Affordability Engineering for Better Alternative Selection and Risk Reduction”

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The Case For Affordability Engineering

"Cost, schedule, and performance problems in the Department of Defense's (DOD) weapon system programs are serious. Recently, we reported that the department's 2008 portfolio of 96 major defense acquisition programs experienced cost growth of $296 billion, experienced an average delay in delivering initial capabilities of 22 months, and have delivered fewer quantities and capabilities to the warfighter than originally planned.[1]" Reasons for these problems included[2]:

- Most programs did not conduct a robust Assessment of Alternatives (AOA)
- Many AOAs did not adequately assess risks for alternatives
- Choosing an alternative too early and conducting AOAs under compressed time frames and without effective guidance limit the scope and quality of AOAs.
- DOD needs the ability to ensure that its [acquisition] policy changes are consistently implemented and reflected in decisions on individual weapon system programs

Notes: 1- GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs, GAO-09-326SP (Washington, D.C.: Mar. 30, 2009).*
2- GAO, Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options, GAO-09-665 (Washington, D.C.: Sep 24, 2009)

Why Affordability is an SE Process

Affordability can be improved, measured and predicted

- These techniques enable analysts to forecast expected affordability of alternative technologies and systems
- They allow the measurement of improvement in affordability of a given system
- The affordability trade space is composed of a relational set of attributes that are contextually sensitive
- Once this set is bounded, the need arises for an implicit comparison to other systems, sub-systems and components.
- The problem may be embedded in how systems are designed, how they are governed, and how they are evolved. (See Next slide)

Affordability Is A Systems Engineering Metric

Affordability Analysis

is an integral part of the system engineering approach. Closely coupled to understanding technical issues, it seeks to use a common set of methods. Analysis can focus on the subsystem, system, and mission levels and is performed for the entire program life cycle. Typical products of an affordability analysis include *cost-effectiveness analyses, risk analyses, and total ownership cost estimates*. An affordability analysis synthesizes information from three basic areas: mission analysis, technical analysis, and cost analysis."

Engineering Affordability Into Our Systems

Affordability Engineering is An Attitude Not A Technique

- There is no formal process or technique called Affordability Engineering but it is an inherent attribute of affordability analysis
- Engineering affordability into systems and services is a team sport requiring cooperation of:
  - Program Managers
  - Systems Engineers
  - Cost Estimators
- Engineering affordability can be an outcome of Affordability Analysis using techniques such as:
  - Value Engineering (VE)
  - Design To Cost (DTC)
  - Cost as an Independent Variable (CAIV)

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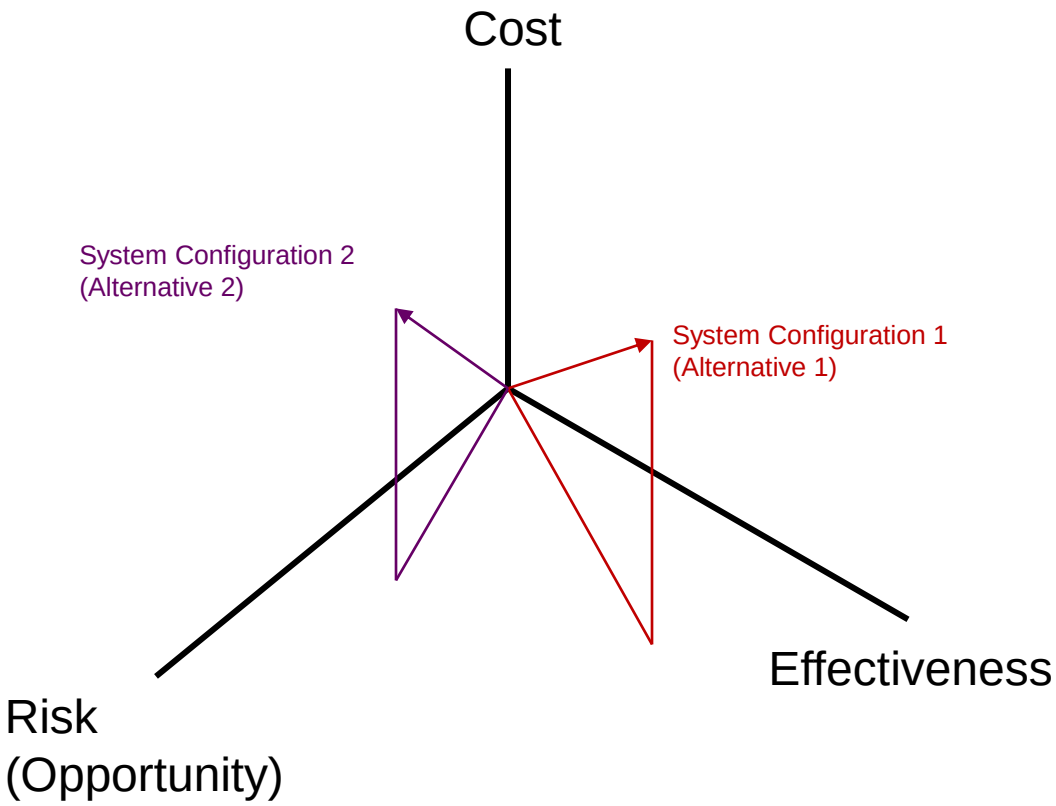
How Affordability is Utilized

- Determine the customer concerns and understand those concerns
- Explicit – States cost goals or operating budgets
- Implicit – Inherent Relationship between performance and Cost
- Compliance – Contract contains a limited budget/funding
- Unit Production – Average Unit Production Cost (AUPC) goals
- Total Ownership Costs (TOC)-Reduced Total Ownership Costs (RTOC)- Life Cycle Costs (LCC) must be some determine percent (normally 30%) less than the replaced system

Affordability Trade-Off Analysis

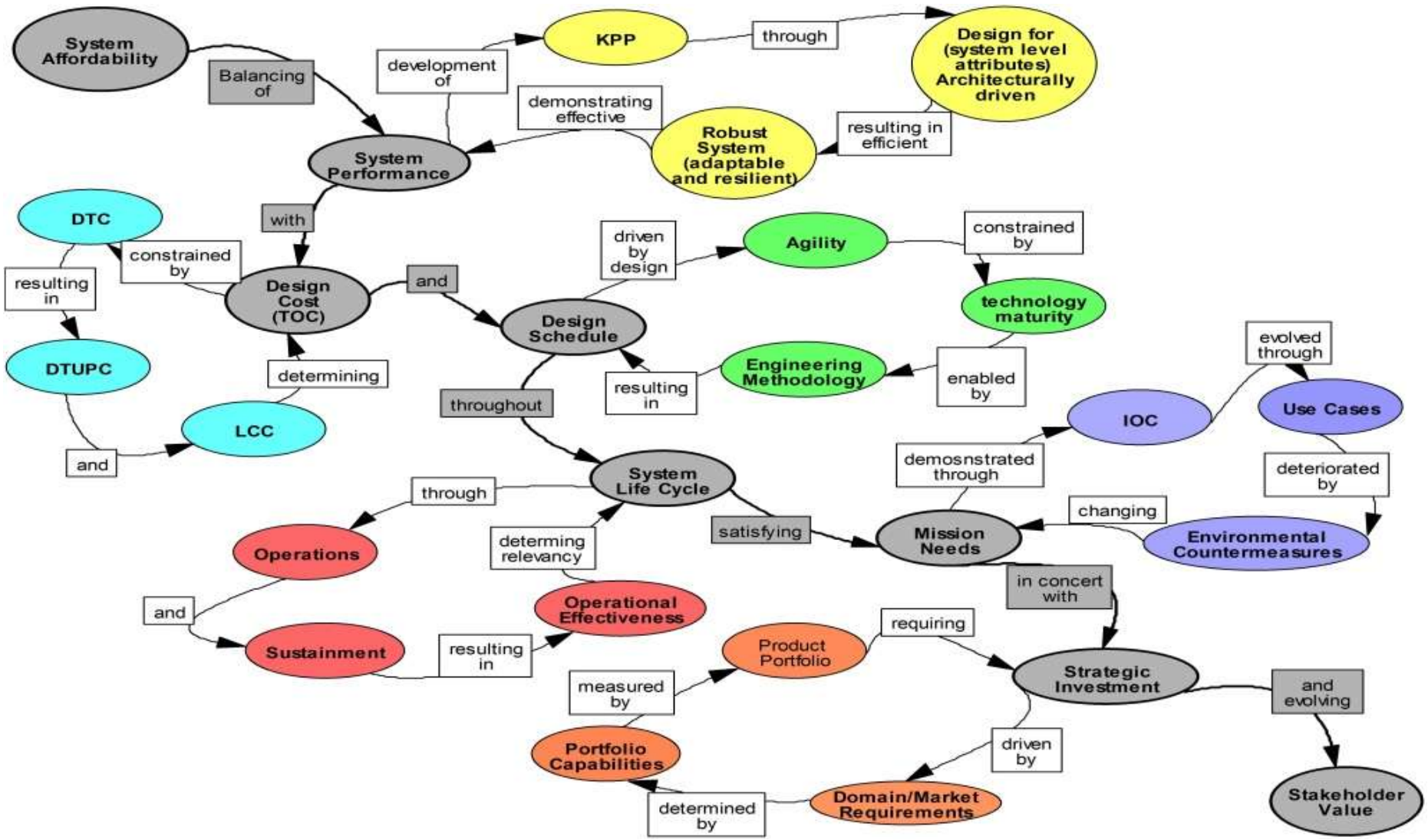
"Trade Off Analyses provide a recommended course of action with impact to decision makers for each set of alternative examined. The impact assessment is given in terms of cost, schedule, performance and risk/opportunity" [Note 1]

- **Cost Analysis**
  - Economic consequences of an alternative selection
  - Cost trade-off data provides a means to value capability (performance), dependability, suitability (requirements), and cost-effectiveness
- **Effectiveness Analysis**
  - Measures the extent to which a system meets mission objectives
- **Risk / Opportunity Analysis**
  - Measure uncertainity of each alternative and their impacts in terms of cost, performance, schedule
  - Measures the capacity for the system to evolve
- **Benefits Analysis**
  - Measures the value decision makers place on prioritized capabilities



Source: Naval Systems Engineering Guide – July 2004 (section 4.5.1 page 104)

Considerations of an Affordability Trade Space



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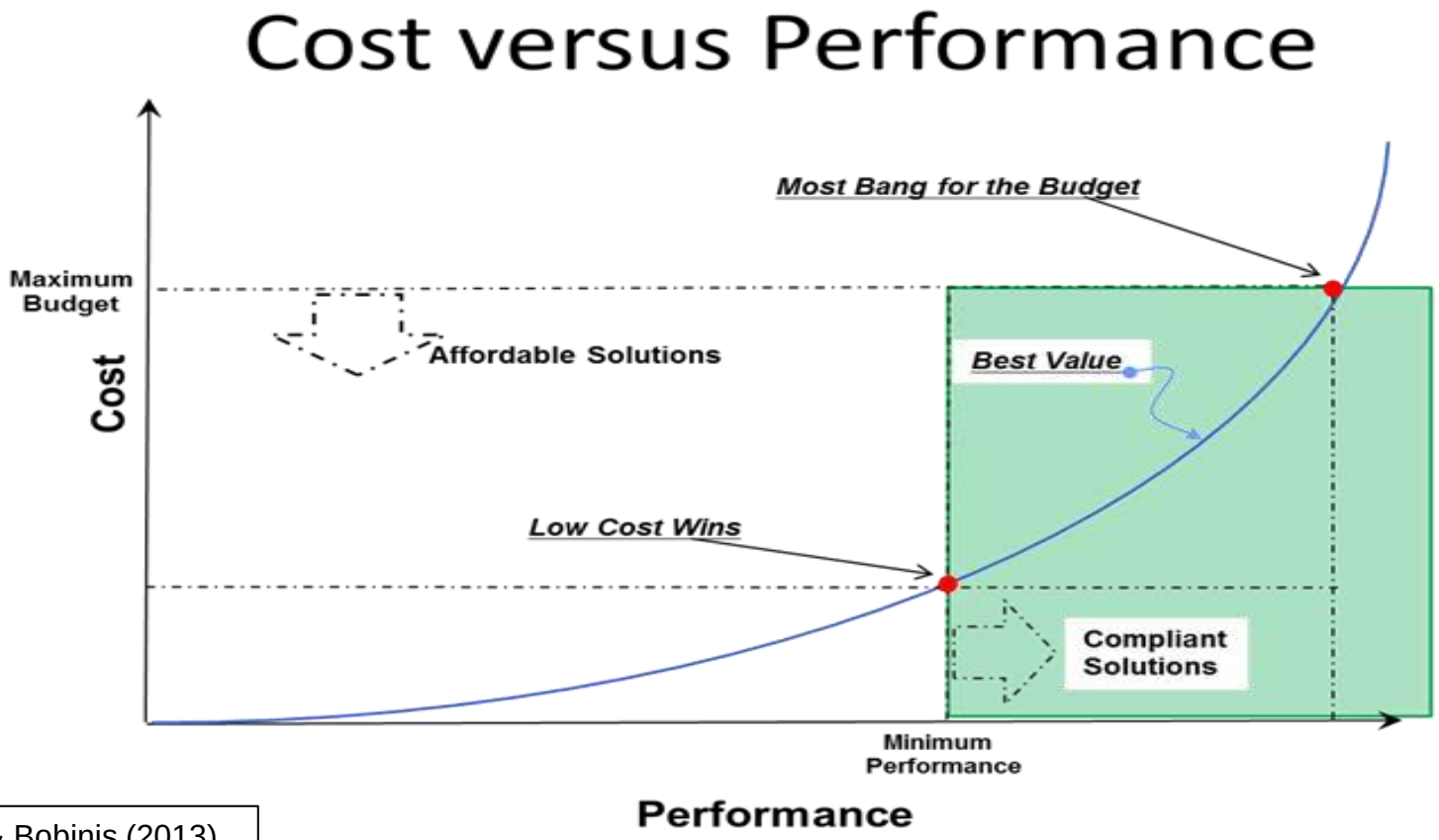
Goal of Affordability Engineering



Tuttle & Bobinis (2013)
"Specifying Affordability"

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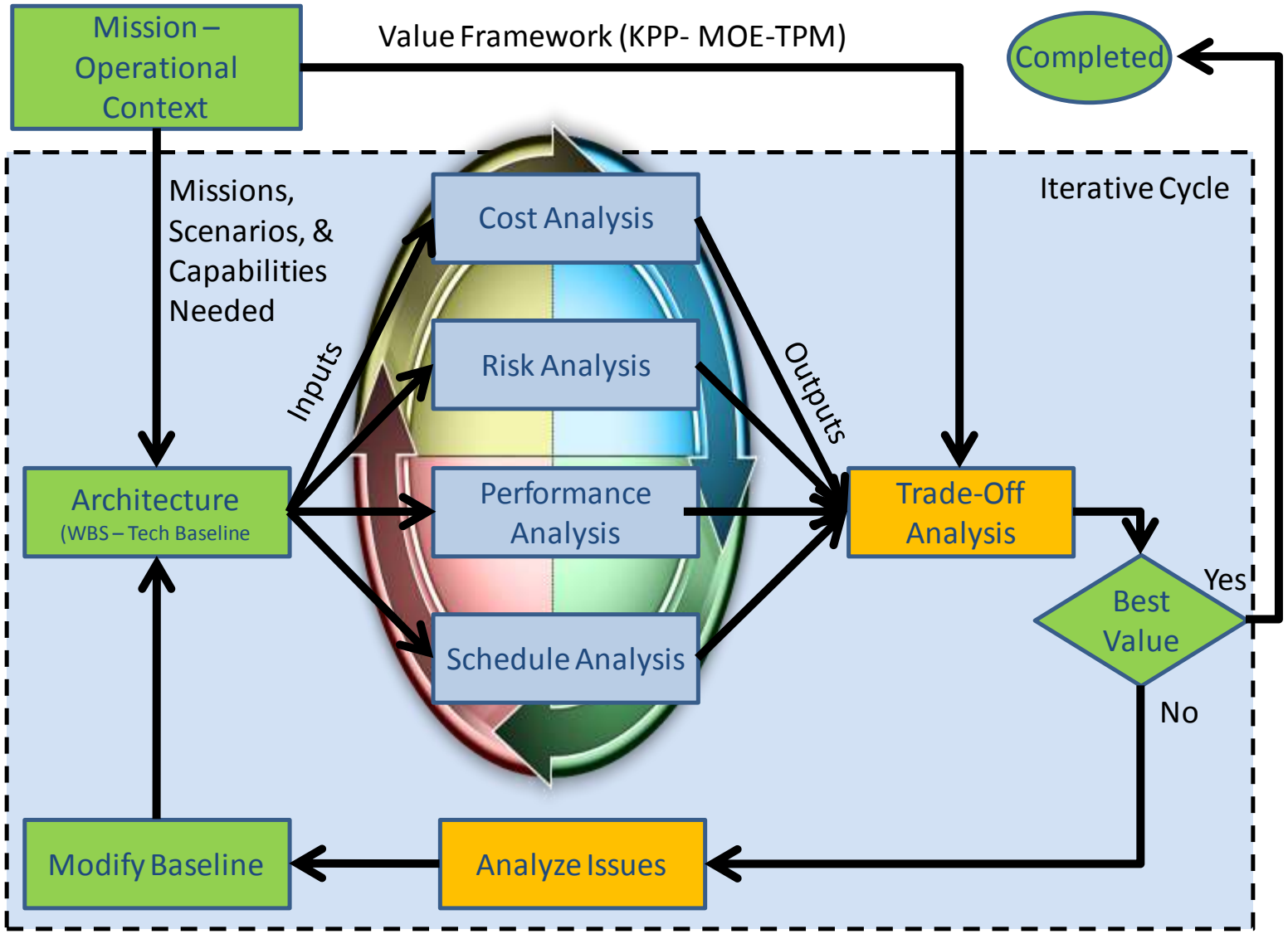
Affordability Analysis Workflow



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Optimize tomorrow

3 Simple Rules For Engineering Affordability

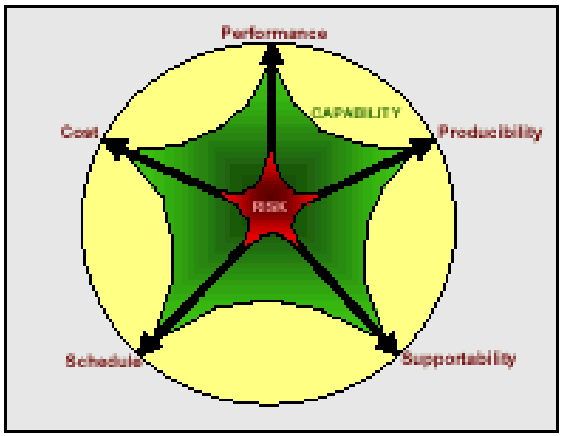
- A Life Cycle view is used for all decisions
- Requirements are traded and set with a balance of cost, risk, schedule, and performance
- Risk is quantified and managed by the program

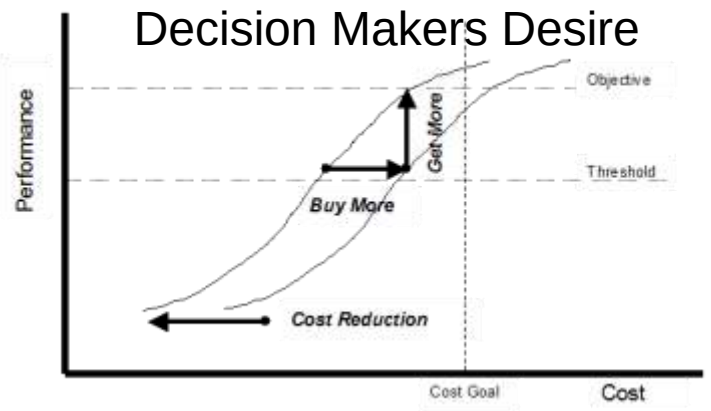
A Life Cycle view is used for all decision

- Emphasis on Cost Objectives and Affordability
- Customer-funding profile and life cycle costs
- Contractor-development and production costs
- User- only necessary and sufficient requirements
- Cost/benefit
- Development
- Production
- O & S, infrastructure costs
- Growth & improvements
- Reliability
- Robust design
- Supportability

Requirements are traded and set with a balance of cost, risk, schedule, and performance.

- Use stakeholder values to make balancing decisions
- Performance-based specifications
- Cost/schedule/performance tradeoffs [common trade study process]
- Requirements provide adequate utility to User (No Gold Plating)
- Design meets goals set for…producibility, other "–ilities"





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Risk is quantified and managed by the program

- CPIPT (cost-performance IPT; User, Customer, Contractor)
- AFFORDABILITY/CAIV Plan and strategy
- Risk mitigation plans informed by cost targets
- Organizational structure
- Incentives
- Cost targets
- Cost reduction initiatives
- KPP/TPM
- IMP/IMS
- Earned Value
- Keep a reserve

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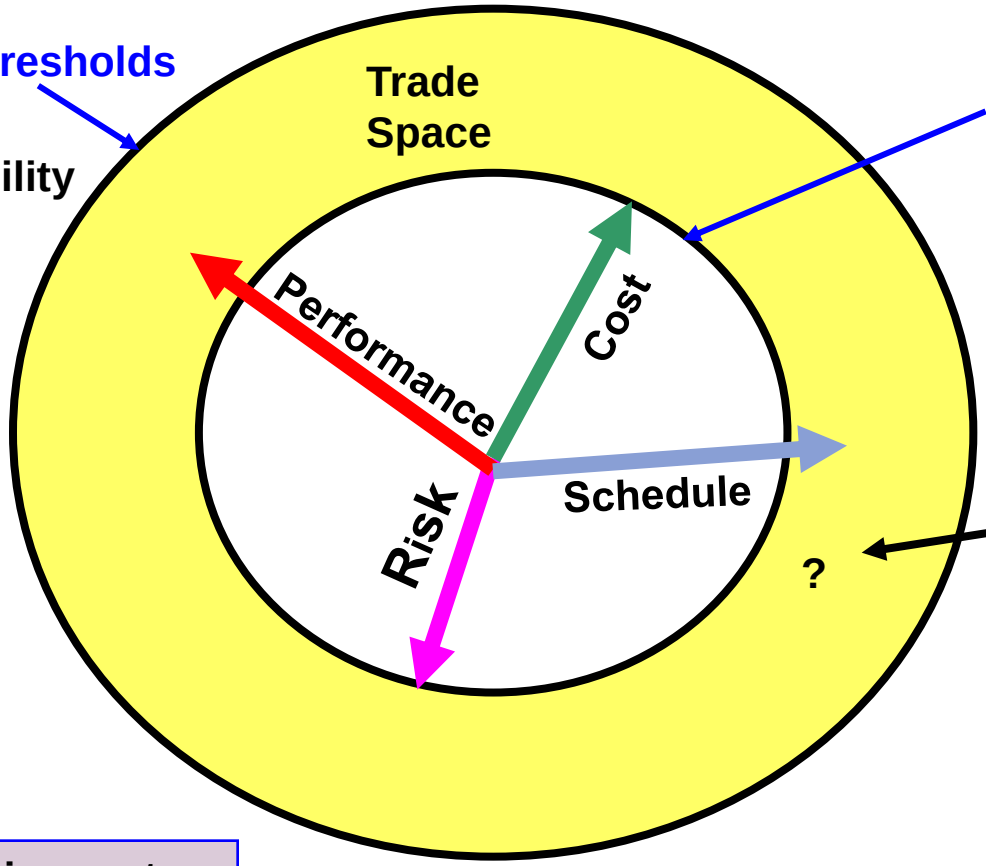
Summary

Focus On Best Achievable Customer Value



Cost Thresholds

Upper Affordability Limit

Cost Goals

What the customer Would like to pay

Program Strategies

Mission Needs

LCC

ILS

Cost Targets

- Price to Win
- Optimum Solution
- Best Bang for the $$
- ?$$?

Customer

Operational Requirements

Technical Requirements

Your mission is to make a product that meets your customer's needs and is affordable

Additional Questions & Next Steps

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Definitions

- Affordabillty[1]

  The degree to which the life-cycle cost of the resources being allocated on a capability in relation to other alternative uses of those resources reflects (i) the importance, urgency, and satisfaction of mission, strategic investment, and organizational needs, and (ii) a prudent balance of performance, cost, and schedule constraints consistent with the time phased availability of budgeted resources.

- Affordability Analysis

  A process and assessment that supports resource decision-making which identifies and quantifies stakeholders' performance expectations, associates value to those expectations, and measures the life-cycle cost of a set of alternatives in relations to the opportunity costs of alternative resourcing actions or plan.

Notes: **1 - BusinessDictonary.com** http://www.businessdictionary.com/definition/affordability.html

Key Techniques

- ## Value Engineering[1]

  Value Engineering is an organized/systematic approach that analyzes the functions of systems, equipment, facilities, services, and supplies to ensure they achieve their essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, and safety

- ## Design to Cost

  - Design to Cost (DTC) is an engineering discipline that meets customer cost requirements through an iterative process that balances cost, performance, and supportability while eliminating non-value added activity. DTC is an inherent element of Integrated Product Development (IPD) and is implemented within the common Integrated Product Development System (IPDS).

- ## Cost as an Independent Variable (CAIV)

  – Cost as an Independent Variable (CAIV) is a management discipline. The DOD CAIV policy sets cost as a military requirement and requires that programs establish aggressive, realistic cost objectives and to manage to obtain those objectives. Cost objectives must balance mission needs with projected out-year resources. CAIV seeks to find the optimal balance between cost, performance, risk, and schedule

Notes: **1 - DoD Value Engineering: A Guidebook of Best Practices and Tools. Retrieved May 10, 2012, from Defense Acquisition University**: https://acc.dau.mil/adl/en-US/452842/file/58455/SD-24.pdf

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