

System Complexity, the “ilities,” and Robustness

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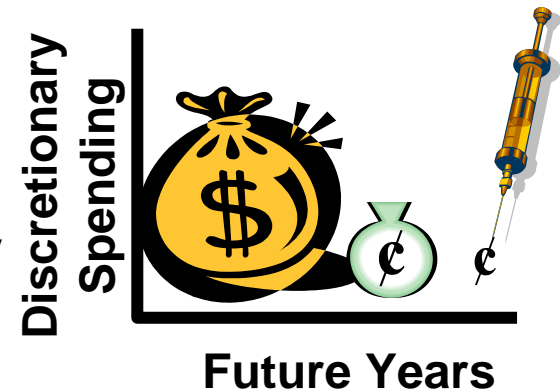
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Problem

- Budgetary constraints will force systems to have a longer life cycle and greater adaptability to a variety of missions.
- Systems engineers need to understand why some systems perform well in the “ilities” (flexibility, adaptability, upgradeability, reliability, scalability, and robustness) and others don’t so that they can incorporate that thought process into the design, development, and spiral development of new systems.
- Program managers need a framework to price an option for incorporating one, some, or all of the ilities into their systems to meet user demand while minimizing life cycle costs.



Background



- The DoD has adopted the JCIDS process for developing and acquiring systems in a more rapid and efficient manner.
- Real Options offers a possible design and systems engineering paradigm for spiral development.
- Professors Richard de Neufville and Oliver de Weck of MIT are working on pricing Real Options for systems.
 - Have studied phasing Iridium and phasing a parking garage as market demand becomes more certain
- De Neufville's work lays a good foundation for understanding options on individual attributes and groups of attributes (nested options).
 - Want options IN a project, not ON (go/no go) a project

Objective

- **Determine the initial design decisions and key attributes that support good performance in theilities**
- **Determine the cost of these attributes on historical systems: was it cheap or expensive as a percentage of overall system costs?**
- **Determine how to price individual attributes (options) and groups of attributes (nested options) to possibly exercise in the future**
- **In essence, help the PM make wise short-term and long-term design and investment decisions**

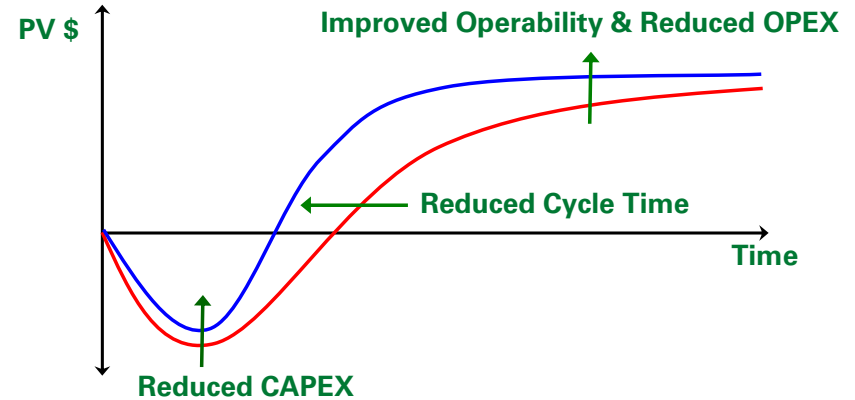


Activities

- **Studying a variety of correlated and uncorrelated complex systems to determine if common design tenets relate across systems**
 - **Mobile Oil platforms for platforming opportunities**
 - **microUAVs for hot/cold spot analysis**
 - **VISA International for IT application**
 - **GPS for space system application**

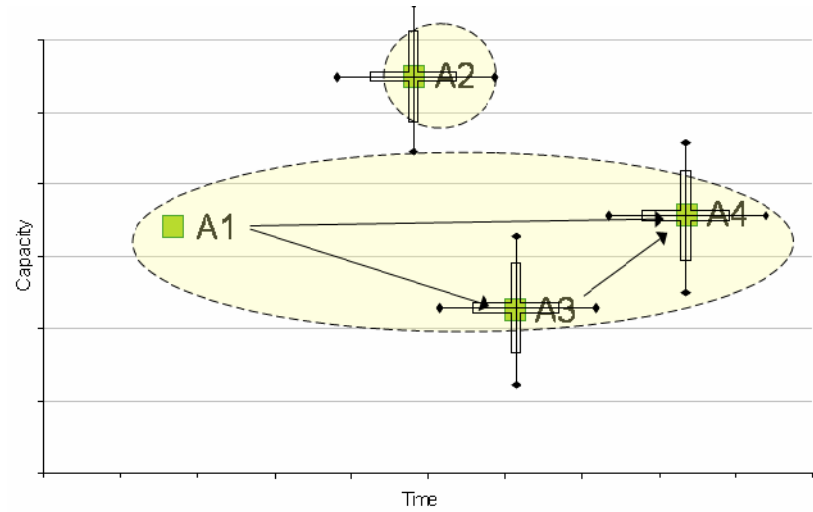
Highlight: Standardization Benefits

- CAPEX reduction
- OPEX reduction
- Cycle time
- NPV-based benefits, not interesting...

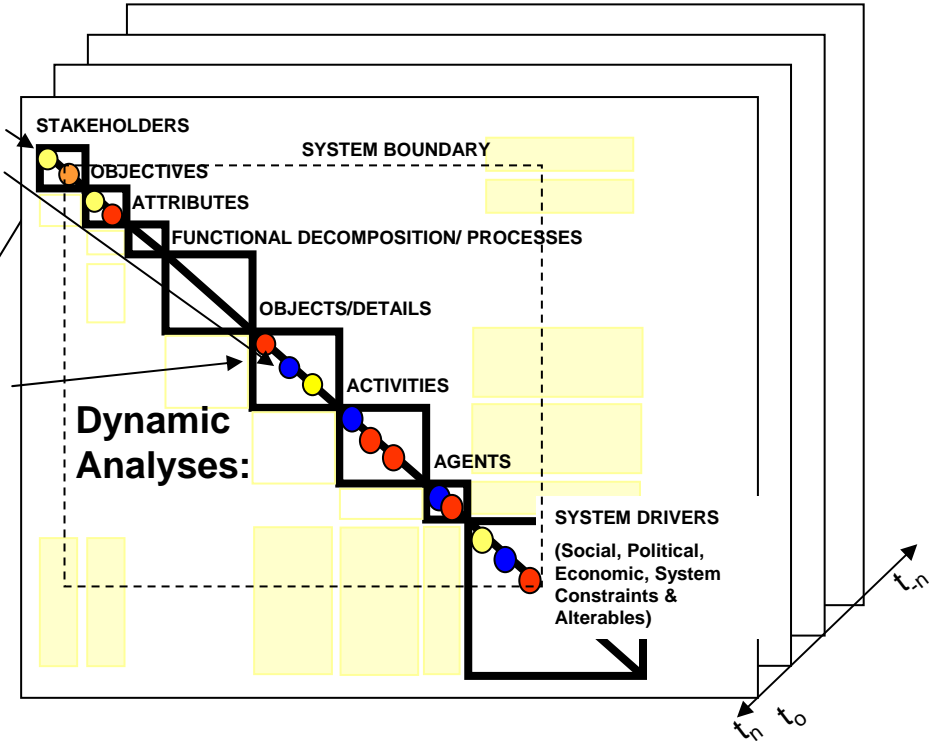
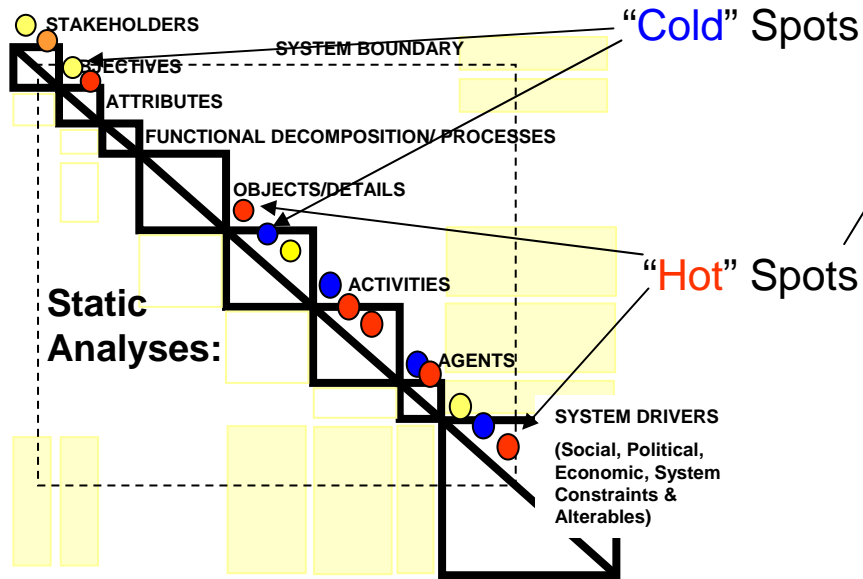


- Uncertainty

- Benefits depend on timing & capacity
- Standardization → commitment → risk if not well planned
- Standardization → flexibility → value if well planned
- Major driver in preliminary design



Highlight: Coupled DSM – Screening for “Hot” and “Cold” Spots



Working Definitions:

- Nodes in an engineering system are “Hot” if future states are uncertain (change is likely) and changes have significant upside or downside consequences
- Nodes are “Cold” if they are unlikely to change and likely changes have insignificant consequences on system

Impact

- **Can influence the design of the vast majority of government projects**
- **Supports near-term goals of a PM (1–3 year horizon) that must show impact while in charge while also supporting society's long-term goals**
 - **PM can decrease initial and long-term costs**
 - **System meets user demand when it arises – good for PM and society**
 - **PM avoids excessive costs when user demand is inaccurate**
 - **Extends usable life of systems and mission applications**
- **Program's initial required investment and life cycle costs should decrease**

Future Plans

- Continue studying a variety of historical systems – possibly B-2, AOC, eBay, or Google
- Apply to current systems – possibly airborne network, MILSATCOM system(s), and DoD IT system
- Link together results of research on non-correlated systems to develop overarching principles related to design tenets that support good performance related to theilities
- Develop a framework to determine the value of a variety of options across a program or enterprise
- Relate to other Real Options MSRs