

Some final comments on system architecture and organizational structures

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On the relation of CS to System Architecture

- Software is not simply another box in a large scale engineering system; CS represents a major mode of thought that is relatively new to much of engineering
- Some CS concepts (e.g., open system architecture) will become increasingly important in the architecture of engineering systems and organizational structures
- Layers of abstraction is a big idea in CS, as well as in branches of pure mathematics.
- Most engineering fields do not rely on layers of abstraction, partly because they lack the information complexity that makes it important if not essential to develop abstractions and use layers. On the other hand, the information complexity of engineering systems is growing a great deal, thus potentially necessitating such architectures

Foundational Issues in Large Scale Systems

- **Traditional engineering goals**

- Function, performance, cost

- **Non-traditional goals** (“ilities”)

- Flexibility, robustness, sustainability, safety, scalability, ...

- These goals often involve long time spans and life-cycle issues

- **Characteristics** (Related to System Architecture or Enterprise Structure)

- Complexity, uncertainty, emergence

- Manage these characteristics, do not let them manage you

- **Relationships** between goals and characteristics

- Relationships or trade-offs are often the fundamental issues

Generic vs. 'Real' Architectures

- Recall various generic hierarchies: pure trees, layers, hybrid tree-layer
- What types of changes in such architectures are close to generic?
 - Level skipping (but no laterality) in all of the types
 - Some extra lateral connections in hybrid architectures

Culture and Organizations

- I believe that methodologies for the design of large scale systems are deeply affected by national cultural values, especially the relative importance placed on competition versus cooperation.
- Tree structured hierarchical approaches and certain forms of modularity and networks (e.g., market-oriented networks) are consistent with an emphasis on competition
- Layered approaches and true team-work are consistent with an emphasis on cooperation in designed systems and organizations.
- In hybrid tree-layer organizations, there is great importance placed on middle managers to foster and sustain values, such as cooperation
- In layered or hybrid tree-layer engineering systems there is likely great importance on abstractions as ways of dividing layers, with no doubt some loss in performance much of the time
- One will likely not have a deep foundation for engineering systems unless you understand the affect of cultural values on the way people analyze and design systems