



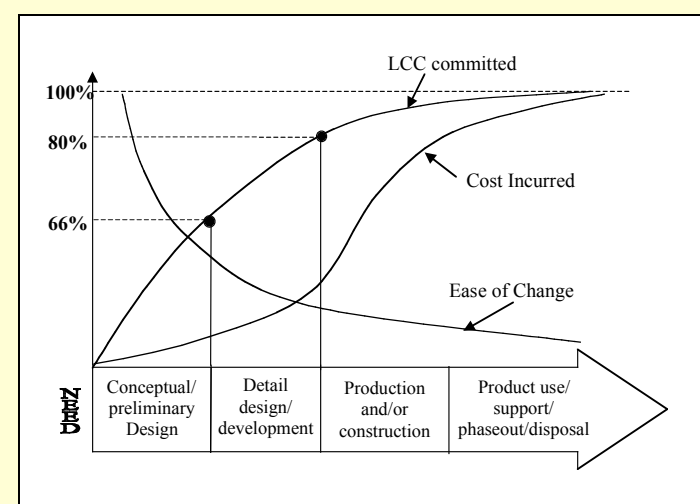
Incorporating System Properties into Multi-Attribute Tradespace Exploration with Concurrent Design

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Committee: Daniel Hastings (Chair), Deborah Nightingale, Olivier de Weck, Thomas Allen

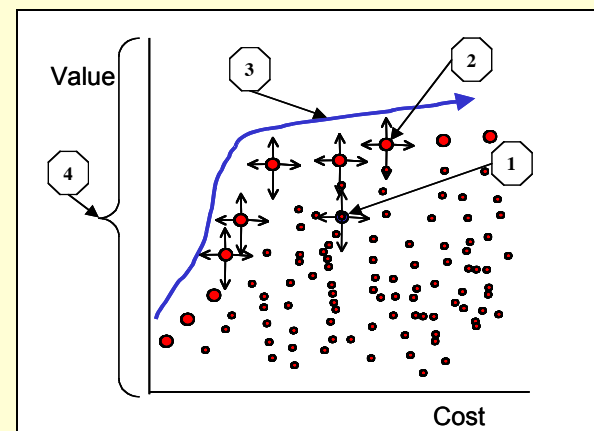
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Motivation



Conceptual Design is high leverage phase in system development

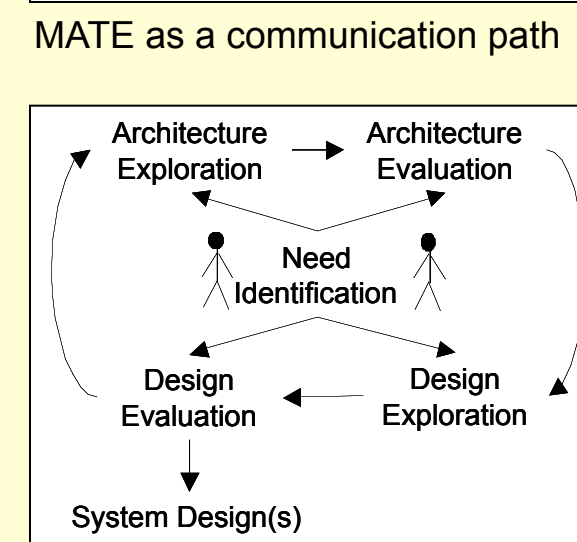
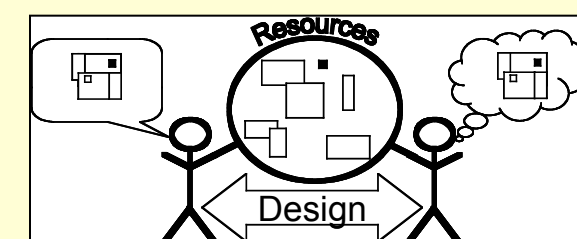
Tradespace Exploration enables 'big picture' understanding



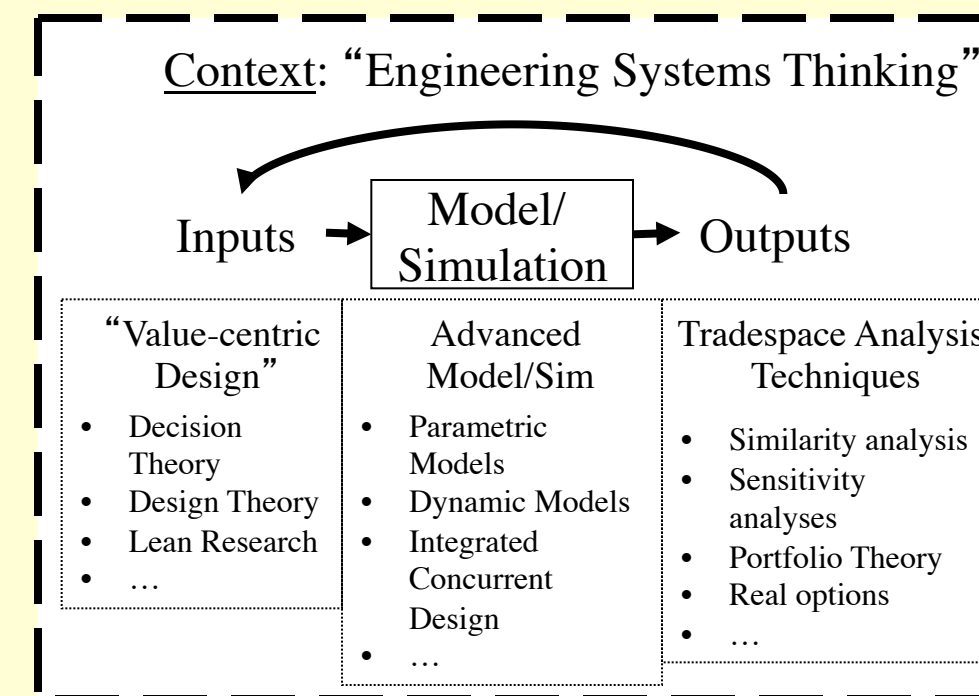
1. Point design
2. "Optimized" designs
3. "Optimized" sets
4. Full tradespace

The "MATE" System

Multi-Attribute Tradespace Exploration



MATE as a process



MATE as a system

Academic Pursuits

- Research Questions
 1. What are the relationships between flexibility, adaptability, robustness, and scalability/modularity for space systems?
 2. How can these 3-4 ilities be quantified and/or used as decision metrics when exploring tradespaces?
- Objective:
 - Extend the Multi-attribute Tradespace Exploration with Concurrent Design process to include consideration of several of the ESD defined "ilities" system properties
- Anticipated contribution (by end of 2005):
 - Expanded generalized framework for Multi-Attribute Tradespace Exploration with Concurrent Design (MATE-CON) process
 - Analysis for incorporating and understanding tradeoffs of certain "ilities" in MATE-CON; impact assessment on quality of system and system-of-system design through tradespace perspective

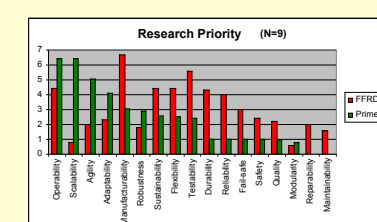
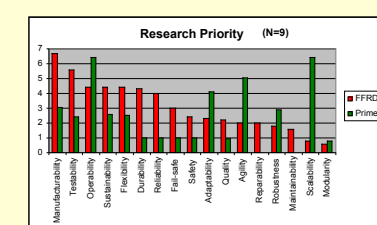
Projects

Project 1

Conceptual Design Industry State of Practice: Applicability, Deployability, and Need

- Visited FFRDC, Prime contractors
- Survey and interview
- Air Force/LAI System Engineering for Robustness Workshop

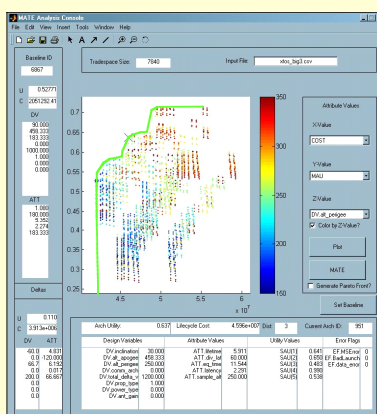
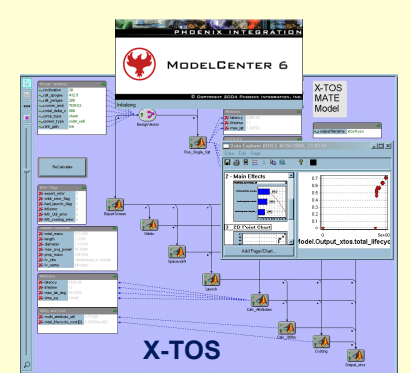
Flexibility	Agility	Robustness	Palatability
1. Flexibility is the property of a system that enables it to adapt to a wide range of operating conditions and mission requirements. It is the ability to change configuration or function in response to a change in requirements. Flexibility may be measured in terms of the number of configurations that can be generated from a single design.	2. Agility is the ability of a system to respond quickly and effectively to changes in requirements. It is the ability to change configuration or function in response to a change in requirements. Agility may be measured in terms of the time to generate a new configuration.	3. Robustness is the property of a system that enables it to maintain performance in the presence of uncertainty. It is the ability to maintain performance in the presence of uncertainty. Robustness may be measured in terms of the range of operating conditions over which performance is maintained.	4. Palatability is the property of a system that enables it to be used by a wide range of users. It is the ability to be used by a wide range of users. Palatability may be measured in terms of the number of users that can be supported.



Project 2

Knowledge Capture, Synthesis, Analysis: Develop MATE Matlab toolbox and reusable model library

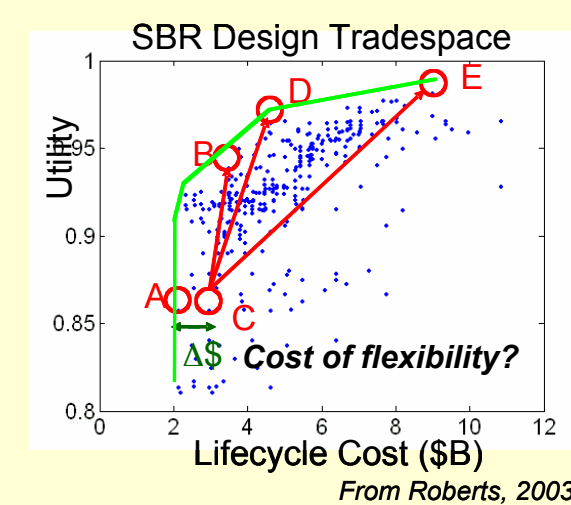
- Incorporate work from six prior MATE models
- Standardize and collect functions



Focus on Robustness, Flexibility, Adaptability, Scalability...

Ex. MATE-CON ilities

Flexibility...



Related:

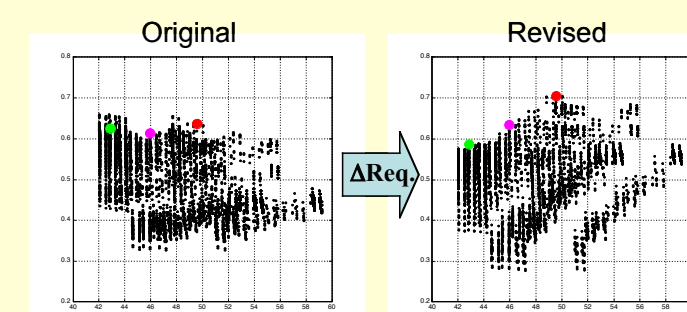
- Adaptability (self-changing)
- Scalability (resizing)

Robustness...

To changes in policy:



To changes in desires:



Publications

Ross, Adam M., Nathan P. Diller, Daniel E. Hastings, and Joyce M. Warmkessel. "Multi-Attribute Tradespace Exploration in Space System Design." In *World Space Congress*, 1-14. Houston, TX: IAF, 2002.

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Ross, Adam M. "Multi-Attribute Tradespace Exploration with Concurrent Design as a Value-Centric Framework for Space System Architecture and Design." Dual-SM, Massachusetts Institute of Technology, 2003.

Ross, Adam M., Nathan P. Diller, Daniel E. Hastings, and Joyce M. Warmkessel. "Multi-Attribute Tradespace Exploration with Concurrent Design as a Front-End for Effective Space System Design." *Journal of Spacecraft and Rockets* 41, no. 1 (2004): 20-28.

Ross, Adam M., and Daniel E. Hastings. "The Tradespace Exploration Paradigm." Paper presented at the INCOSE 2005 International Symposium, Rochester, NY, July 10-15 2005 (Submitted).