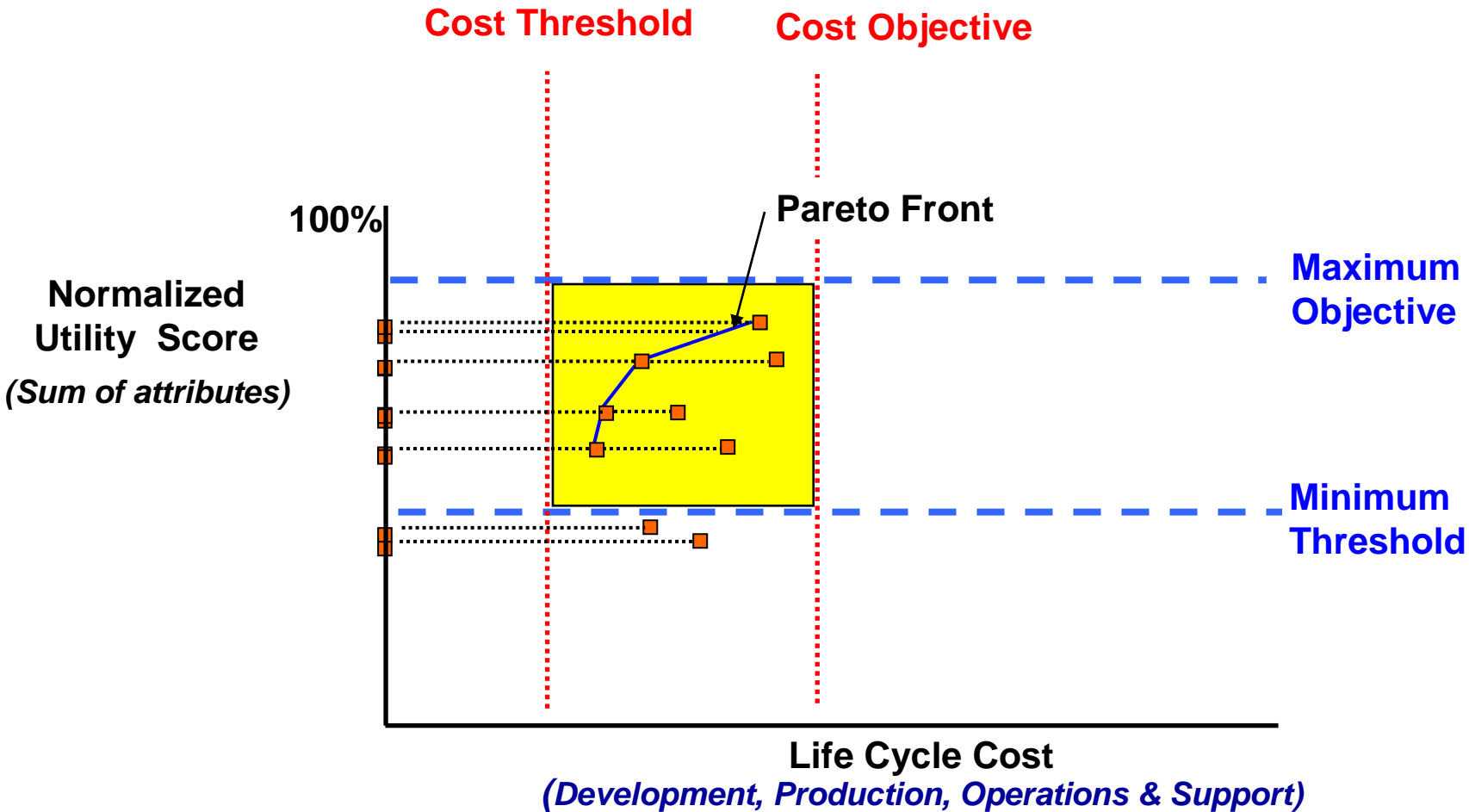


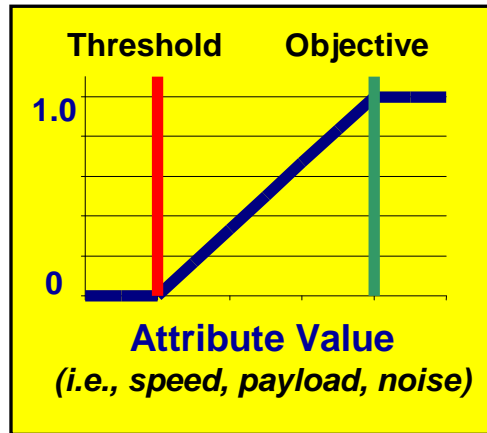
Chart 11

Method to Identify Best Value Engineering Solutions

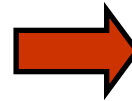
Customer Attribute Priorities



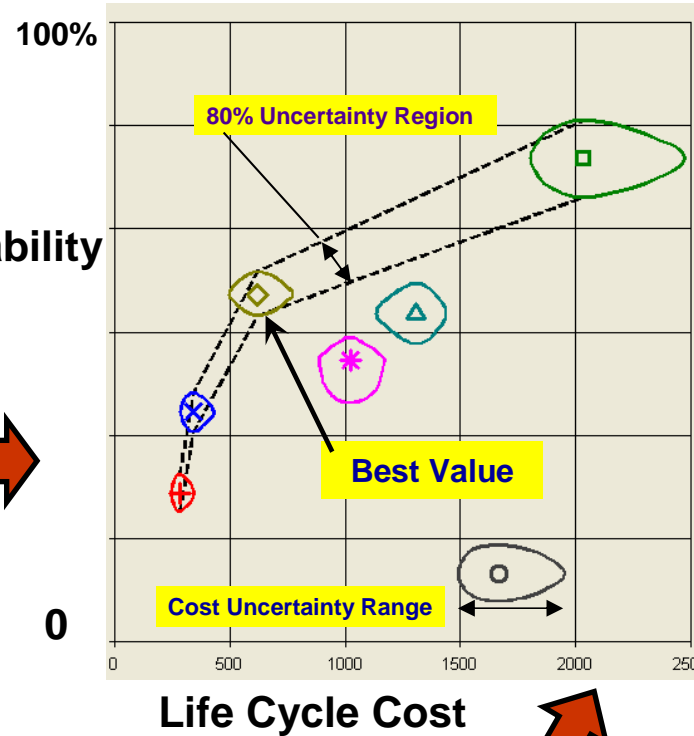
Customer Desirability (utility score)



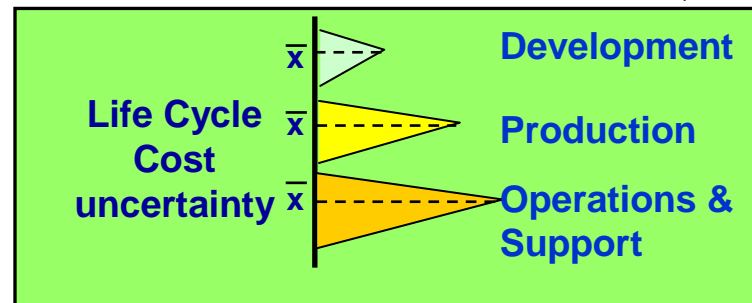
Desirability



Value Analysis



Cost-Risk Analysis



Design Trade Study Evaluation

Using Value Analysis Method

Attribute Weighting Factors	
Attribute Name	Total: 12
Sonic Boom	3
Airport Noise	2
Cruise Emissions	2
Cruise Speed	1
Payload	1
Range	1
Fuel Efficiency	2

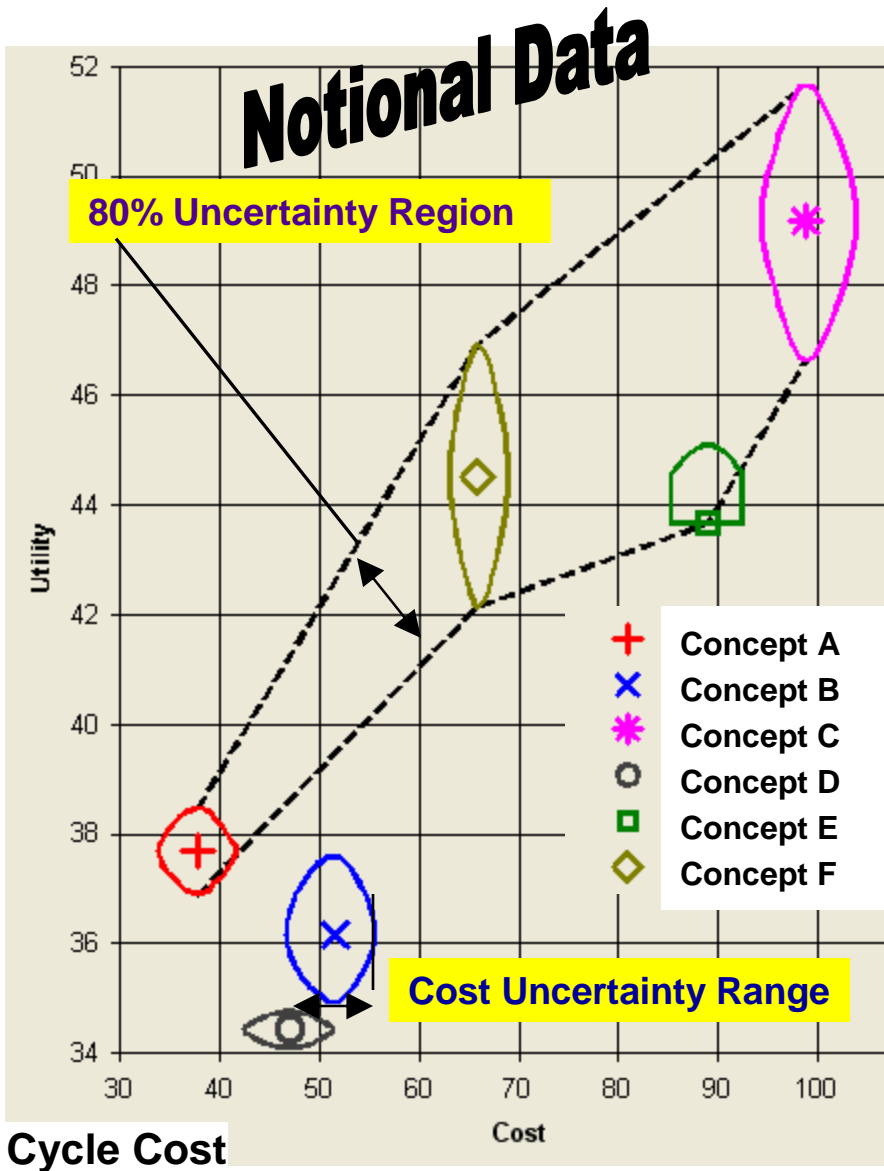
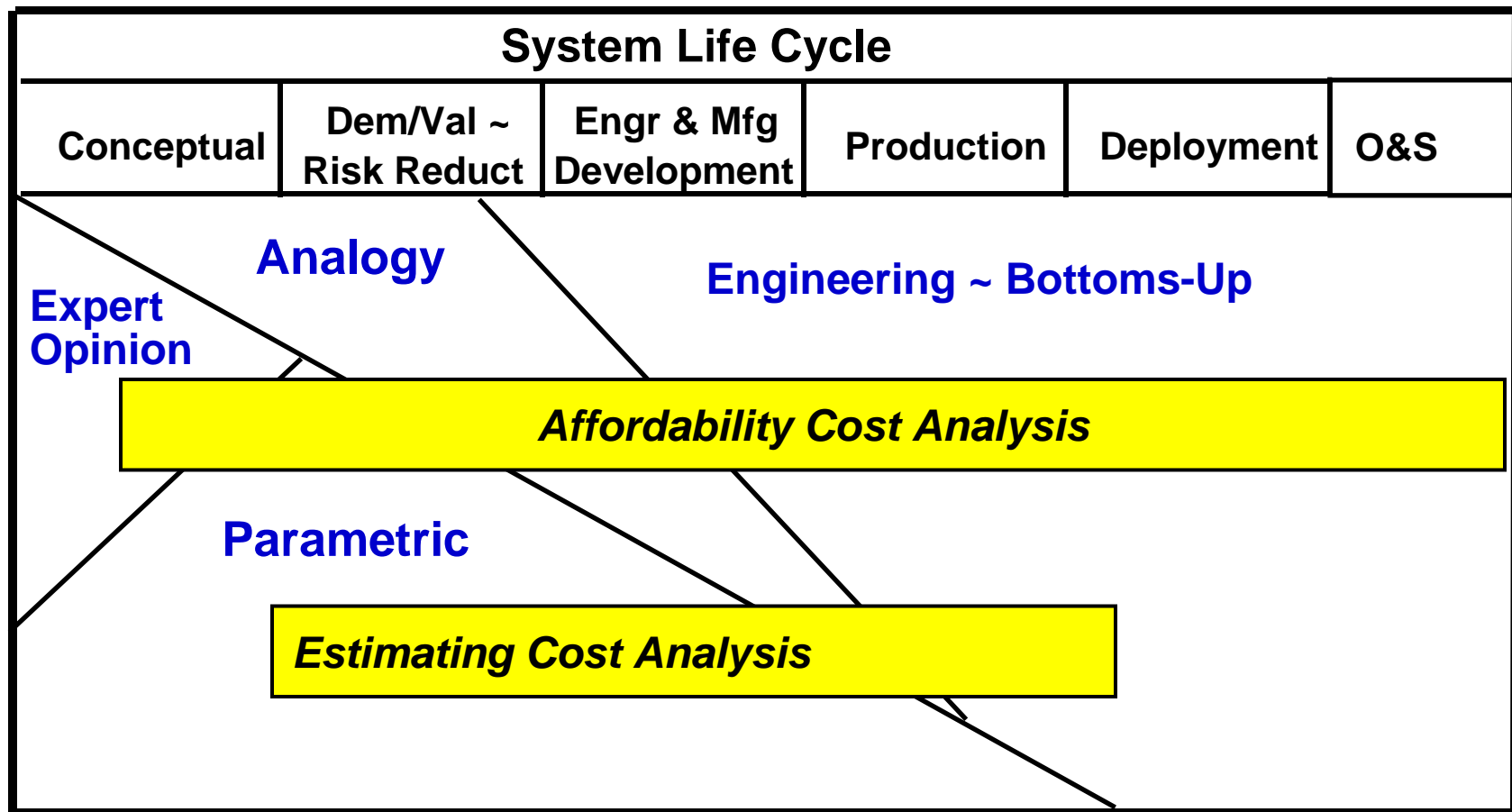


Chart 13

Life Cycle Phase of Program Determines Cost Estimating Methods



Affordability Cost Analysis is Involved in early & O&S phases

NASA “Process Based Economic Analysis Tool” (P-BEAT)

Cost Estimating Tool for Design Trade Studies (Boeing Developed for NASA)

P-BEAT Input Screen

D	E	F	G	H
Program Name: JIMO				
Show BOM		Save Trade		Save Baseline
Show Chart		Get Trade		Get Baseline
<i>Trade</i> <i>Baseline</i>				
Study Name: Thruster				
Description: Alternate - 2		SSME Hardware 13		
Year \$: 2001		2001		
Development Cost: \$534,862,677		\$250,000,000		
Proteic First Unit Cost: \$2,897,806		\$2,500,000		
Avg. Unit Prod. Cost: \$2,530,501		\$2,183,118		
<i>Programmatics</i>				
Prod. Qty. Req'd:	3.0		3.0	
Least:	3		3	
Likely:	3		3	
Most:	3		3	
Prod. Lot Size:	3.0		3.0	
Platform:	Space		Space	
Rating:	Manned		Manned	
Mobility:	Mobile		Mobile	
Standards:	Military		Military	
Reusability:	Expendable		Expendable	
Platform Value:	2.267		2.267	
Acquisition Philosophy:	Ratio	Percent	Ratio	Percent
Design & Build:	1	50%	1	100%
Sub-contract:	1	50%		0%
Build-to-print:		0%		0%
Buy & Integrate:		0%		0%
Supplier Furnished Equipment:		0%		0%
Importation Wrap Rate %:	123.0%		123.0%	
Production Wrap Rate %:	123.0%		123.0%	
Composite Labor Rate:	\$45.00		\$45.00	
Design Maturity: <i>Design Characteristics</i>				
Least:	Simple Modification		Simple Modification	
Likely:	New Design		Extensive Modification	
Most:	Advanced State of the Art		New Design	
Design Capability:				
:Extensive experience				

Benefits of Analogy Cost Estimating:

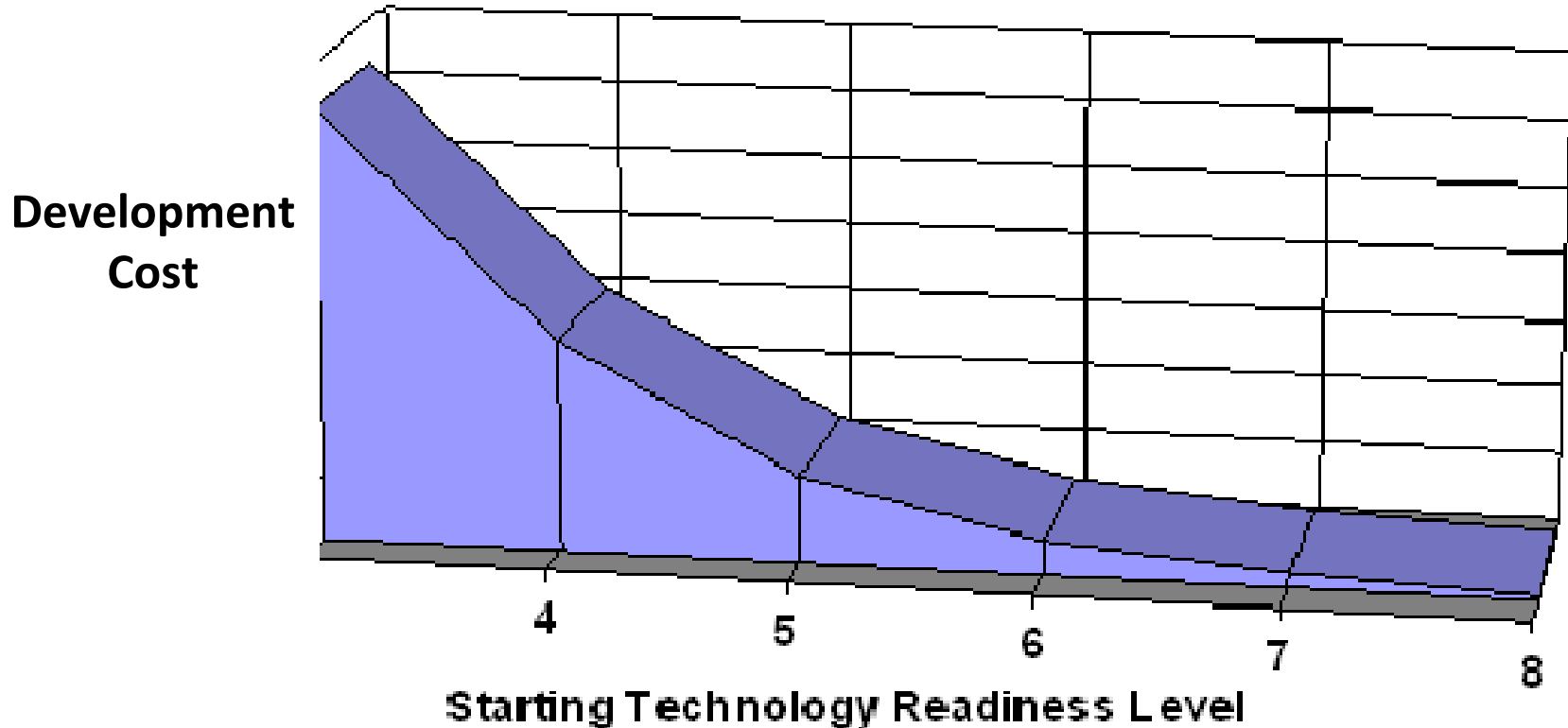
- Facilitates cost estimate “buy-in” from IPT members
- Allows “early” cost impact during conceptual design

P-BEAT Features:

- Free use and training to contractors
- Cost estimated using few or many cost-driver inputs
- Built-in regression for cost vs. performance analysis

Impact of Technology Maturity on Development Cost

P-BEAT Cost Analysis



R&D Planners Need Cost Estimates Based on Technology Maturity

Example Cost Analysis with P-BEAT

NASA Study of Aircraft Technologies

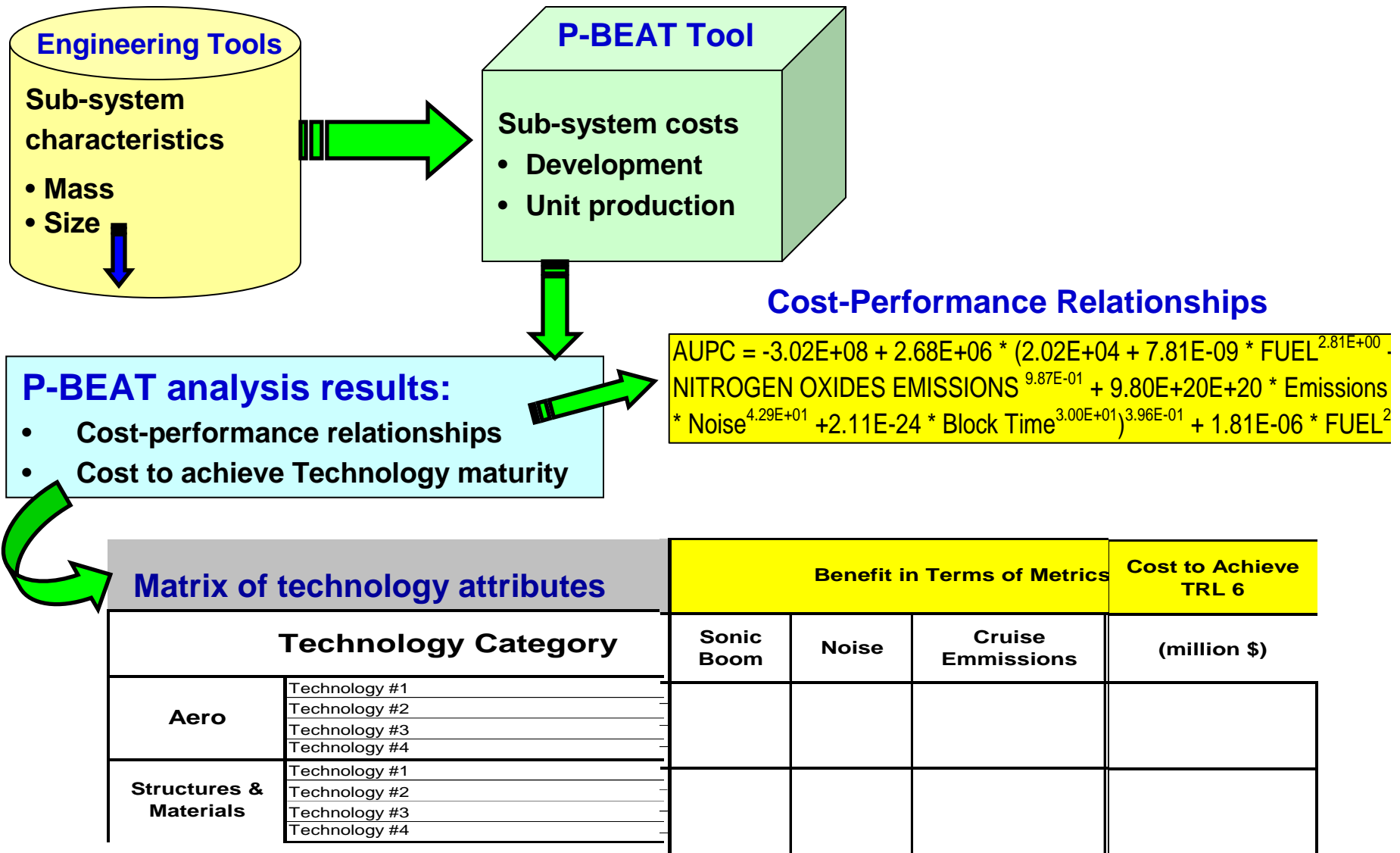


Chart 17

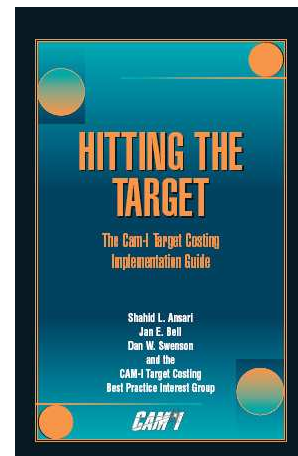
Cost As an Independent Variable (CAIV)

- **DoD Affordability Process**
- **Used to develop an acquisition strategy for acquiring and operating affordable DoD systems by setting aggressive, achievable cost objectives and managing achievement of these objectives**
- **Helps arrive at cost objectives (including life-cycle costs) and helps the requirements community set performance objectives**



Target Costing

- **Commercial Affordability Process**
- **Sponsored by the Consortium for Advanced Management – International (CAM-I) www.cam-i.org**
- **Focused on setting and achieving aggressive cost targets**
 - **Assigning Cost Targets**
 - **Designing products & processes to meet those targets**



Value Engineering

$$\text{Value} = \frac{\text{Function}}{\text{Cost}}$$

(To the Customer)

- “We buy functions; what things do.”
 - Larry Miles, inventor of Value Analysis
- Functional Analysis Systems Technique (FAST)
 - Logically diagrammed functional relationship

Functional Analysis Systems Technique (FAST)

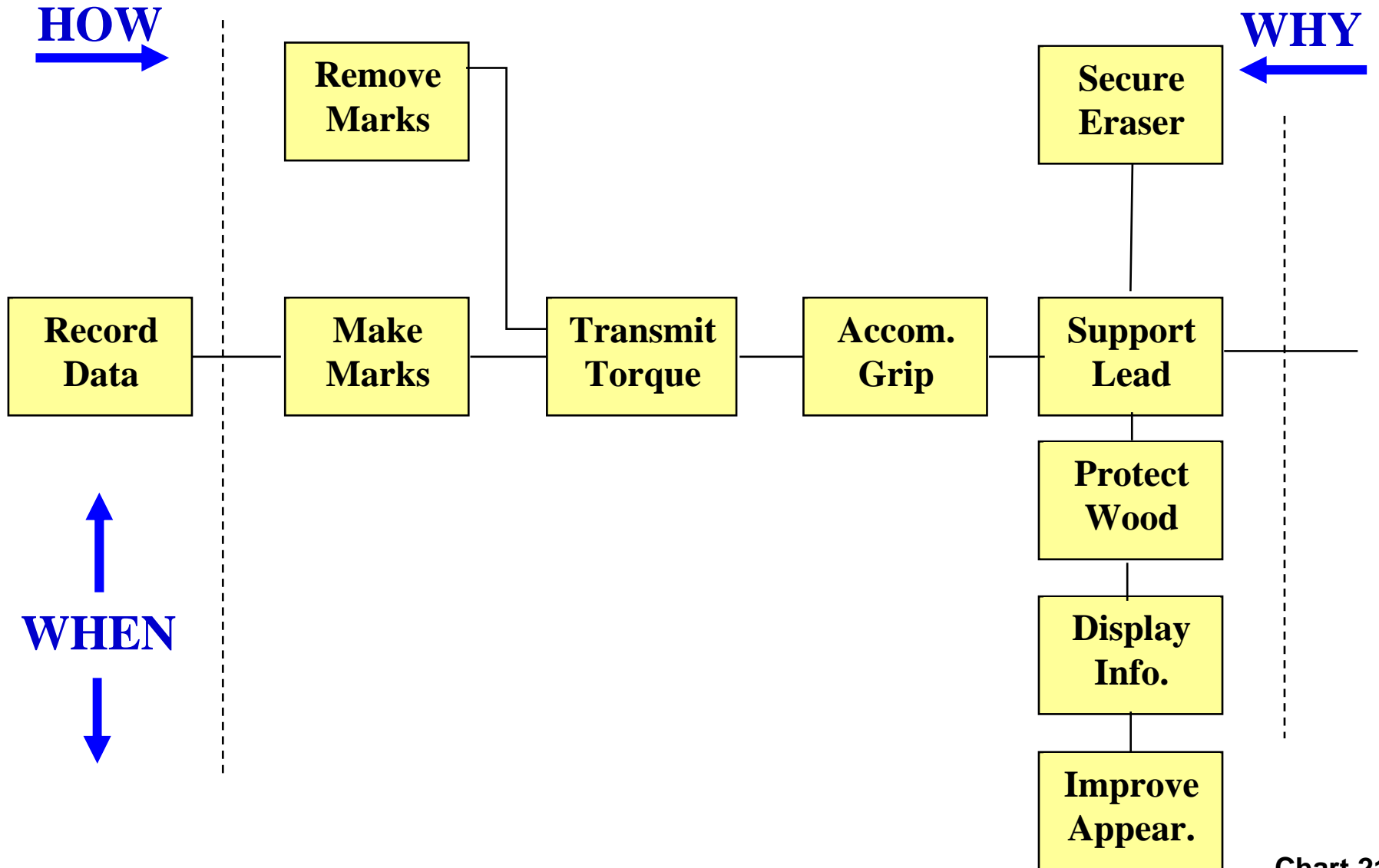


Chart 21

Personal Applications of Affordability

- Mike's story



Summary

Systems Engineering Capability Needs:

- CAIV approach to Systems Engineering used by industry
- Target Cost Analyses and Cost Control Practices
- Value Engineering to enhance Systems Engineering functional analysis

Affordability Analysis Capability Needs:

- Cost-estimating and cost-performance methods & tools
- Best Value Analyses for early design trade studies
- Collaboration with Affordability experts to learn best tools and methods used in industry & government (eg. NASA and ISPA Cost Conference experts).