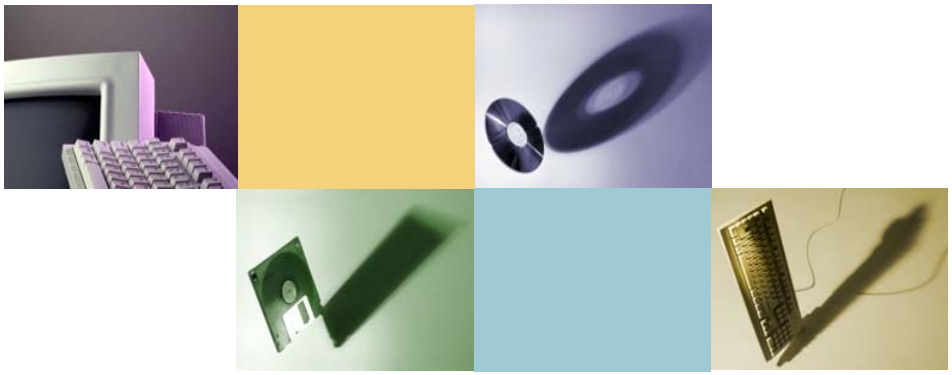
Software Intensive Systems

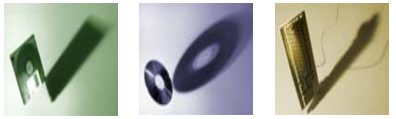


2006 summer study
Out brief for
Assistant Secretary of the Navy (RD&A)

23 June 2006
SSC San Diego

The Terms of Reference

- Review relevant DOD and government programs
- Review industry tools, practices, and standards
- Identify potential benefits of best practices
- Recommend changes in Naval acquisition management, systems engineering, training, education, and business practices
- Suggest S&T investment
- As appropriate, evaluate emerging tools for specifying, bidding, and engineering software-intensive systems and suggest strategies for use across multiple organizations



Study panel and sponsor

- Chair - Dr. Patrick L. Winston
  Professor of Computer Science, MIT
- Co-Chair - Ms. Teresa B. Smith
  Director Strategy, SD&T, Northrop Grumman Electronic Systems Sector
- Dr. Eric Horvitz
  Principal Researcher and Research Area Manager, Microsoft
- VADM Douglas J. Katz
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- Mr. Richard L. Rumpf
  President Rumpf Associates International
- Dr. Howard Shrobe
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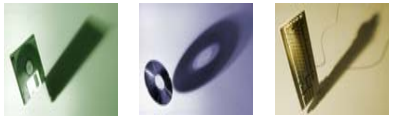
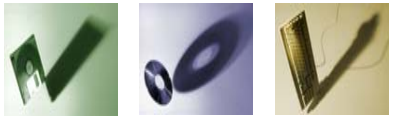


Briefings and visits

- Briefings, programs and defense industry
  - Naval Focus: PEO-IWS; DASN-IWS; LMRS; Aegis; DD(X); FORCEnet; ARCI
  - Army Focus: FCS, SW Improvement Program (Bolton)
  - Joint Focus: SIAP, JSF; JTRS; GIG
  - OSD/Agency Focus: Missile Defense Agency, NSA, Quadrennial Defense Review, NII/GIG
- Other briefings
  - Government: GSA
  - FFRDC: SEI
  - Industry: Raytheon, Microsoft, Lockheed Martin
- Site visits:
  - SIAP Program Office
  - GIG Testbed (JHU/APL)
  - Microsoft Corporation



Joint Vision 2020

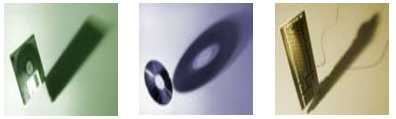
The playing field

- "…the continued development and proliferation of **information technologies will substantially change the conduct of military operations**. These changes in the information environment make *information superiority* a key enabler of the transformation of the operational capabilities of the joint force and the evolution of joint command and control… **Information superiority is the critical enabler of the transformation** of the Department …"

  From Joint Vision 2020
  General Henry Shelton, CJCS, 2000

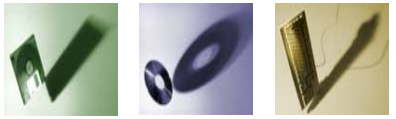
- "Key to achieving this full spectrum dominance will be the ability of U.S. forces to acquire information superiority and the technologies that enable it."

  Delores Etter, DDR&E, DUSDA&T, 2000

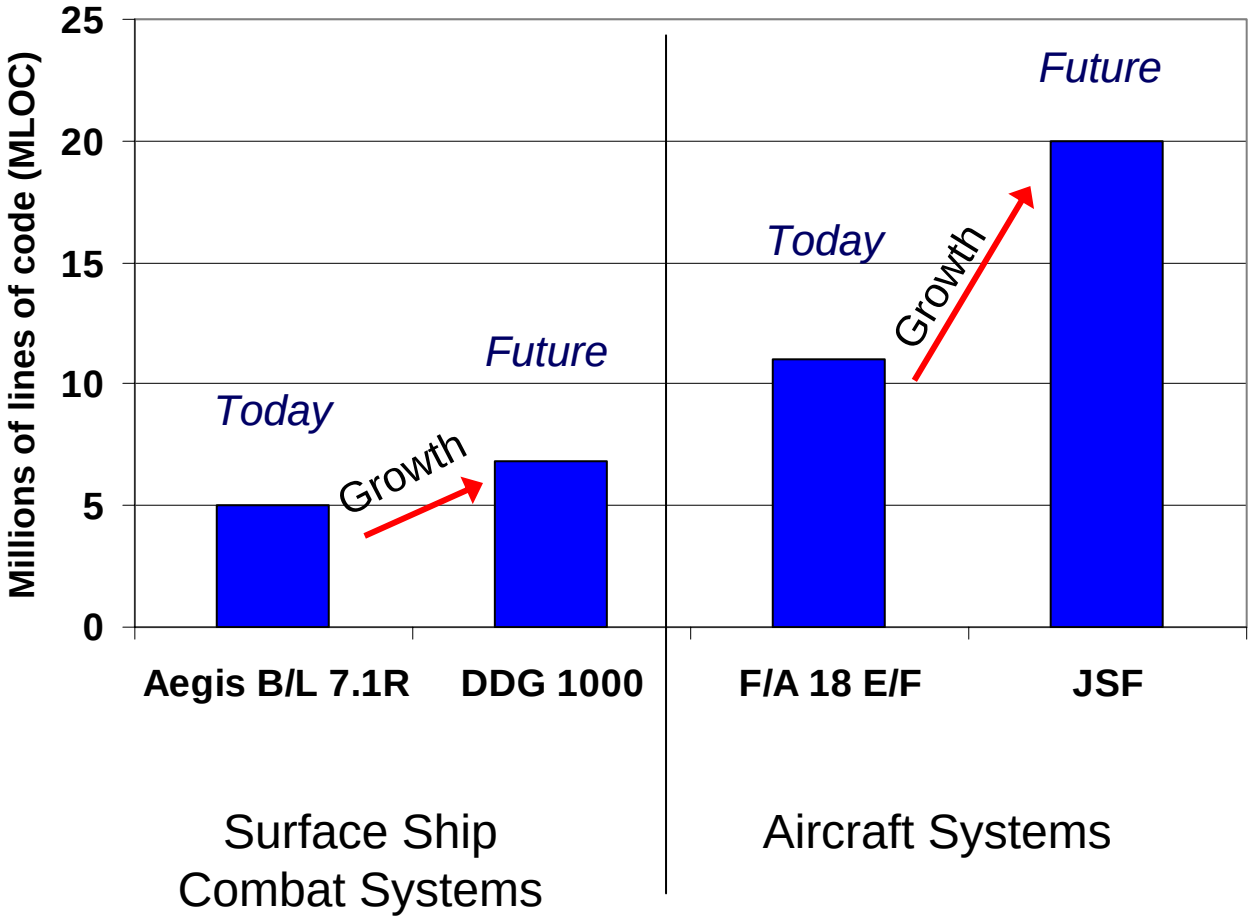


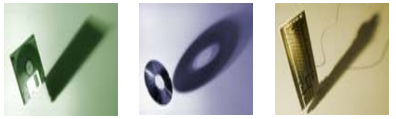
More capability and lower cost

- Software enables new capabilities, such as:
  - Information gathering, fusion, and distribution
  - Coalition collaboration
  - Intelligence gathering
- Software advantages relative to hardware
  - Zero cost replication
  - Greater flexibility
  - Easier upgrade
  - Superior SWAP (Size, Weight, and Power)



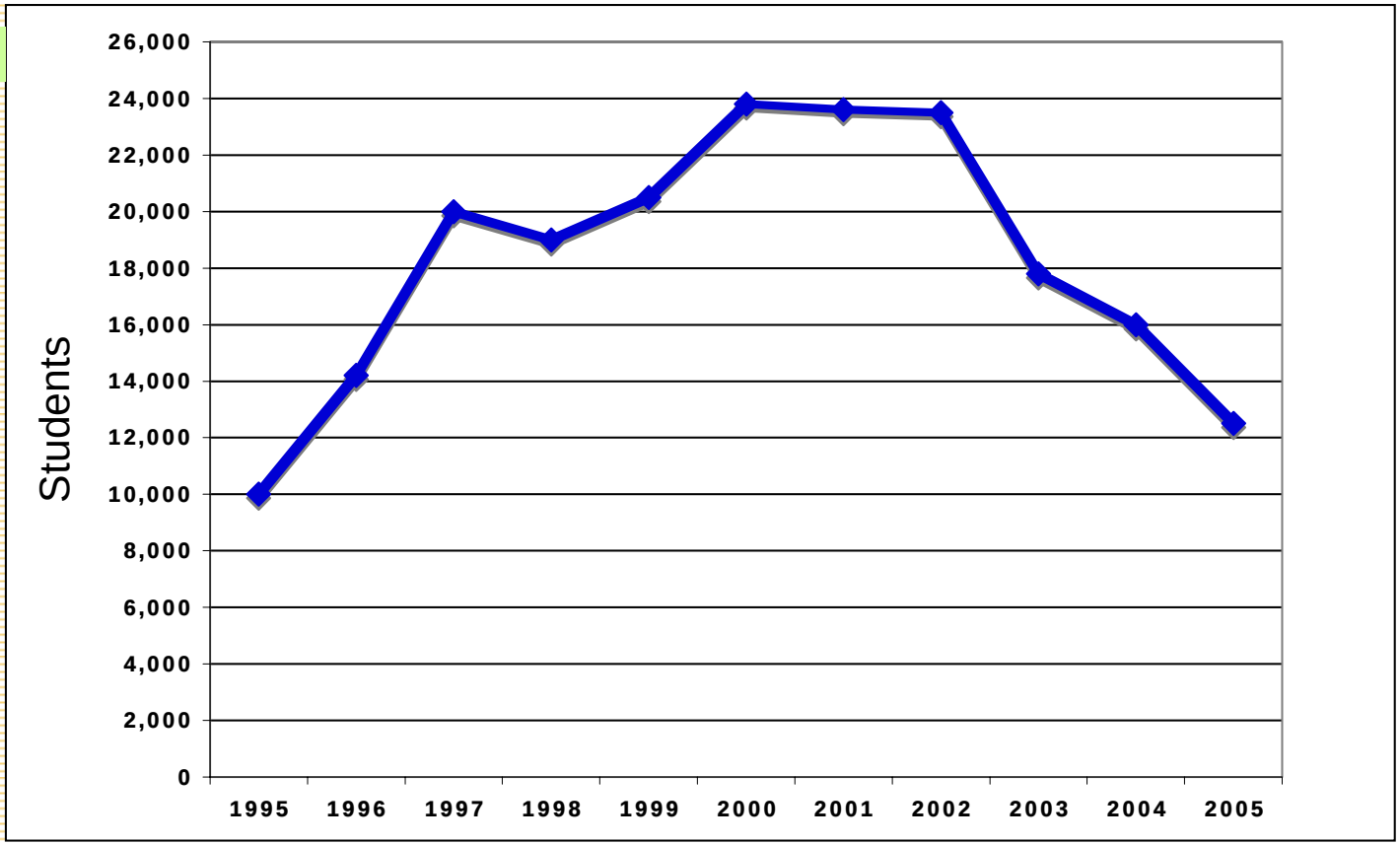
Size of typical Naval combat systems





Human resources
The pipeline is running dry

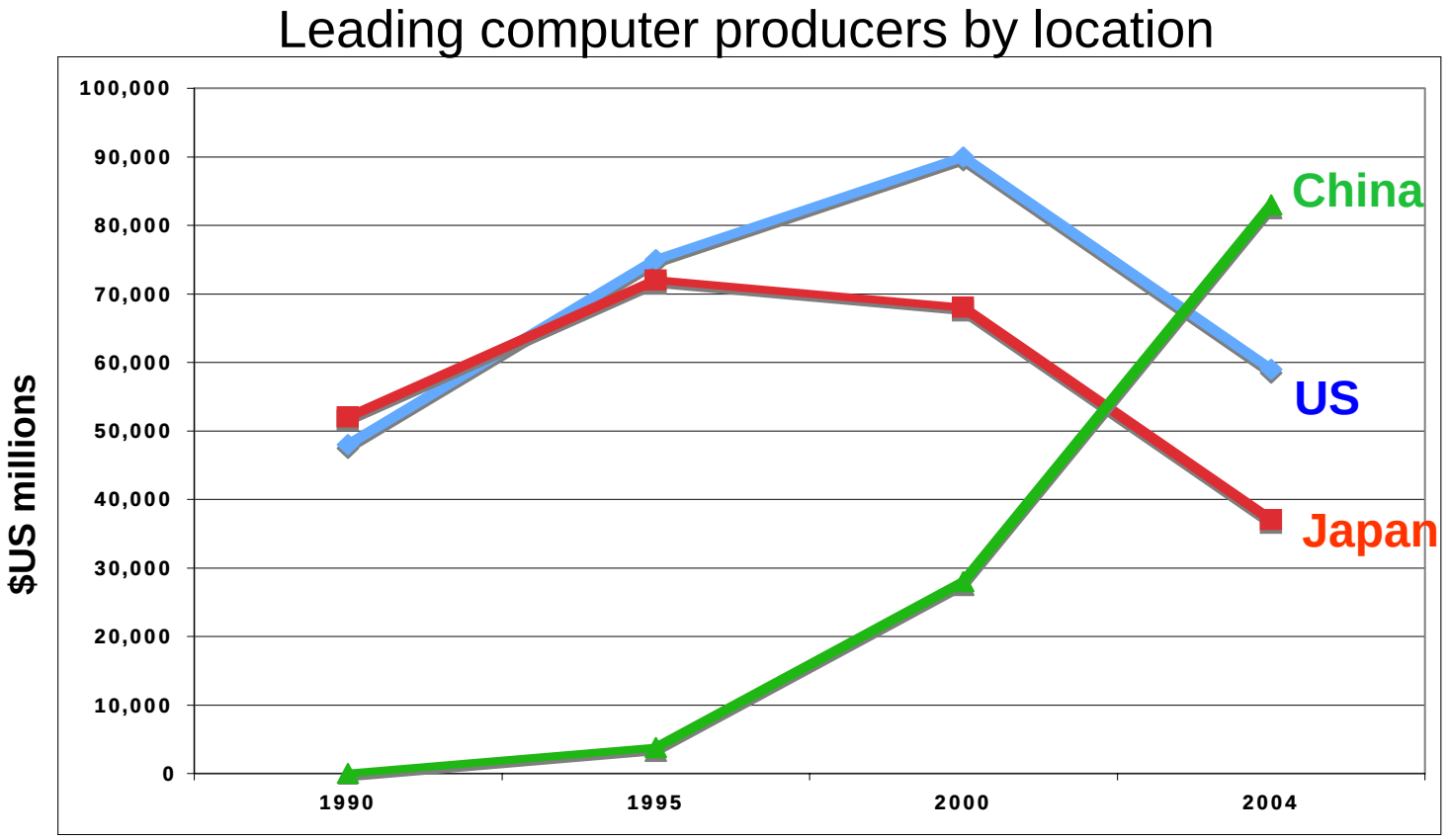
US CS/CE Undergraduate Majors



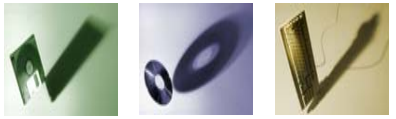
May 2006 Computing Research News

Globalizing of Software and Hardware

- 470,000 IT jobs outsourced overseas, ~25%
- 80% of 300mm fabrication factories are overseas



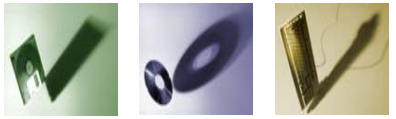
Source: Reed Electronics Research, *Yearbook of World Electronics Data*



History of study

- DSB Task Force on Military Software (1987): "Many previous studies have provided an abundance of valid conclusions and detailed recommendations. Most remain unimplemented."
- DSB Task Force on Defense Software (2000): "The Task Force reviewed six major DoD-wide studies that had been performed on software development and acquisition since 1987. These studies contained 134 recommendations, of which only a very few have been implemented."

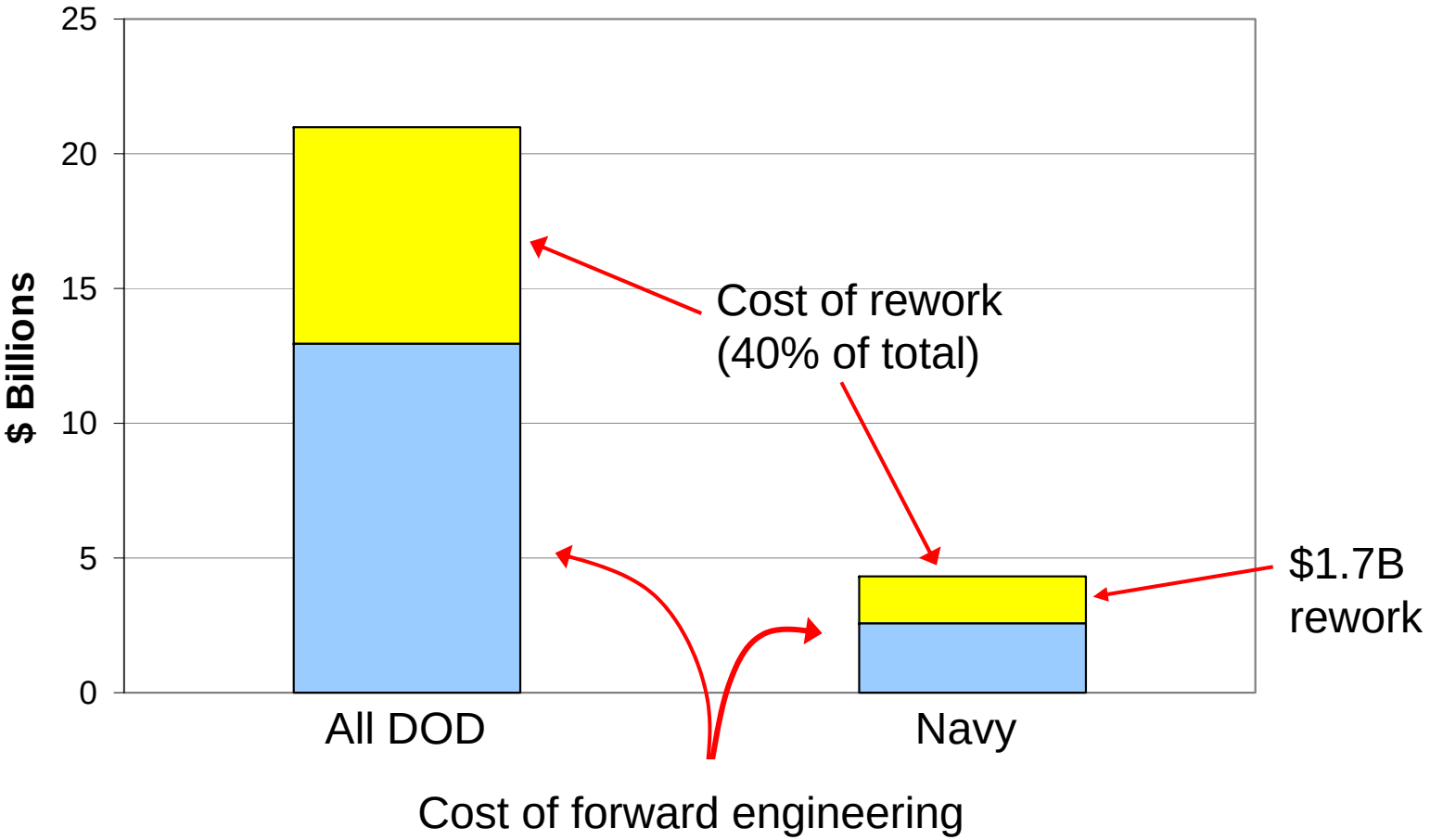
Is anybody listening?



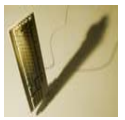
Our central recommendation: structural innovation

1. **Mobilize** in the short term:
   Rapid Evolution Software Engineering Teams (RESET)
2. **Transform** in the midterm:
   A Naval Software System Center
3. **Consolidate** in the long term:
   - Status quo after step two?
   - A Naval warfare center?
   - A joint warfare center?

Impact of rework costs (FY2005)





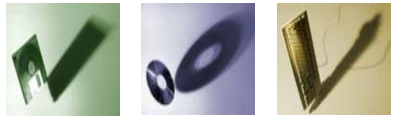


Problems with Naval software intensive systems

- Specifying
- Developing
- Acquiring
- Testing
- Life-cycle maintenance
- Focused research

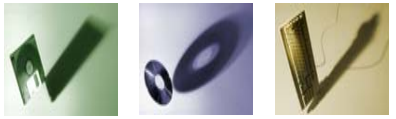
Representative Findings

- Inadequate system engineering–particularly, requirements definition and system requirements flow-down
- Model driven methods (MDD and MDA) valuable when matched to a task—they are not universal silver bullets
- Few experienced software acquisition professionals
- Programmer productivity varies enormously
- Inadequate application of existing process methodologies
- Inadequate incentives for openness
- Testing, security, and interoperability often too late
- Lack of investment in software engineering research



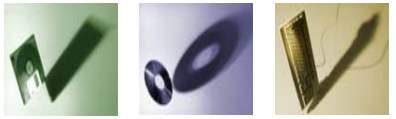
Leadership recommendations

- Put somebody in charge:
  - Establish acquisition educational standards
  - Promote basic process improvements
  - Increase awareness of software problems, technology, and opportunities
- The ASN (RDA) is already engaged (memo of 15 May 2006)

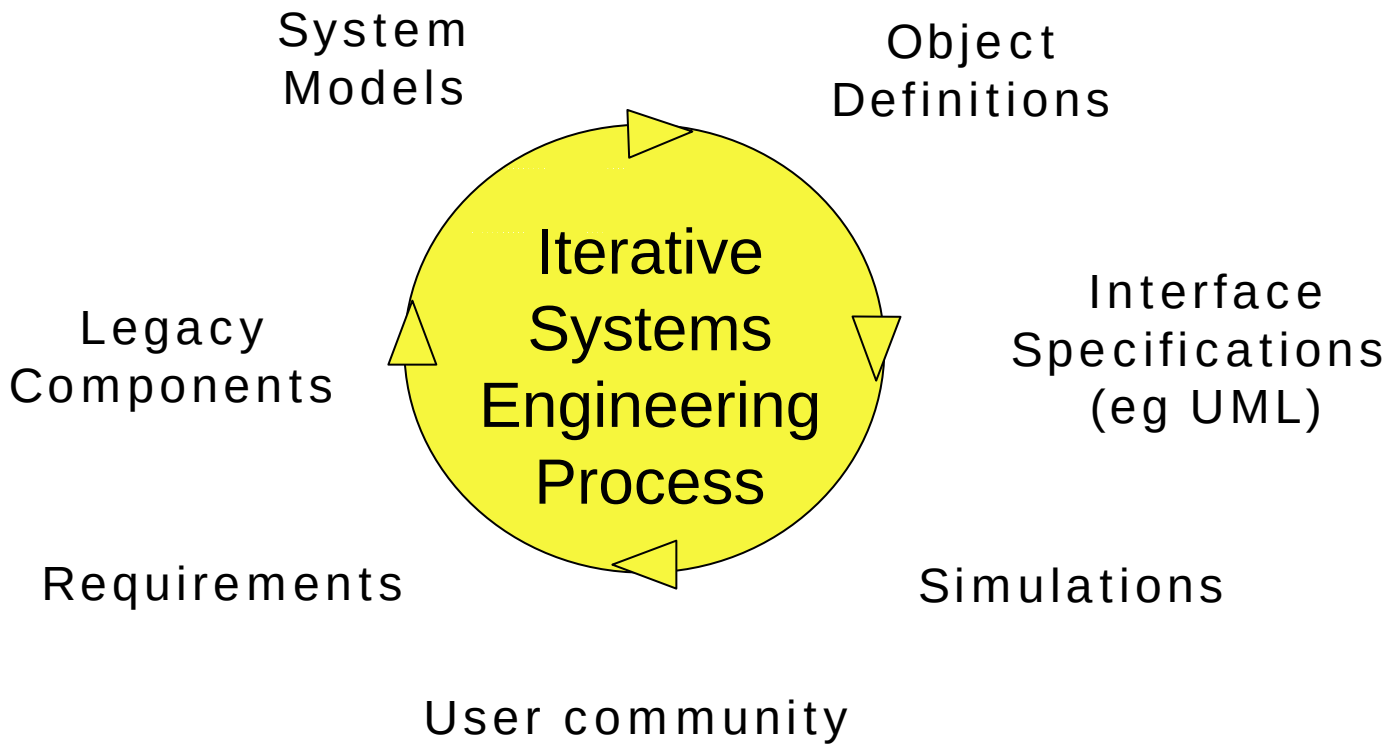


Acquisition and practice recommendations

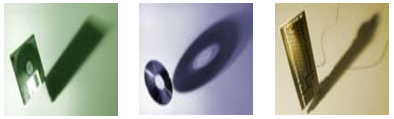
- Create software acquisition specialty within the Navy
- Develop real incentives to share specifications, interfaces, models, and software (e.g. ARCI program)
- Apply emerging software engineering tools to appropriate problems
- Deploy system engineering methods that enable specification, implementation, and testing to evolve together



Recommendation focus: the user-requirements loop

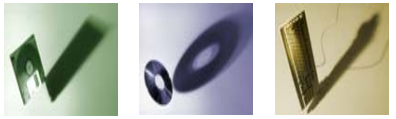


Model driven tools can stimulate and enforce iterative systems engineering



Naval S&T program recommendations

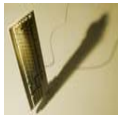
- Start focused effort
- Leverage existing software engineering research and practice
- Develop, for example:
  - Software tools for evolutionary systems engineering
  - Practices for automated daily build, test, and evaluation
  - Domain-specific model languages
  - Technology for dealing with legacy systems
  - Means to exploit lessons-learned and best-practices knowledge bases (such as those of NASA, DOE, FAA, and ONR activity at University of Maryland)



Assessment

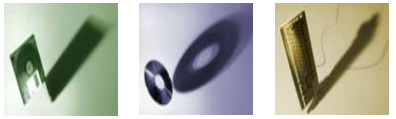
- Information dominance central to defense, but at risk
- Lots of opportunity, but little decisive action to date, for lack of structure
- Visionary action and structural innovation needed





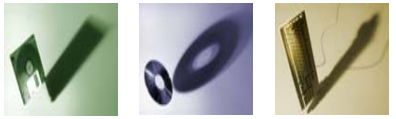
Step one: Rapid Evolution Software Engineering Teams

- Staff each with 10-20 full time equivalents
- Complete user-requirements loop
- Promote use of system engineering tools, policies, and practices
- Champion best-practice software methodology emphasizing commonality, evolution, adaptation, reuse, reliability, interoperability, security and rapid response to changing defense needs
- Identify open systems needs and ensure compliance
- Recommend contract incentives
- Monitor progress and sustain support



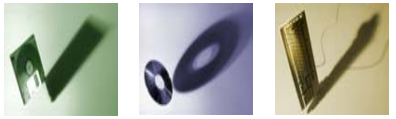
Step one: Implementation

- Embed on contractor site in two or more representative programs (to promote commonality), such as CG(X), BAMS, Aegis upgrade, LCS
- ASN RDA provides seed money to selected PEO to initiate activity
- Staff with expert personnel from ONR, NRL, UARC, FFRDC (such as SEI), Warfare Centers, National Laboratories, government agencies, academia, and noncompeting contractors
- Report to ASN through PEO



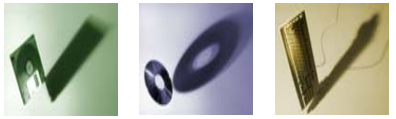
Step two: Naval Software System Center

- Staff with ~50 full time equivalents
- Institutionalize and staff RESET teams
- Build models and assist in building models
  - Complete requirements---users loop
  - Complete model---VV&A loop
  - Solve ownership problem
  - Ensure compliance with lessons learned
- Maximize Naval commonality
- Manage and staff independent expert reviews
- Recommend incentives and acquisition policy
- Manage innovation through programs, such as SBIRs, ATDs/JCTDs, …



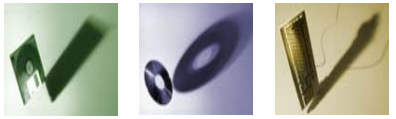
Step two: Implementation

- Embed in SYSCOM, NRL, or existing warfare center
- ASN RDA funds for FY08 via redirection, then for FY09 as line item
- Report to a PEO, DASN to ASN, and OPNAV
- Enterprise coordination



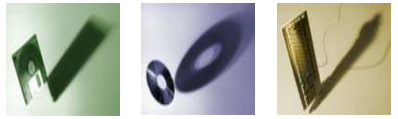
Step three: Consolidation

- A cross-cutting, horizontally integrated, possibly joint activity that ensures information dominance
- Size and structure to be evolved from experience with steps one and two



Risks and challenges: steps one–three

- Human resources difficult to obtain
- Cultural resistance
- Budget priorities
- Industry pushback
- Contracting difficulties
- Multiyear sustenance



Summary

- Assessed situation and articulated concerns
- Listed findings and recommendations
- Established need for innovative structure
- Identified risks and challenges
- Proposed three-step plan for ASN RDA action

To maintain information dominance, inaction is not an option