New Concepts and Trends

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The Software Engineering Institute - Improving the Practice of Engineering: Create, Apply and Amplify

Federally Funded Research and Development Center
Created in 1984
Sponsored by the U.S. Department of Defense
Locations in Pittsburgh, PA; Washington, DC; Frankfurt, Germany
Operated by Carnegie Mellon University
Overview

- Transformational Trends
  - Development
  - Acquisition
  - Human Element
  - Risk Management
  - Communications
- Ten Future Trends
- Wrap-up

“Perfect Storm” Event, October 1991
National Oceanic & Atmospheric Administration
Development: Need for Space, Air, Ground, Water, Underwater Software-Intensive Systems that are Interconnected

- Several million SLOC programs; “Hybrid” systems combining legacy re-use, COTS, new development
- Multi-contractor teams using different processes; dispersed engineering, development & operational locations
- New technologies create opportunities/challenges; products change/evolve, corporations mutate
- Business/operational needs change - often faster than full system capability can be implemented
- Skillset Shortfalls; Cost and schedule constraints
- Demands for increased integration, interoperability, system of system capabilities
- Enterprise perspectives/requirements; sustainment concerns

Development Complexity of Software-Intensive Systems is Increasing
The Acceleration of Innovation in the 21st Century:
- Impacting Both Defense and Society

The Amount of New Technological Innovation is Doubling Every Two Years
- Requires More Upfront SE/SW Engineering to Leverage Trends
Augustine’s Law: Growth of Software - Order of Magnitude Every 10 Years

In The Beginning

1960’s
F-4A
1000 LOC

1970’s
F-15A
50,000 LOC

1980’s
F-16C
300K LOC

1990’s
F-22
1.7M LOC

2000+
F-35
>6M LOC


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Trend & Implications: Augustine’s Law Will Hold

2080?

F-50 - 4.7B Lines of Code

Need for increased functionality will be a forcing function to bring the fields of software and systems engineering closer together.
Moore's Law: The Number of Transistors That Can be Placed on an Integrated Circuit is Doubling Approximately Every Two Years

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Increased Technological Rate of Adoption

- Automobile (1886)
- Telephone (1876)
- Television (1926)
- Radio (1905)
- VCR (1952)
- Microwave (1953)
- PC (1975)
- Cell Phone (1983)
- Internet (1975)

Source: Rich Kaplan, Microsoft

- Automobile = 56 years
- Telephone = 36 years
- Television = 26 years
- Cell phone = 14 years
Acquisition: Life of a Program Manager in a System of Systems and/or Net-Centric Operation…
A Key Challenge is How to Obtain a Better Alignment of Risk Among the Relevant Stakeholders
2005 study confirmed*:

- In advanced knowledge-based organizations, management’s desire for the flow of knowledge is greater than the desire to control boundaries
- Unlike the matrix organization, there is less impact on the dynamics of formal power and control
- Important to measure the system in terms of user performance

* Using Communities of Practice to Drive Organizational Performance and Innovation, 2005, APQ study

From "Science and Technology to Support FORCEnet," Raytheon TD-06-008. Used by permission.

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Human Element

The ability of organizations to compete will increasingly depend on the innovation of the human element.
Society Drivers: Bimodal Demographics (Space Industry)

Graduate School Shortfall

Reconstituting This Group

Average Space Industry S&E Workforce Age Distribution

Trend: Industry/Gov’t Will Increasingly Focus on Attracting, Training and Retaining Systems Engineering Talent

Source: Lockheed Martin (0004305-001: AIAA SE Workforce Data. Frank Cappuccio VP & GM Skunk Works)
Objective is for Software and Systems Engineering to Become More Integrated Versus Separated.
Human Element in the Work-Space Environment

Source: Doug Phair; Technology Evangelist; dphair@mitre.org; February 2008
Communication: Increased Capabilities in the Digital Spectrum Enables Improvements in Communication and Collaboration

*Friedman, Thomas L. “The World Is Flat”, Farrar, Straus and Giroux, 2005*
Higher-Maturity Approaches to Process Improvement Are Important and Synergistic Trends

Data-Driven (e.g., Six Sigma, Lean)

- Determine what your processes can do (Voice of Process)
  - Statistical Process Control
- Clarify what your customer wants (Voice of Customer)
  - Critical to Quality (CTQs)
- Identify and prioritize improvement opportunities
  - Causal analysis of data
- Determine where your customers/competitors are going (Voice of Business)
  - Design for Six Sigma

Model-Driven (e.g., CMM, CMMI)

- Determine the industry best practice
  - Benchmarking, models
- Compare your current practices to the model
  - Appraisal, education
- Identify and prioritize improvement opportunities
  - Implementation
  - Institutionalization
- Look for ways to optimize the processes

CMMI and Six Sigma, Siviy, et al, 2007, Addison Wesley
1. Greater demands on systems and software engineers will stimulate growth in the field – nationally and internationally

2. Industry/Gov’t will increasingly focus on attracting, training and retaining systems and software engineering talent – short and long run – with emphasis on providing a Generation Y work environment

3. Increased reliance on systems and software engineering processes and technologies to effectively manage the acquisition/”green” space

4. The laws of Augustine’s and Moore will continue to hold and will continue to be a forcing function to bring the fields of software and systems engineering closer together

5. Improvements risk-reduction collaboration mechanisms will be significant enablers for increases in systems and software engineering communication and “decision velocity”
Systems and Software Engineering: Ten Trends

6. Systems and software engineers will continually find way to innovative to reduce complexity

7. Increased importance of modeling and simulation

8. Increased customer requests for system and software engineering support will occur earlier in life cycle

9. Shift of systems and software engineering focus from the platform to the networks and ground systems

10. Process improvement will continue to be important!
Recommended Readings


Friedman, Thomas L. “*The World Is Flat*”, Farrar, Straus and Giroux, 2005

Gates, William H. III “*Business @ The Speed of Thought – Using a Digital Nervous System*”, Time Warner Books, 1999


