THE ROLE OF ACADEMIA IN SYSTEMS ENGINEERING

November 16th 2016

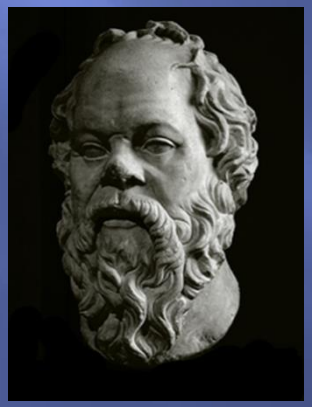
Dr. Alex Both

Agenda

- Why this paper?
- Academia Status Quo
- A holistic approach to Systems Engineering
- Systems Engineer's Roles & Responsibilities
- Academic SE Options
- Undergraduate & Transition
- Conclusions

Socrates Quote, ca 400 BC

"I neither know nor think that I know"



Why?

- Ever increasing cost of complex system development
- Lack of systems training within the industry
- Change has to come from the top
- Need to train the next generation of systems engineers

How?

- Assess how Systems Engineering is currently taught in Academia
- Identify the need and benefits of Systems Engineering and how it can be introduced into an engineering curriculum.
- Highlight the need for a holistic approach to Systems Engineering (Inception to grave)
- Identify Graduate Systems Engineering Paths for engineers

Academia Status Quo in Systems Engineering

- Only one in the top 10 US engineering schools offer an undergraduate degree is Systems Engineering
- One called this "General Engineering" and states:
- *"A common misconception is that general engineering is the undecided option for students who have not yet chosen an engineering major. In contrast, it is a very specific major with the full academic rigor of all engineering majors."*

Academia Status Quo in Systems Engineering

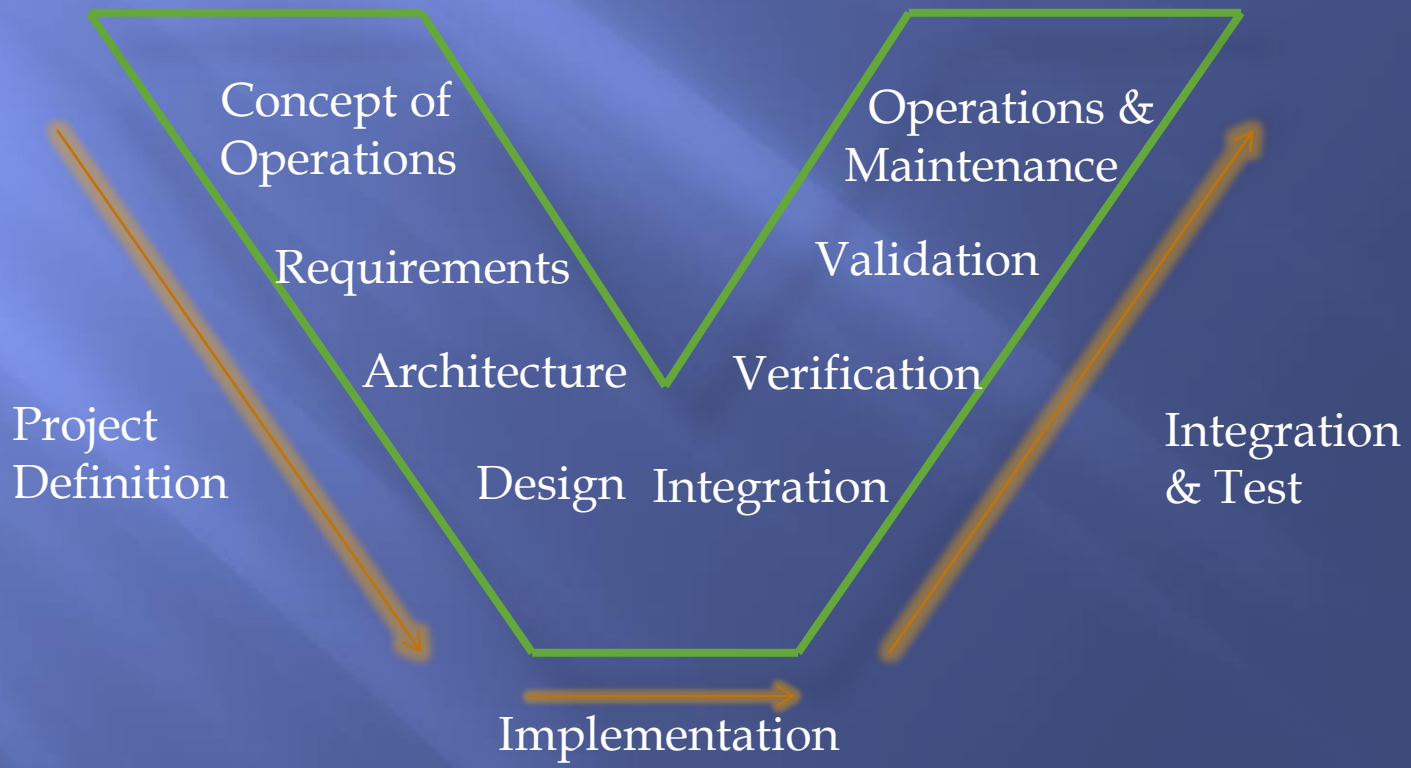
- Academia not in step with industry trends that are characterized by an ever increasing system complexity and integration
- Undergraduate training is often in engineering silos and separate from business
- Definite link between Engineering & Management at the graduate level

Systems Engineering Definitions

- INCOSE: Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem

International Council on Systems Engineering (INCOSE)

INCOSE Focus: The V-Model



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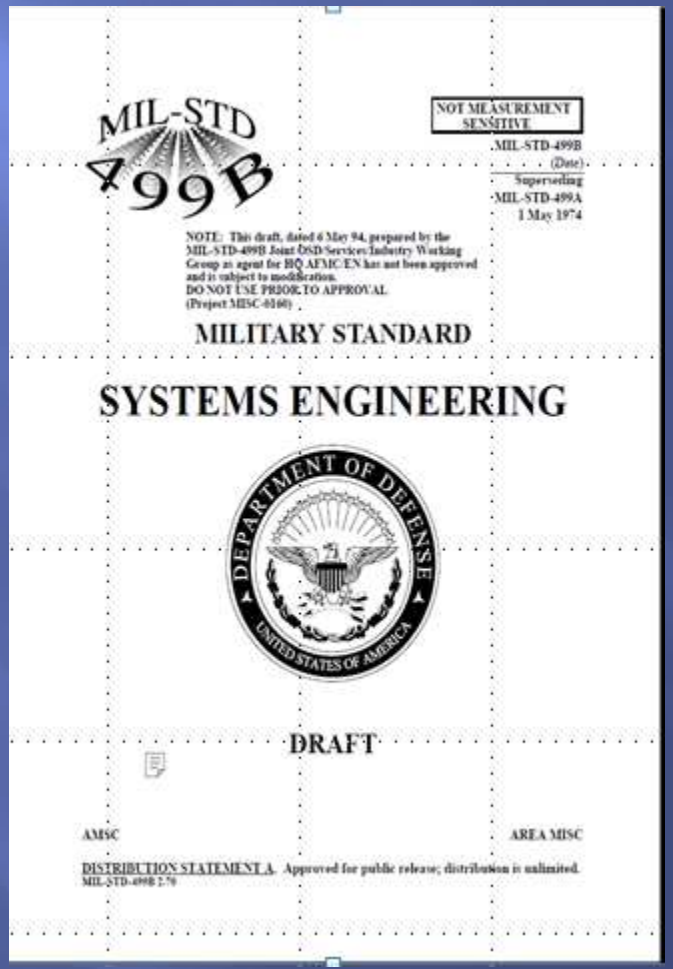

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MIL-STD-499A

1 May 1974

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SYSTEMS ENGINEERING

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The Significance of the Why, How and What

Issues with the V-Model

- It's a supplier-focused process that leads to costly point solutions
- OEMs use the full development life cycle model
- OEM model addresses the "why" which defines strategy and the "how" which leverages business and technical capabilities
- A company cannot succeed on the "what" alone
- A holistic approach starts with a mission, strategy and a plan before even a product is approved for development

A Broader Definition of Systems Engineering

- The Left Wing of the V-Model
  - Strategic Planning (product line & technology)
  - Competitive Analysis
  - Engineering Feasibility and Risk
  - “tribal knowledge”
- The Right Wing of the V-model
  - Field Support
  - Maintenance Plan (predictive)
  - Change Management
  - Obsolescence
  - Retirement/Disposal

Full Life Cycle System Development Process

The Left Wing

- Incorporates the “Why”, “How” and “What”
- Leverages company products and technology
- Identifies risks and opportunities
- Assesses risk mitigation
- Identifies development plan
- Develops system concept
- Creates a plan

The Right Wing

- Enhances in-service experience (customer satisfaction)
- Supports production (change/obsolescence)
- Exposes ancillary products/future growth business opportunities
- Provides lessons learned for future product development (IP)

R&R of a Systems Engineer inside the "V"

- Follow the System Engineering Management Plan
- Capture Customer Requirements
- Allocate & Manage Requirements
- Operate in a Multidisciplinary organization
- Validate Requirements & Manage Technical Risk
- Design/ Architect System
- Oversee Implementation (internal & external)
- Conduct Trade Studies (balance cost, scope and schedule)
- Conduct Integration & Verification
- Support Certification and EIS

R&R of a Systems Engineer outside the "V"

- Support strategic planning & target opportunities
- Support product planning & technology assessment (evaluate competing products & technologies)
- Identify and assess technology risk (known unknowns)
- Support business case, lifecycle strategy including aftermarket (support services)
- Develop technical solution in line with customer and business expectations and generate proposals

R&R of a Systems Engineer outside the "V"

- Provide in-service support (troubleshooting methods)
- Manage change and upgrades in a cost effective way
- Manage obsolescence and retirement
- Support manufacturing
- Capture in-service lessons learned (including how the system is used)

Key Systems Engineering Skills

- Embrace the "big picture"
- Develop a strategy and a plan aligned to the mission
- Analyze and Manage Risk
- Well rounded engineering background
- Perform System Analyses and Trade Studies
- Support Balanced Decision Making (cost-schedule-performance)

Four SE Academic Paths

ENTREPRENEURSHIP	Business	Engineering	Research
• Strategy • Competitive Analysis • Entrepreneurial Business Development • Risk Mngt. • Finance • Marketing	• Business Development • Program Mngt. • Contracts • Supply Chain Mngt. • Risk Mngt. • Security • Policies • Finance • System Life Cycle • Logistics • IP • Manufacturing	• Requirements • MBD • System Architecture • SoC • Trade Analysis • Design • Security • Business Development • Domain Systems • System Test • Tools	• Analytics • Autonomous Systems • AI • Self Learning • Advanced Architectures • IoT Systems • Cloud Systems • Tool Design • Security

Transition to a Masters in Systems Engineering

Aerospace
Medical
Nuclear
Mechanical
Computer Eng.
Electrical
Industrial
Civil
Computer Science

Engineering
Business
Research
Entrepreneurship

Systems Engineering is not just about building systems right. It is also about enabling engineers to build the right systems.

Q&A

Dr Alex Both: alexboth@comcast.net