ESS 2008
Poster Session

Operational Flexibility in Complex Enterprises: Case Studies from Recent Military Operations

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Research Group: LAI

Thesis Committee: Dr. Joel Moses, Chair
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Motivation / Problem

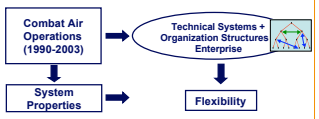
- ***Problem: DoD's desire to use networks and information to enable flexibility presents key challenges:***
  - Military operations are complex, high-paced, socially driven, technically enabled *systems* that are difficult to predict and to control
  - Hierarchical structures and the need for accountability create a continual tension between local (operational/tactical) and system-level (strategic) optimization
  - Current approaches mainly address narrowly focused, lower level problems and do not address issues that can aid *ex ante* design of enterprise flexibility
- **Solution: focus on system-level attributes and properties**
  - *Flexibility* is a property of increasing utility in military operations and other large scale systems (manufacturing systems; regional economies; corporate strategies; complex engineering systems)
- **Knowledge Gaps**
  - Role of architecture
  - Role of hierarchical relationships in creating system level properties
  - Role of multi-level lateral interactions in enabling flexibility
  - Little thought to explicit design of complex *enterprises*

Key Question(s)

- ***"What is the relationship between architecture and flexibility in complex enterprise systems?"***
- ***"How do we design flexible enterprises?"***

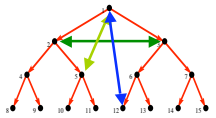
Methodology

Meta-analysis of primary and secondary research using architectural framework and model development. Extension of previous ESD case study research on combat air operations.
(Kometer, ESD Ph.D., 2005)



The Research

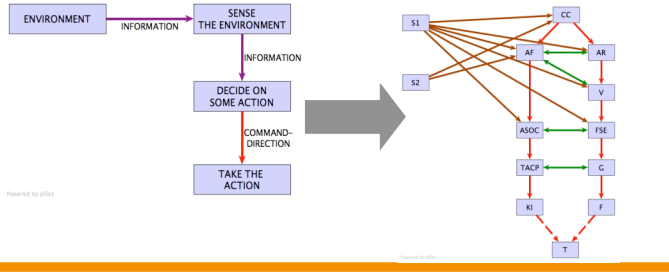
- **Number of *alternatives* in a system is a measure of flexibility**
- ***Flexibility* can be enabled in an enterprise by explicit design of the enterprise architecture using a layered structure with a mixture of lateral and vertical connections**



Structure	Paths (root to bottom)	Increase above base
Base	8	-
Add edge (2,3)	16	8
Add edge (1,5)	10	2
Add edge (1,12)	9	1

Operational flexibility in complex enterprises is enhanced by lateral interactions at multiple system levels

Army and Air Force architecture in second Iraq War



Results/Insights

- **Hierarchical architectures with lateral interactions at multiple levels are more flexible than traditional tree-structured hierarchies**
  - ***ad hoc* lateral interactions at the tactical level enable flexibility but can contribute to loss of coherence**
  - **Layer violations can result in unintended outcomes**
- **Lateral interactions *at higher levels of the enterprise are important* to maintain strategic coherence**
  - **Where lateral interactions at high levels failed, did not exist, or were by-passed, either operational problems developed or tactical/operational level flexibility was inhibited (Desert Storm, Kosovo, Afghanistan)**
- ***Lateral interactions at lower levels are required* to gain operational and tactical flexibility in uncertain and fast-moving operations**
- **Architectural framework and the flexibility metric enables system level comparative analysis of flexibility along a spectrum of possible operational enterprise architectures**
- **Layered hierarchical approaches provide a powerful design tool for operational architectures and present a potentially rich source of insight to many challenging enterprise problems**

Wrap up

- **Architectural perspective builds upon and extends process-based analysis of Kometer**
- **Simple flexibility metric requires further exploration with higher fidelity data → may provide an *enterprise level design variable* that avoids excessive specificity but provides enough clarity to support design of enterprise architectures**
- **Potential applications to other complex operational problems such as health care and defense acquisition**

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