

The Changing Role of the Systems Engineer in a System of Systems (SoS) Environment

by
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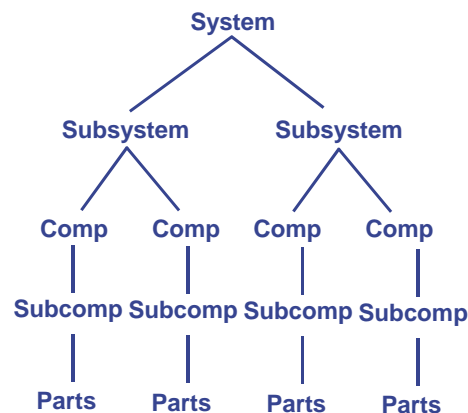


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Topics

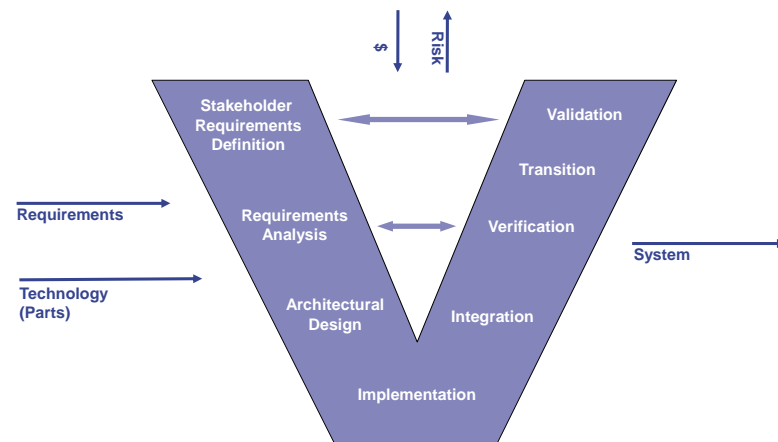
- The Role of the Systems Engineer in a Traditional Systems Engineering (TSE) Environment
- Applications and Extensions for Commercial-off-the-Shelf (COTS)-Based Systems Engineering
- Applications and Extensions for Systems of Systems Engineering (SoSE)
- Summary and Conclusions

The concept of “system hierarchy” is a key concept relevant to this discussion.



Changing Role of the SE in an SoS Environment

We will use the traditional “Vee” development model with the processes of ISO 15288 to characterize the Traditional Systems Engineering (TSE) process.



TSE: The Systems Engineer as Craftsman

- The Systems Engineer (sometimes called the System Architect) is expected to:
 - Understand the customer’s needs
 - Translate them into requirements and a system design
 - Allocate & derive component requirements
- TSE focuses on control
 - Control of requirements
 - Control of design
 - Control of integration & test



Topics

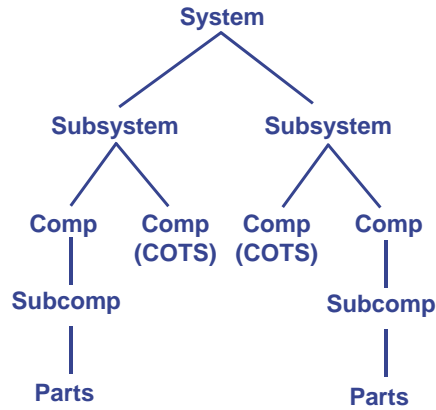
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Definition of a COTS Product

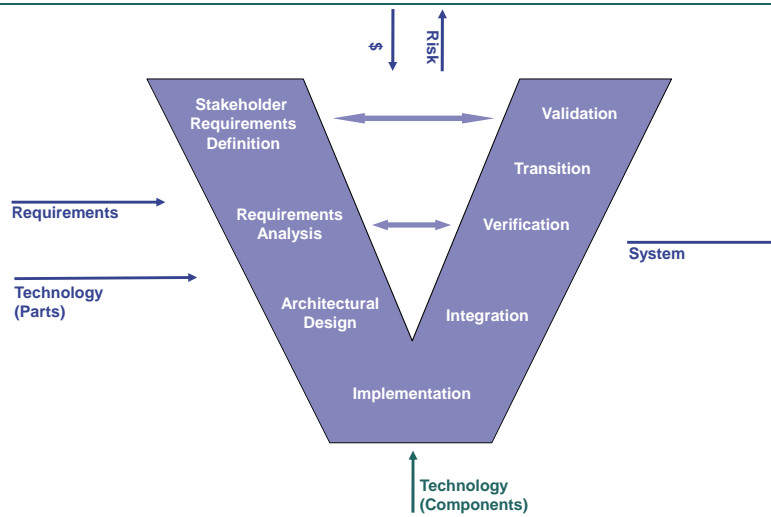
- Sold, leased, or licensed to the general public
- Offered by a vendor trying to profit from it
- Supported and evolved by the vendor, who retains the intellectual property rights
- Vendor (not customer) controls the frequency of the product's maintenance and updates
- Available in multiple, identical copies
- Used without hardware or source code modification

Changing Role of the SE in an SoS Environment

The “system hierarchy” is influenced by the lower-level COTS components.



Impacts of using COTS on the Traditional Systems Engineering (TSE) process.



There are many TSE Lessons Learned from using COTS

- Programmatic Lessons Learned
 - Strategic Alliances
 - Standards Participation
- Systems Lessons Learned
 - Layered Architectures
 - Interface Management
 - Technology Roadmaps
 - Two-Level Maintenance
 - Form, Fit, Function, Interface (F3I) Testing
- Hardware Lessons Learned
 - Open, Standard Interfaces
 - Isolate Unique I/O
- Software Lessons Learned
 - Open, Standard Interfaces
 - Parameterized Software
 - Software Development Environment
 - Hardware Availability does not Equal Software Availability

COTS SE: The Systems Engineer as Composer

- Composers create wonderful music that takes advantage of the set of available instruments
- Similarly, the COTS-based SE composes a design that takes advantage of the set of COTS components
- COTS-based SE relies more on indirect control
 - COTS supplier
 - Multiple COTS customers (you are only one of many)
 - COTS “features”
 - Role of COTS Integrator
 - Several additional stakeholders



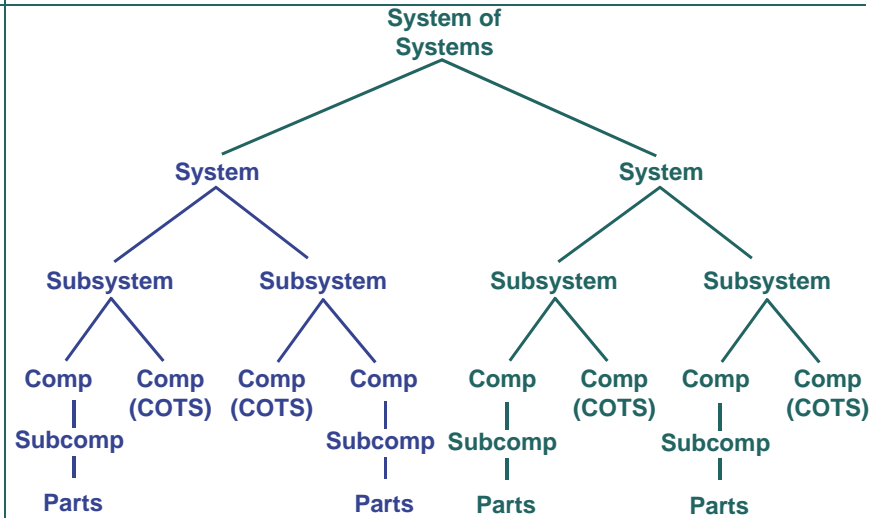
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Definition of Systems of Systems (SoS)

- The common definition of Systems of Systems is...
 - An interacting collection of individual systems that produce results that are not able to be achieved by the individual systems themselves.
- Maier states Systems of Systems possess two additional properties:
 - Operational independence of the individual systems
 - Managerial independence of the individual systems

Extending the “system hierarchy” to include a SoS.

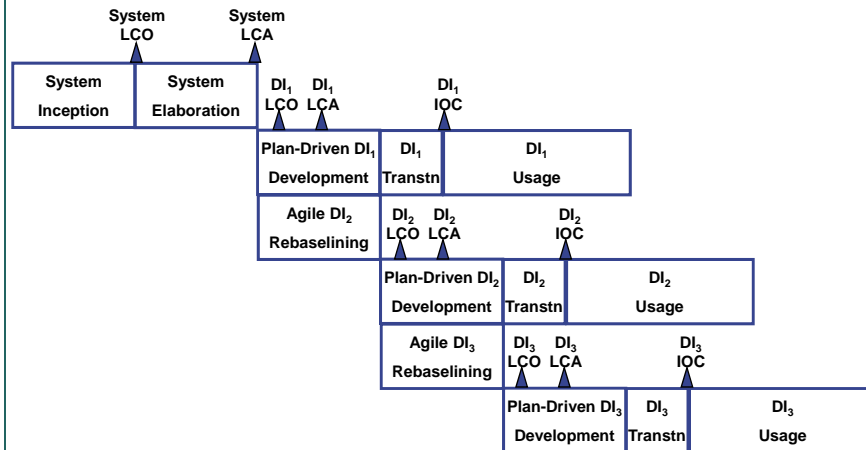


Boehm and Lane introduced the *Spiral 2005* process for SoS developments.

- Life Cycle Objectives (LCO)
 - The stakeholder's commitment to support system architecting
- Life Cycle Architecture/Development Increments (DI_N/LCA)
 - The stakeholder's commitment to support the full life cycle development
- Incremental Operational Capabilities/Development Increments (DI_N/IOC)
 - The stakeholder's commitment to support operations

These typically replace the more traditional reviews.

Typical *Spiral 2005* life cycle view:



SoS Success Relies on Influence

- We will look at two metaphors for influence
 - Conducting
 - The set of activities to ensure the elements in the SoS work together in harmony
 - Choreographing
 - The set of activities to ensure the expressive nature of each of the elements is fully realized, while still conforming to its overall objectives

SoSE: The Systems Engineer as Conductor (w/ SoS Integrator)

- The orchestration is controlled by one party (usually a SoS Integrator serves as the “conductor”)
- It can be thought of as a process flow between parties, yet controlled by a single party
- Goal is to manage the interdependencies and consequences for the good of the emergent whole

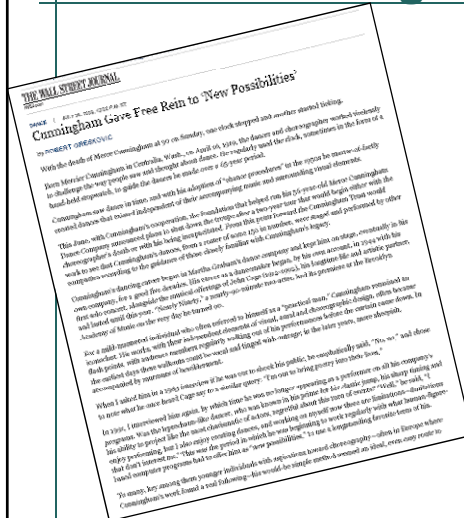


SoSE: The Systems Engineer as Choreographer (w/o SoS Integrator)

- More collaborative in nature than conducting
- Each party involved describes the part it plays in the interaction
- No one party “owns” the total effort, yet there is give-and-take for the good of the whole



WSJ Article on Choreographer Merce Cunningham



“He regularly used the clock, sometimes in the form of a hand-held stopwatch, to guide the dances he made over a 65-year period.”

“... he matter-of-factly created dances that existed independent of their accompanying music and surrounding visual elements.”

“.. he was beginning to work regularly with what human-figure-based computer programs had to offer him as “new possibilities,” to use a longstanding favorite term of his.”

Source: Greskovic, 2009
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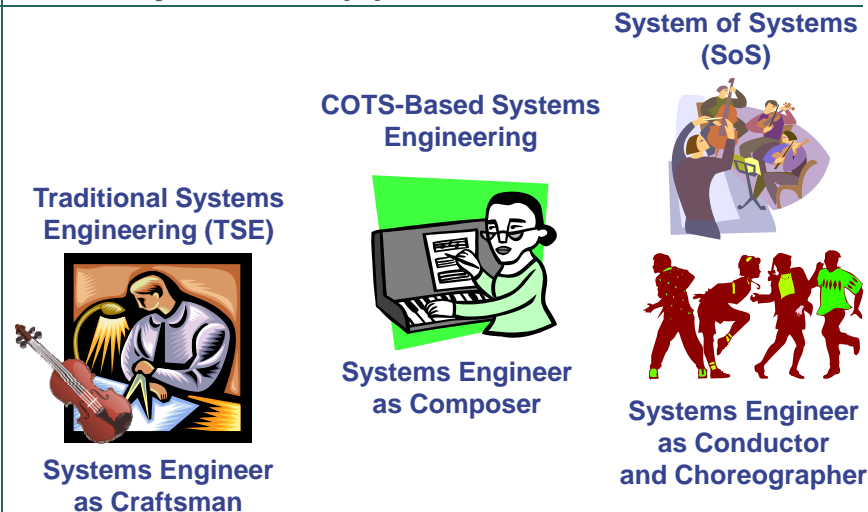
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Summary & Conclusions

TSE	COTS-Based SE	SoSE
SE as Craftsman	SE as Composer	SE as Conductor SE as Choreographer
Influence via Specifications	Influence via Mods & Negotiations	Influence via Increment Capabilities
Top-Down Design & Bottoms-Up I&T	Simultaneous Req/Des/Int/Test	Simultaneous Req/Des/Int/Test
White Box Components	Black Box Components	Black Box Systems
Part Technology Scanning	Component Technology Scanning	System Technology Scanning
Allocated Functionality	Wrappers & Glue	Meta Wrappers & Glue

Understand your environment! Know your role(s)!



Comments? Questions?



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