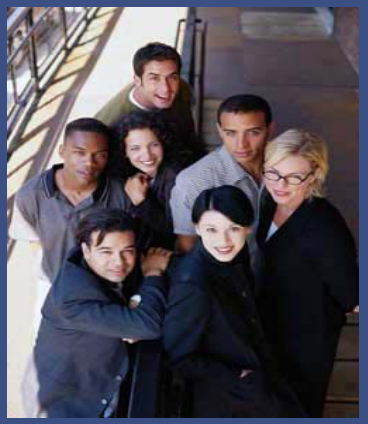
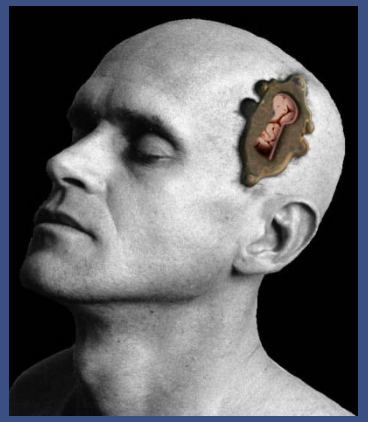


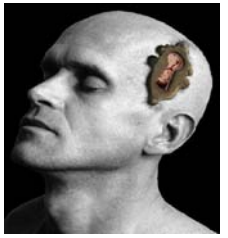


Leveraging Capability Maturity Model Integration for Acquisition (CMMI®-ACQ) Processes to Improve Organizational Workforce and System Acquisition Performance

Dr. Kenneth E. Nidiffer & Rick Barbour
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213
703-908-1117

10th Annual NDIA
CMMI® Technology Conference and Users Groups
Denver, CO
15 – 18 November 2010

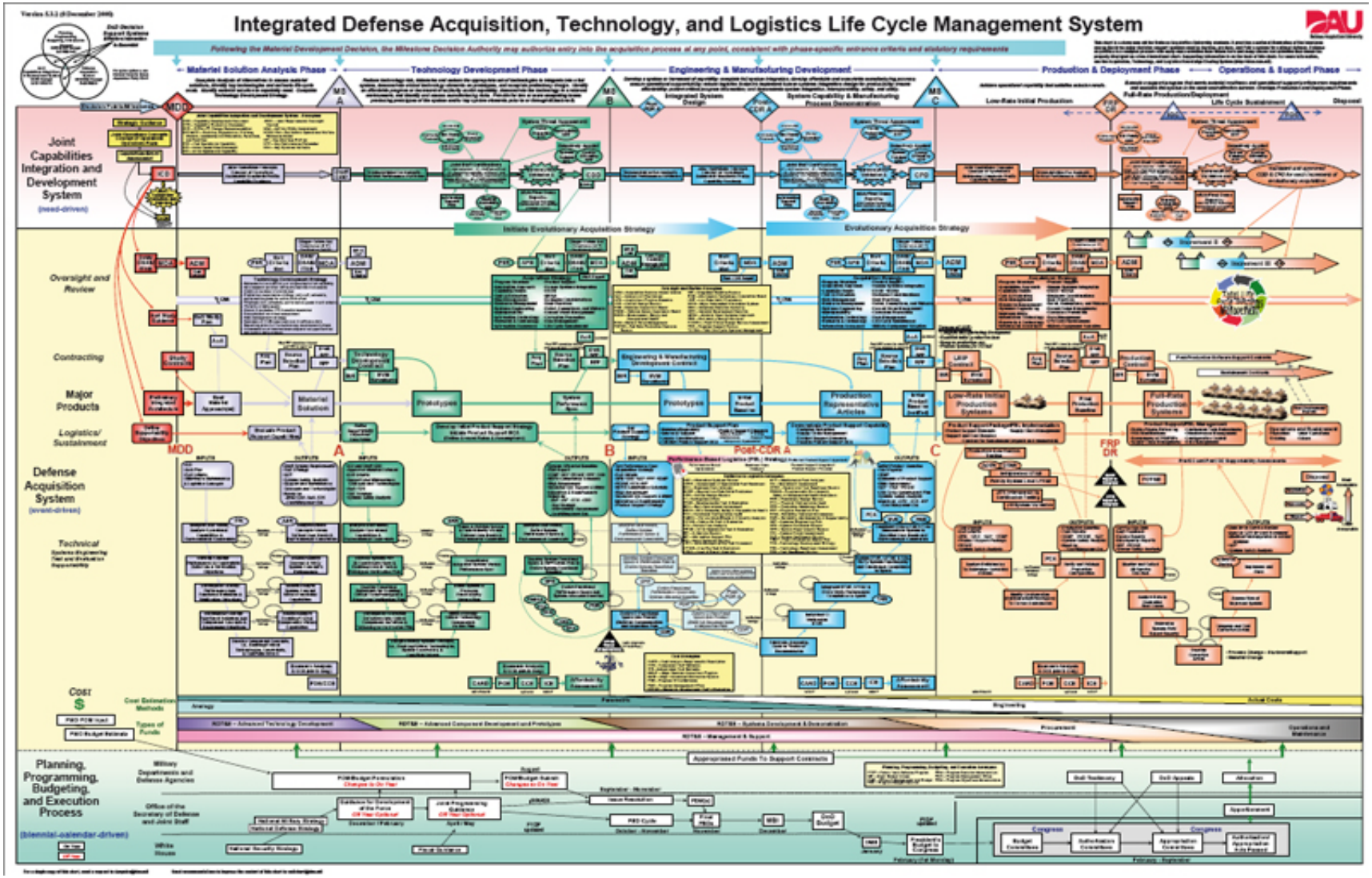
Overview

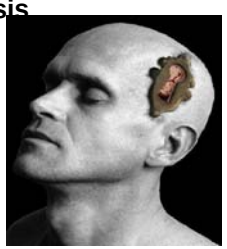


- Is your organization working towards achieving acquisition excellence?
  - The application of systems-engineering to improve the workforce may be part of the answer!
- What are the rate-limiting variables/drivers that limit success?
- How can the CMMI ® - ACQ model be used?

Achieving Acquisition Excellence via Effective Application of CMMI ® -ACQ

An Effective Process for Major Defense Systems – but not very agile





DOD Software Acquisition Process Improvement Programs

DoD Major Events and Leadership Rotation

Cohen 01-24-1997 to 01-20-2001 | **Rumsfeld** 01-20-2001 to 12-17-2006 | **Gates** 12-17-2006 to Present

Pre-Public Law Actions-SSWG

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

OSD Policy for Systems Engineering Forum Established Feb 2, 2004

DoDD 5010.42 CPI/LSS May 15, 2008

Army Strategic Software Improvement Program Aug 18, 2002

OSD Guidance on Section 804 Mar 21, 2003

OSD Software Intensive Systems Steering Group (SISSG) June 11, 2003

Air Force Software-Intensive Systems Strategic Improvement Program Jan 13, 2004

Navy Software Process Improvement Program May 15, 2006

DoD/NSA Establish Systems Engineering Research Center (SERC) Nov 24, 2008

DOD Software Acquisition Training and Education Working Group Feb 2, 2008

OSD Software Intensive Systems Steering Group (SISSG) June 6, 2000

OSD GAO Response Dec 21, 2004 Follow-up will be though SE Revitalization

OSD GAO Response Dec 1, 2006 Follow-up Section 804 met under SE Revitalization No further reporting.

Declared end of OSD Reporting on PL 107-314

GAO Audit Reports

OSD Tri-Service Assessments Initiative 1999-2003/4

GAO-01-116 Mar 2001 Report

Public Law 107-314, Section 804 Dec 2, 2002

GAO-04-393 Report July 2004

GAO-04-393 Follow-up Report July 2005

GAO-04-393 Follow-up Report July 2006

GAO-09-888 Sept 2009 Report

Software Improvement Focus | Systems Engineering Improvement Focus

DDR&E Imperatives

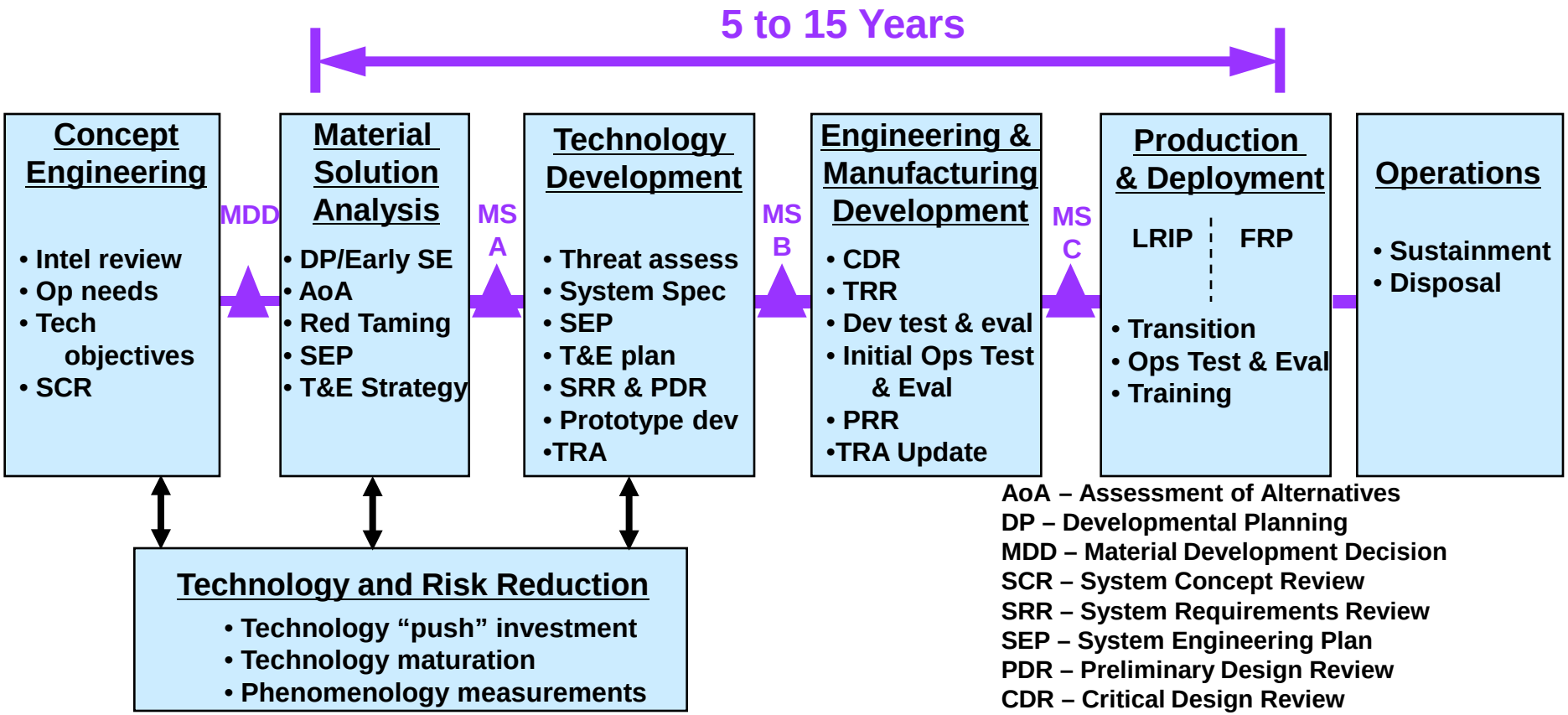
1. Accelerate delivery of technical capabilities to win the current fight.
2. Prepare for an uncertain future.
3. Reduce the cost, acquisition time and risk of our major defense acquisition programs.
4. Develop world class science, technology, engineering, and mathematics capabilities for the DoD and the Nation.

Source: The Honorable Zachary J. Lemnios
Director, Defense Research and Engineering

External Forces: Defense Acquisition Approach

Systems Engineering is key discipline

Source: The Honorable Zachary J. Lemnios
Director, Defense Research and Engineering



AoA – Assessment of Alternatives
DP – Developmental Planning
MDD – Material Development Decision
SCR – System Concept Review
SRR – System Requirements Review
SEP – System Engineering Plan
PDR – Preliminary Design Review
CDR – Critical Design Review
TRR – Test Readiness Review
PRR – Production Readiness Review
LRIP – Low-Rate Initial Production
FRP – Full Rate Production

70-75% of Cost Decisions Made Prior to Milestone A
Impact 72% of Total Life Cycle Costs

23 Principal Actions to Improve Efficiency within 5 Major Areas (14 September 2010)

1. Target Affordability and Control Cost Growth
2. Incentivize Productivity and Innovation in Industry
3. Promote Real Competition
4. Improve Tradecraft in Services Acquisition
5. Reduce Non-Productive Processes and Bureaucracy

Defense Science Board Report & Public Law 111 (Section 804)

Task Force on Department of Defense Policies and Procedures for the Acquisition of Information Technology March 2009

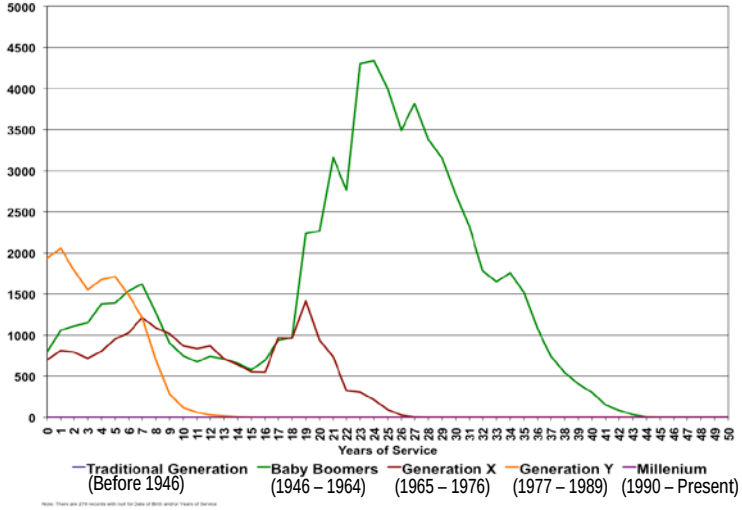
DOD acquisition process is too long and too cumbersome to fit the needs of the many IT systems that require continuous changes and upgrades

The National Defense Authorization Act for Fiscal Year 2010 ("the Act") Public Law 111 (Section 804)

The National Defense Authorization Act for Fiscal Year 2010 ("the Act") Public Law 111 includes a significant set of legislative provisions that modify Department of Defense (DoD) procurement policies and practices.

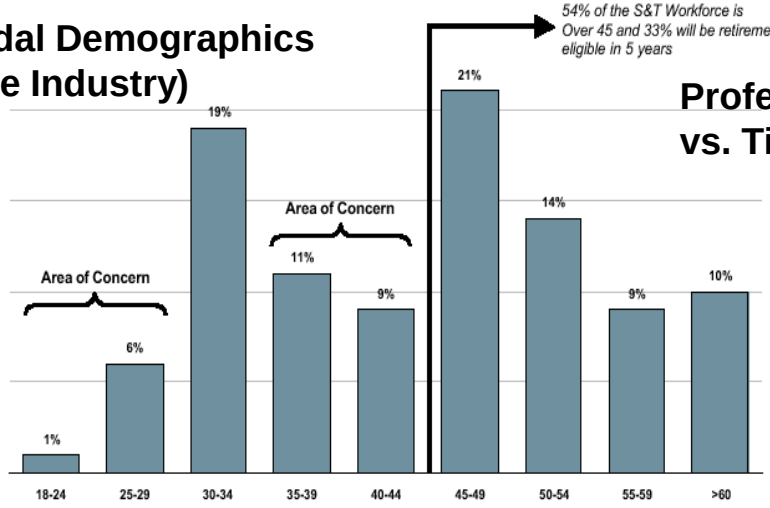
External Forces

AT&L Civilians – Risk of Losing



Source: DAU

Bimodal Demographics (Space Industry)

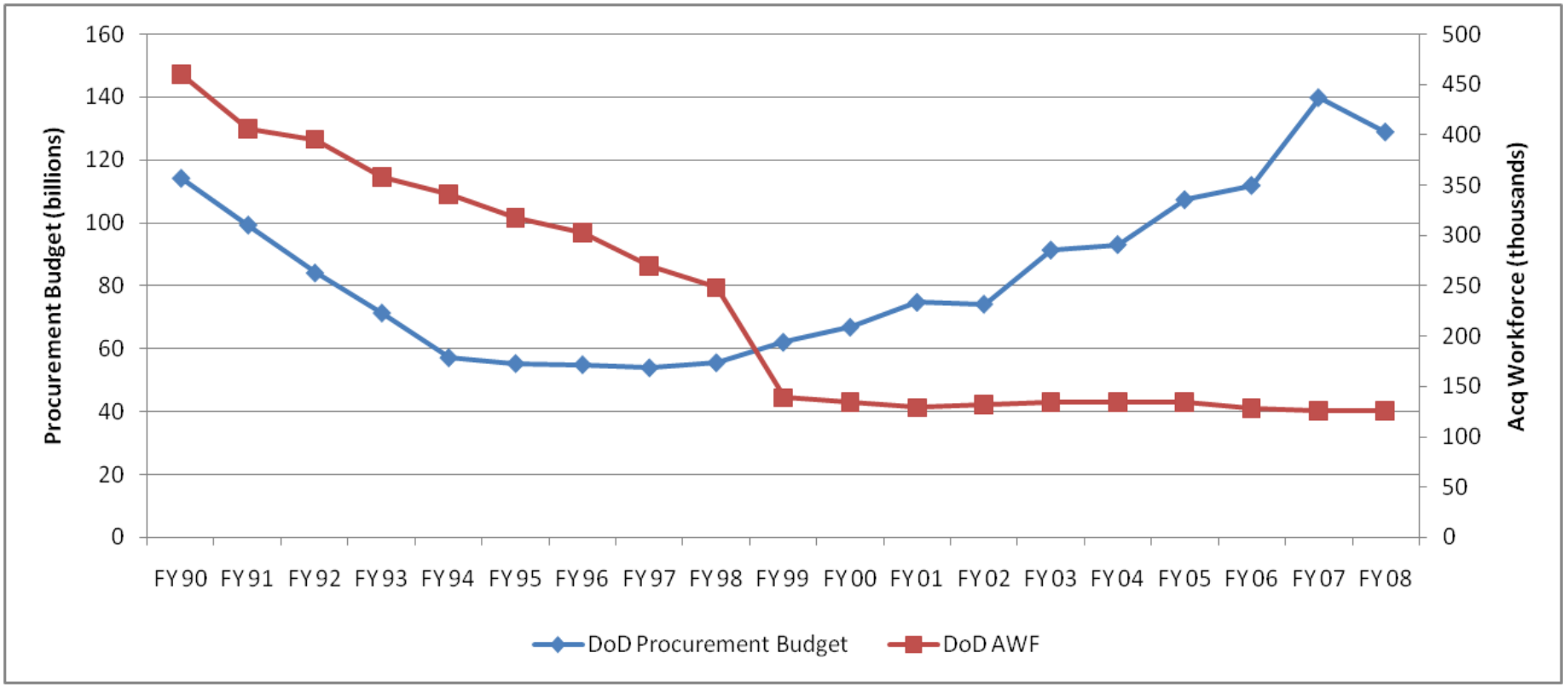


Source: LMSC

Professional Growth vs. Time

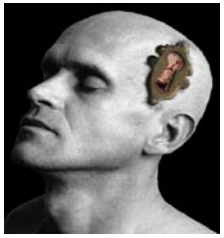
Source: DAU

Procurement Budget vs. DoD Acquisition Workforce



Increasing # of Procurements & Complex Systems Coupled With Huge Decrease In Acquisition Workforce

Recapture Acquisition Excellence: Revitalize The Acquisition Workforce



Problem

- **Acquisition capability has slowly atrophied**
- **Organic Workforce reductions - 23% since 1999**
  - **Force shaping, reduced training, retirements of critical cost estimators, price analysts, experienced system engineers, contracting officers**

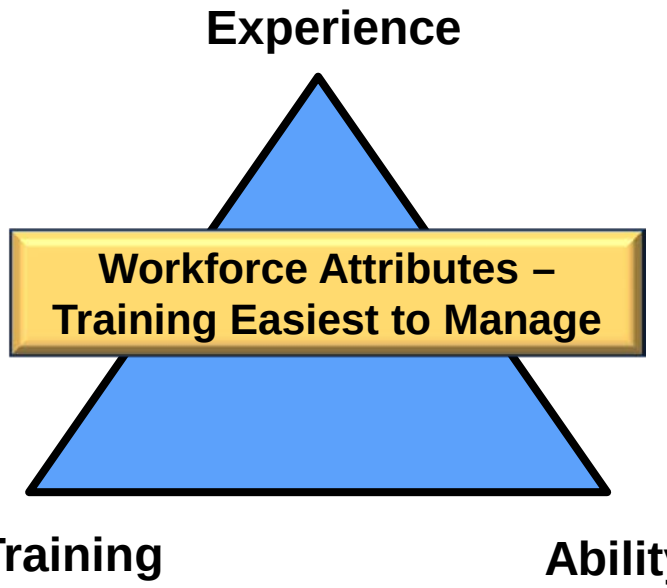
Initiatives

- **Recapitalize the Acquisition Corps/Training**
- **OSD Funding Increased Numbers and Training of Organic Acquisition Personnel**

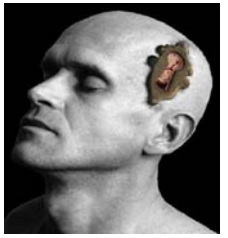
It May Not Be All About the Acquisition Workforce – But Viable Solutions Must Consider the Human Element!

Project Purpose

Use a systems engineering approach to assess acquisition training and organizational training processes for improving acquisition excellence



Business Motivation



Internal

- Improve organization's performance efficiencies by putting in place trained workforce that can leverage suppliers' capabilities to deliver quality solutions rapidly, at lower costs, and with appropriate technology

External

- President Barack Obama – Mar/May 2009
  "The government will assist agencies in assessing the capacity and ability of the Federal acquisition workforce to develop, manage, and oversee acquisitions" and Weapon Systems Acquisition Reform Act of 2009, Public Law 111-23, 22 May 2009

Summary of Systems Engineering Drivers

External Forces

- Increasing size of untrained defense acquisition workforce
- Retiring of experienced and capable workforce

Technological

- Accelerating technological changes makes systems specific acquisition training difficult at best
- Identifying future competencies to ensure most relevant training content

Human Capital

- Changing workforce demographics requiring newer methods of training and management

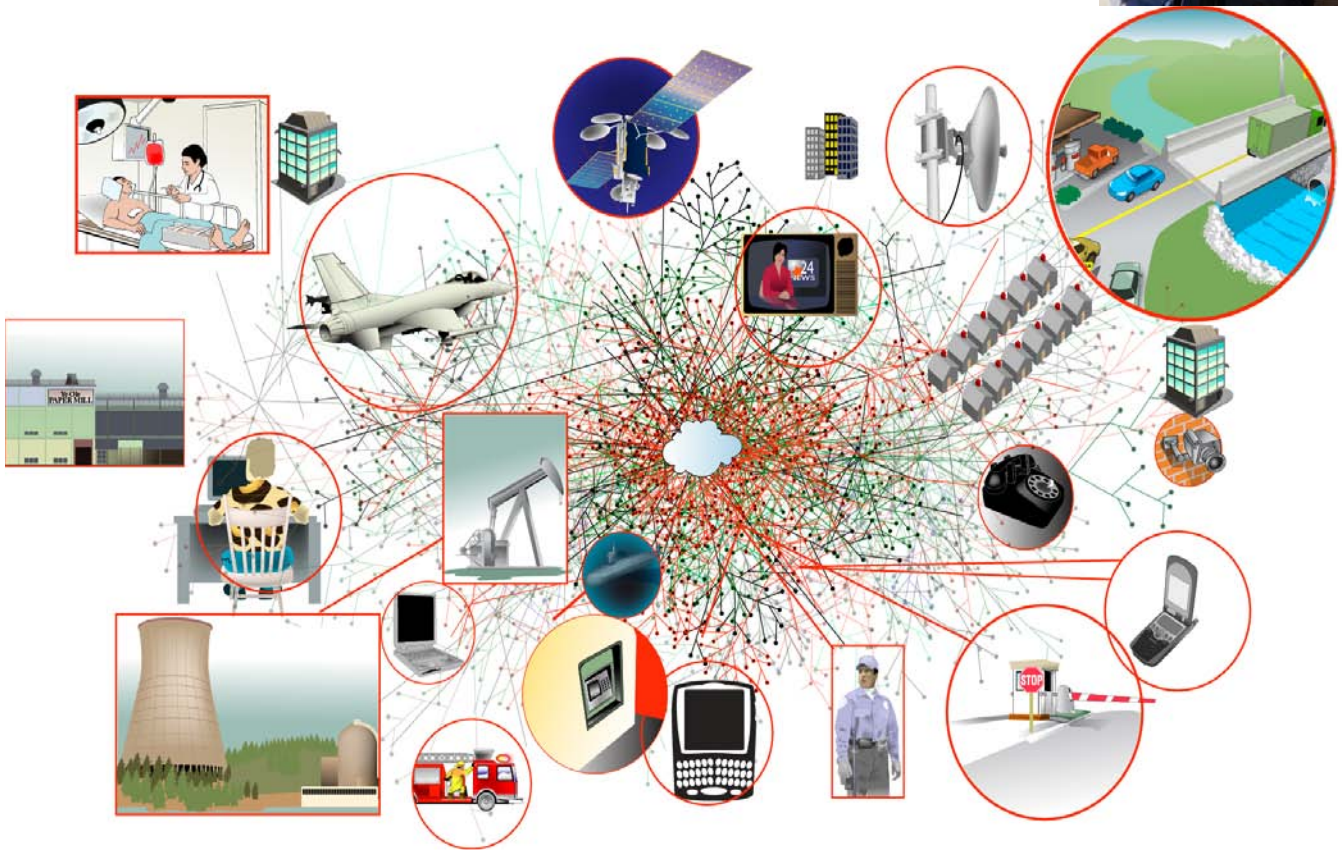
Client Business Environment

- Achieving acquisition excellence in a fiscally constrained environment

What Is the Cyber Environment?

Includes all

- System of Systems
- Architecture
- Services
- Netted Hardware/ Platforms
- People who digitally connect to cyberspace



Cyberspace is where our daily work and our priority missions are conducted

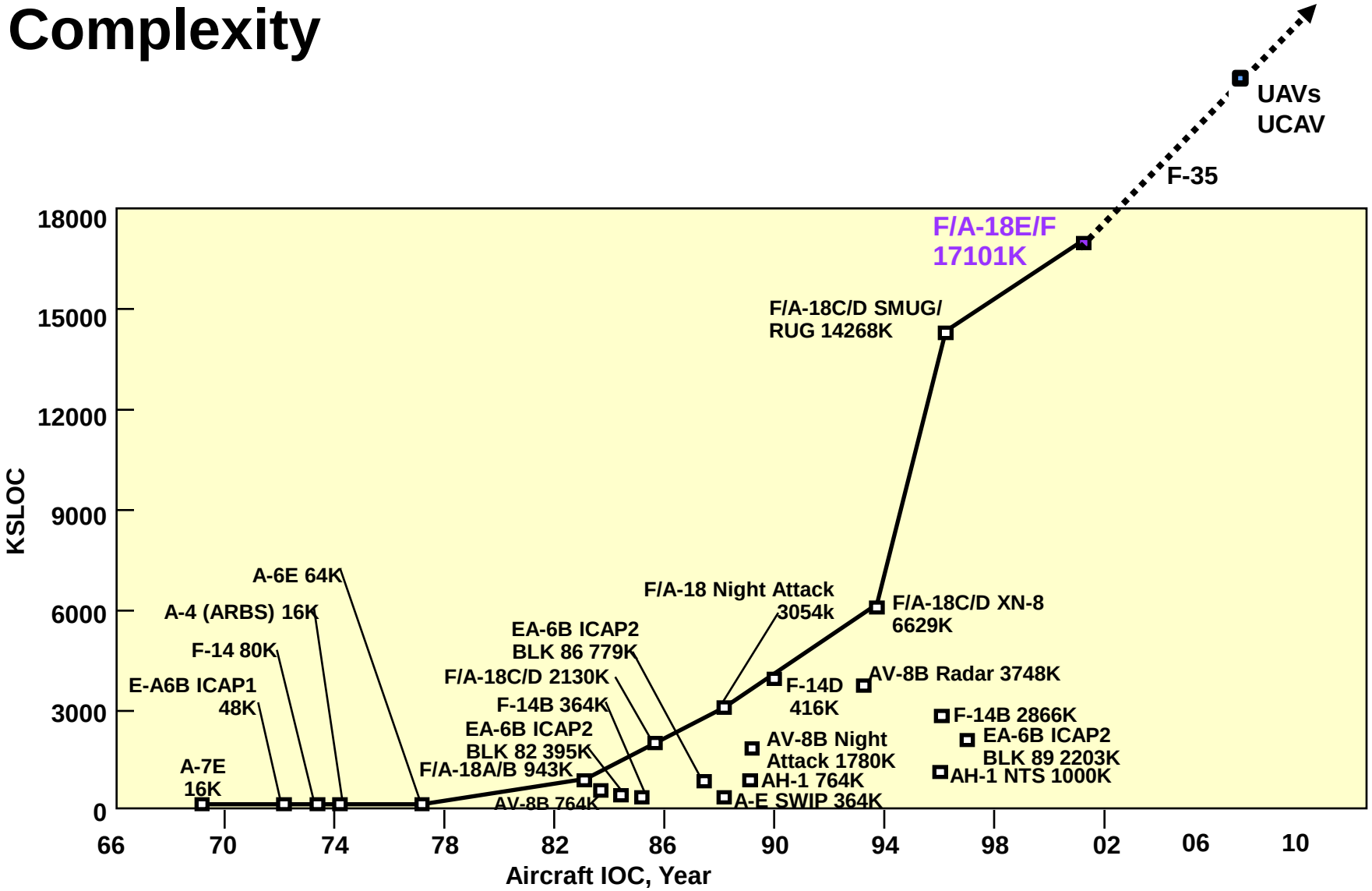
Federal IT Market Growth

In the next five years, IT contractors will see the federal market for their services increase by a compound annual growth rate of 5.4 percent to a total of $111.9 billion by 2015.

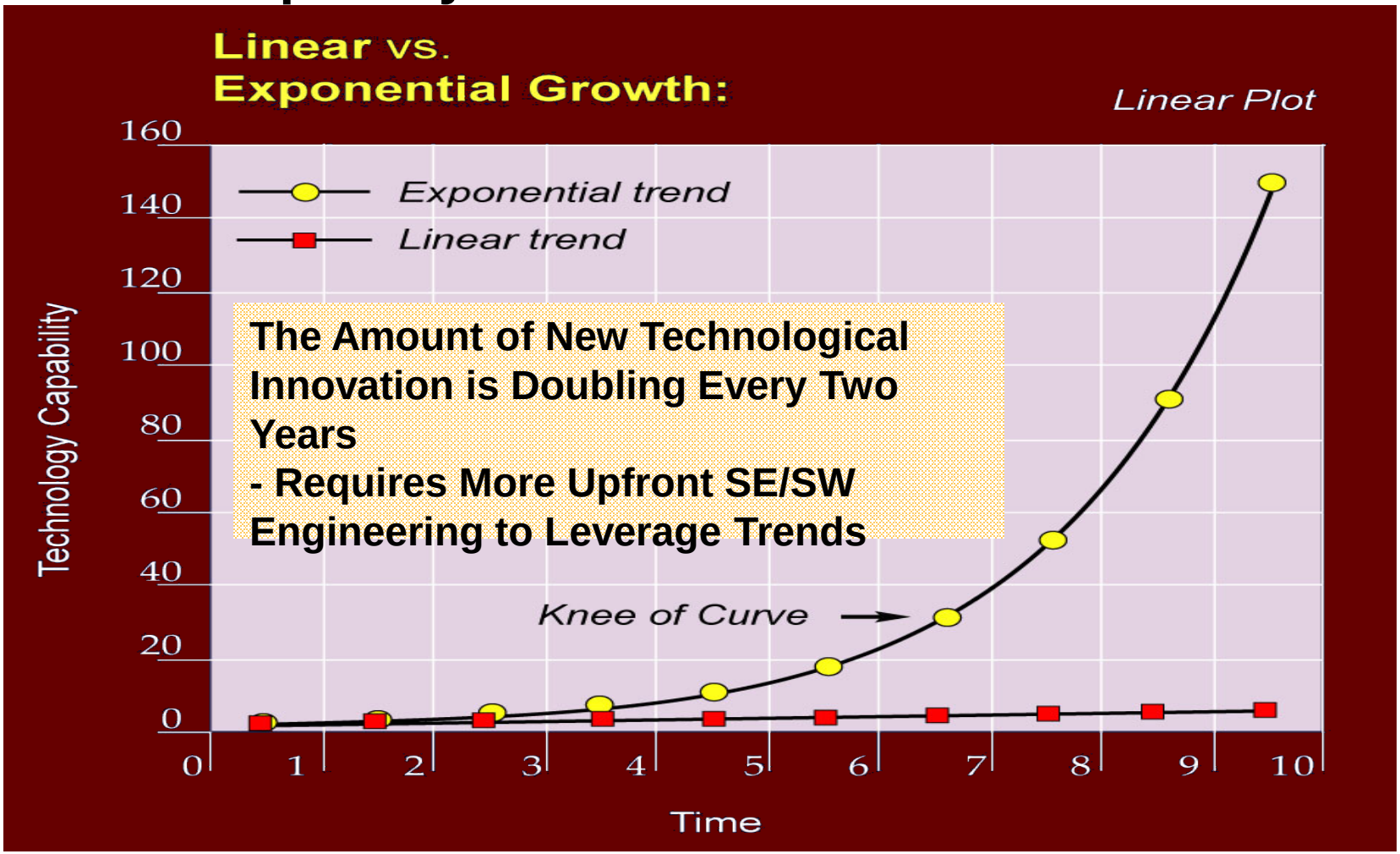
…spending with contractors will outpace overall IT growth

-- Ben Bain
Federal Computer Week
April 8, 2010

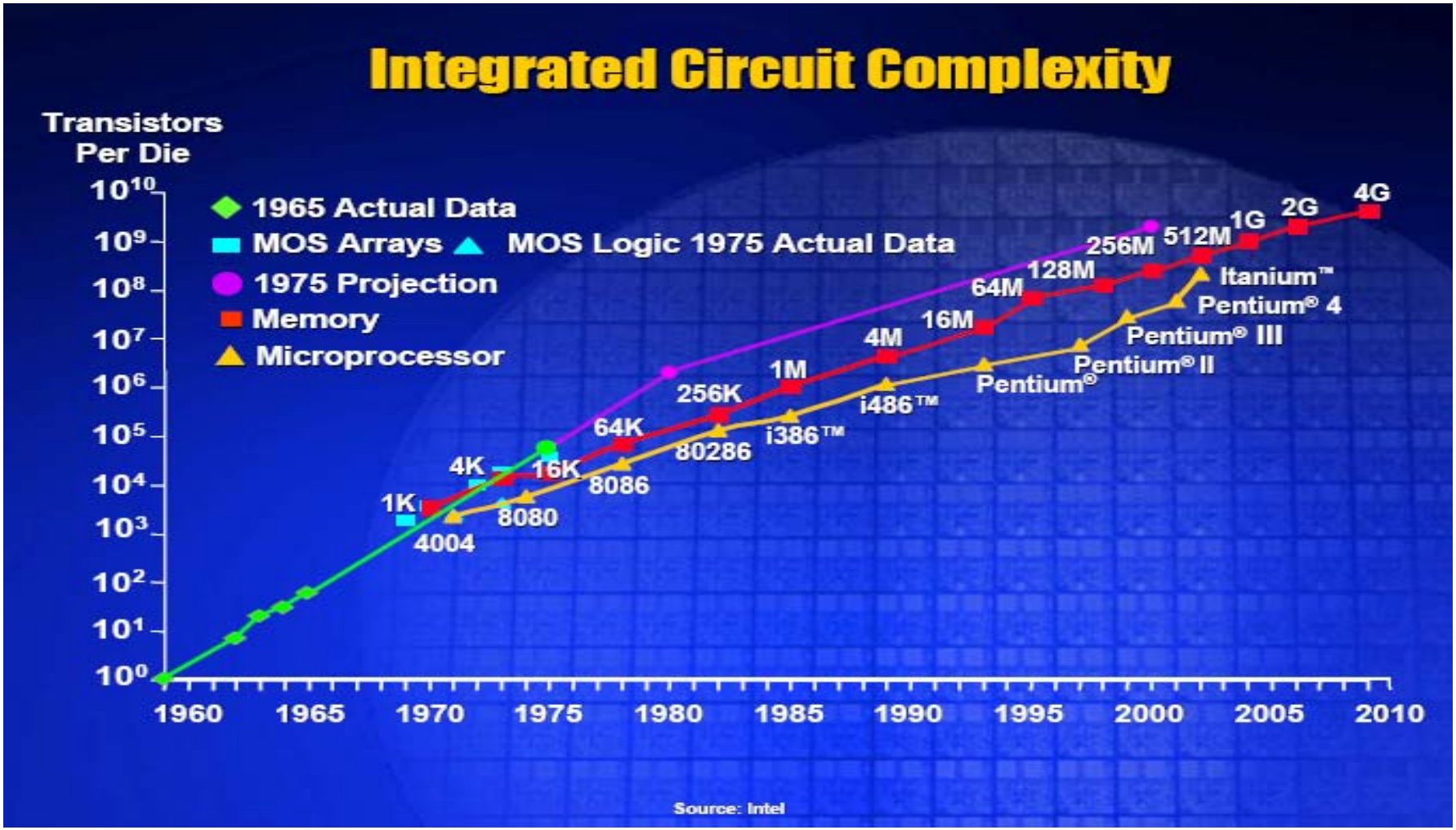
Increasing Software Lines of Code & Complexity



Technological: Acceleration of Innovation in the 21st Century - Facilitating Our Ability to Build Move Complex Systems

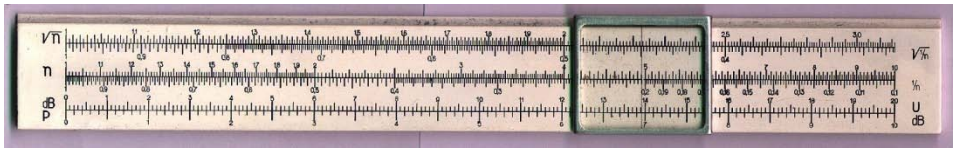


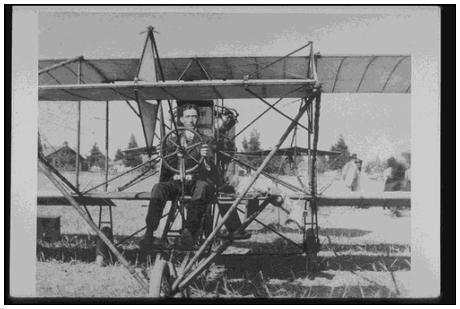
Technological: Moore's Law Holding - The Number of Transistors That Can be Placed on an Integrated Circuit is Doubling Approximately Every Two Years



Technological: Augustine's Law Holding - Growth of Software is an 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

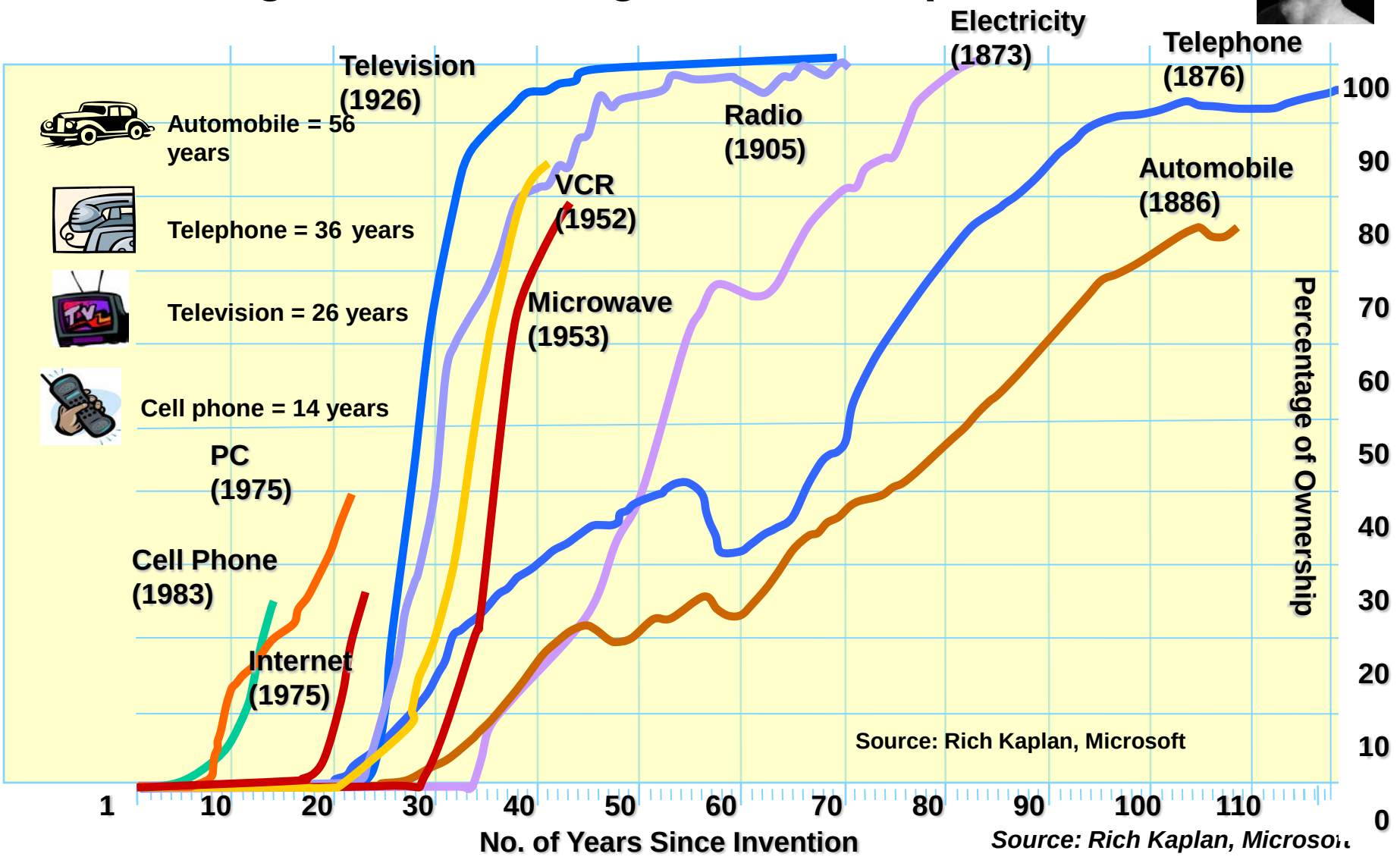
1990's

F-22
1.7M
LOC

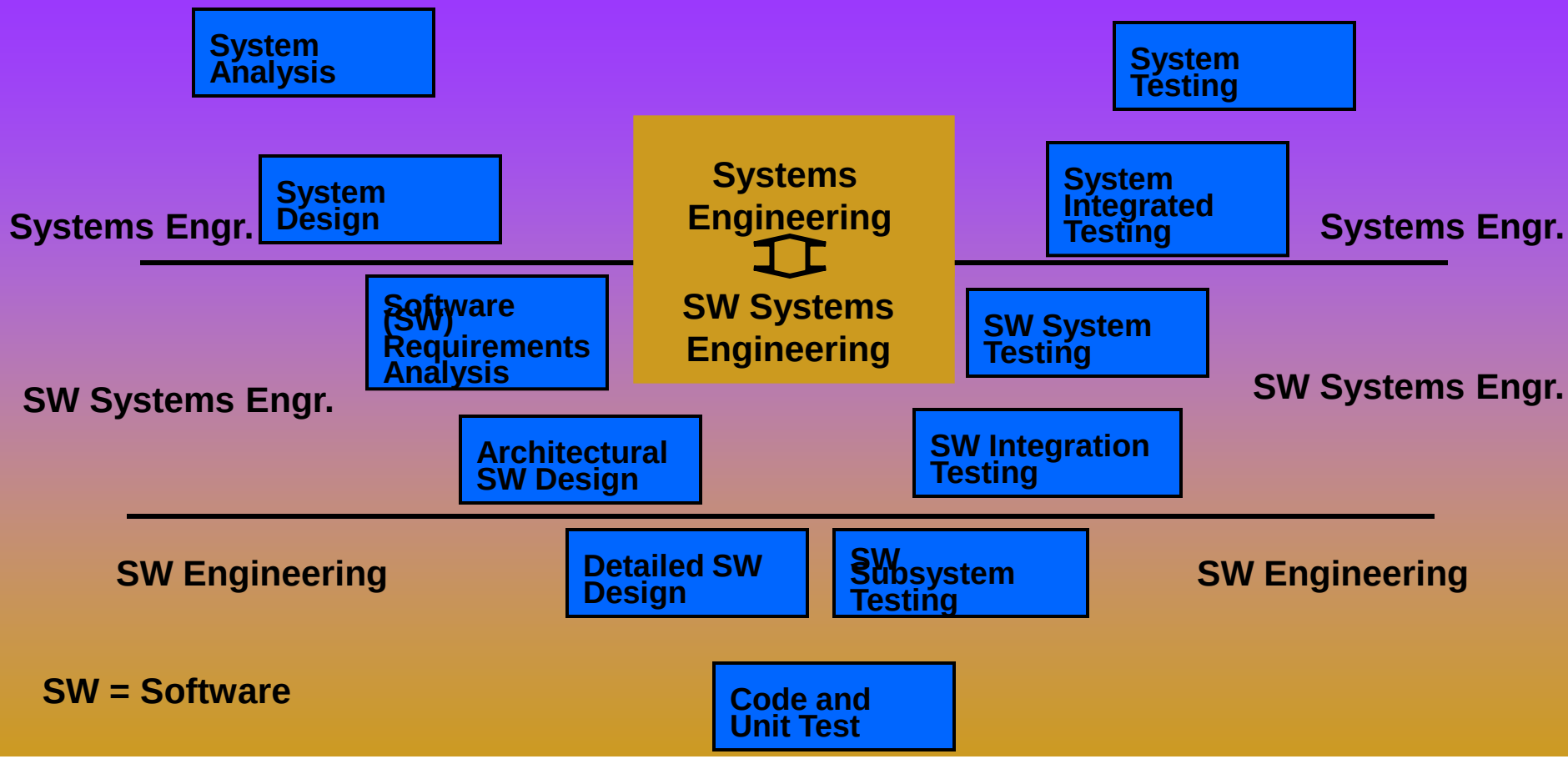
2000+

F-35
>6M
LOC

Technological: Increasing Rate of Adoption



Human Capital: Refocusing University Curriculums - Alignment of Software Systems Engineering

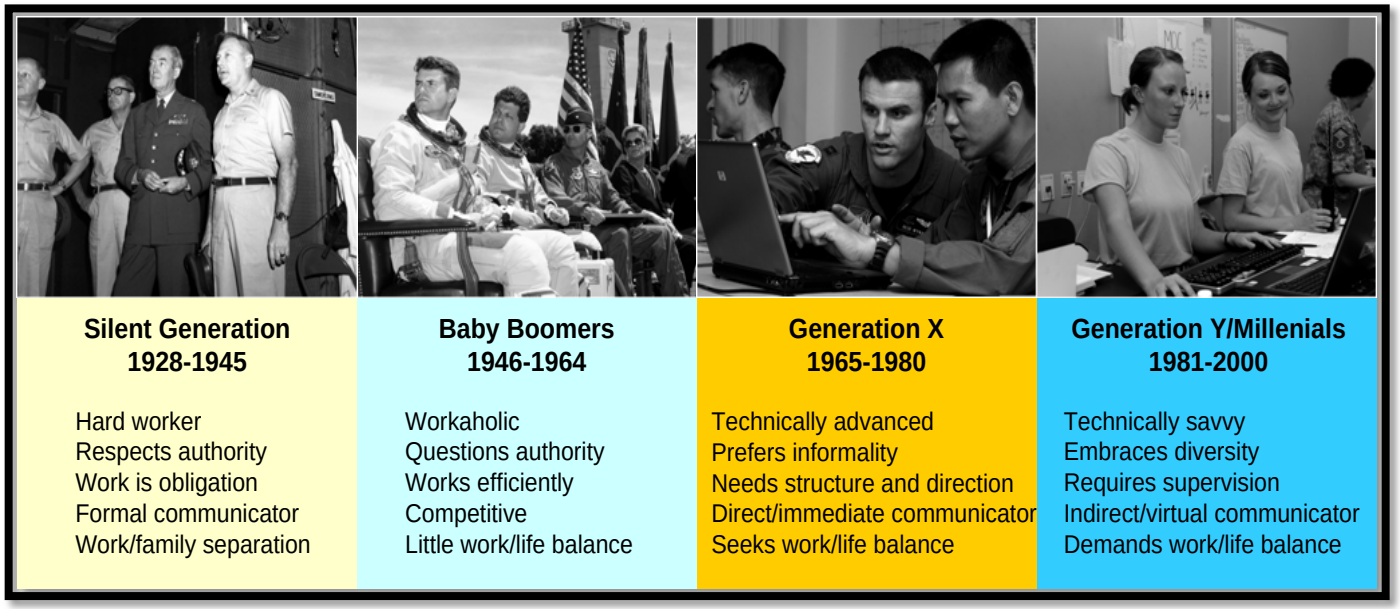


OSD Initiatives: Graduate Software Engineering Reference Curriculum (GSwERC) & Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE)

Human Capital: Changing Demographics

Demographics of workforce are changing and different views may emerge with four generations to consider

Generation Y professionals entering workforce will likely necessitate non-traditional training techniques, such as virtual approaches

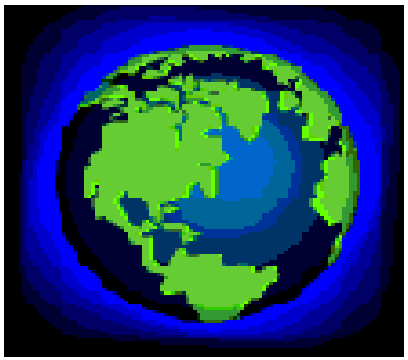


Client Business Environment: Increasingly Complex

Characteristics	Commercial Software Products	Information Technology & Internet Financial Services	Government Aerospace Systems
Market	Commercial	Information technology & internet	Government
Industry	Software	Financial	Aerospace
Packaging	Products	Services	Systems
Primary Output	Software	Integrated system engr & HW & SW & network	Integrated system engr & HW & SW & network
Purpose	User empowerment: effectiveness, efficiency, creativity	Organization/business operations	Mission/science capabilities
Project Duration	1-36 months	1-18 months	6 months - 10 years
Team Size	1-1000's	1-1000's	10's-1000's
Ratio of Custom to COTS/Reuse	Software: Low-high	Business logic: High Others: Low	All: High
Agreement	License	Service level agreement	Contract
Customer	External	Internal and external	External
# Customers	100's-1,000,000's	1-1,000,000's	1
Focus	Features, Time-to-market, Ship it	User experience, Workflow cycletime, Uptime	Reliability, Milestones, Interdependencies

Source – Northrop Grumman

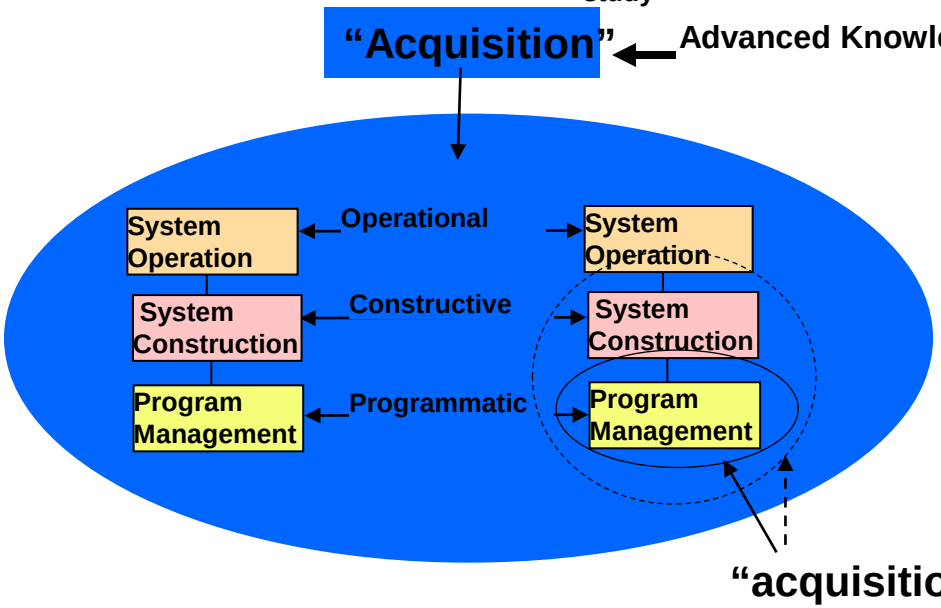
Client Business Environment: Acquisition Shifts

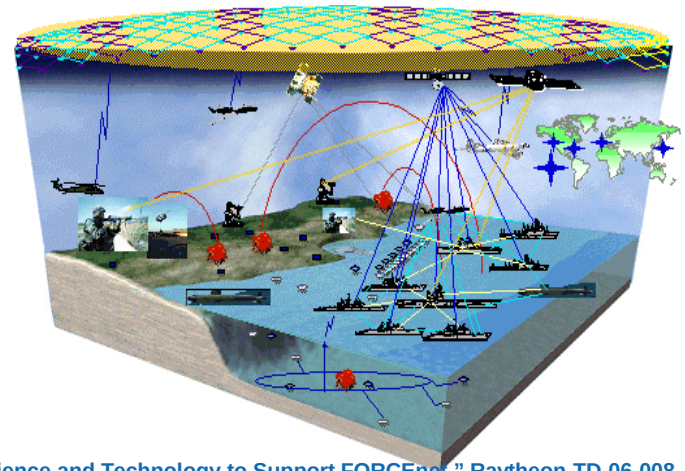


2005 study confirmed*:

- 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

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





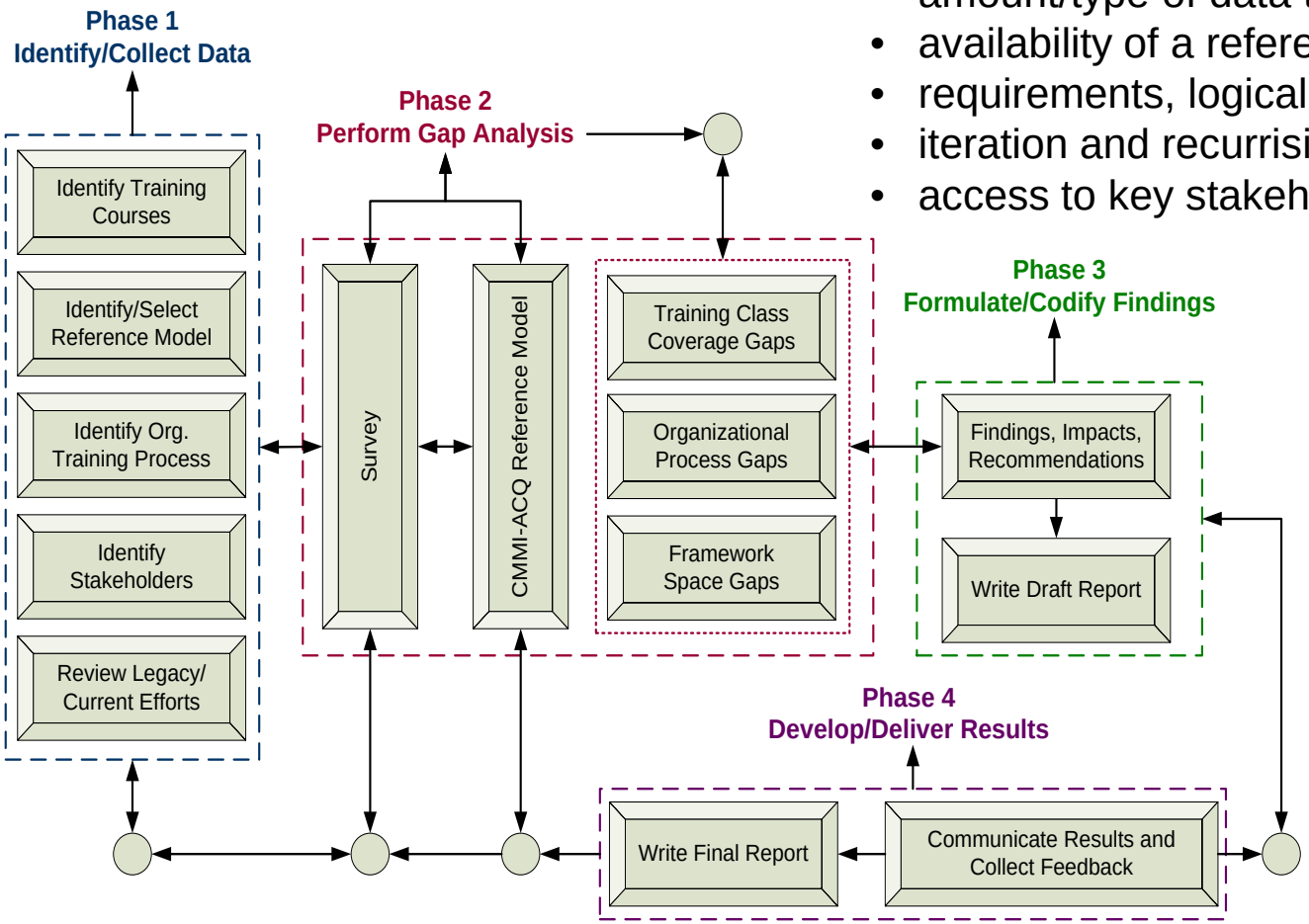
From "Science and Technology to Support FORCEnet," Raytheon TD-06-008. Used by permission.

Ref: Jim Smith, (703) 908-8221,jds@sei.cmu.edu

Systems Engineering Approach

Selected based on

- amount/type of data to be reviewed
- availability of a reference model
- requirements, logical and physical loops
- iteration and recurrision activities
- access to key stakeholders



Project Objectives

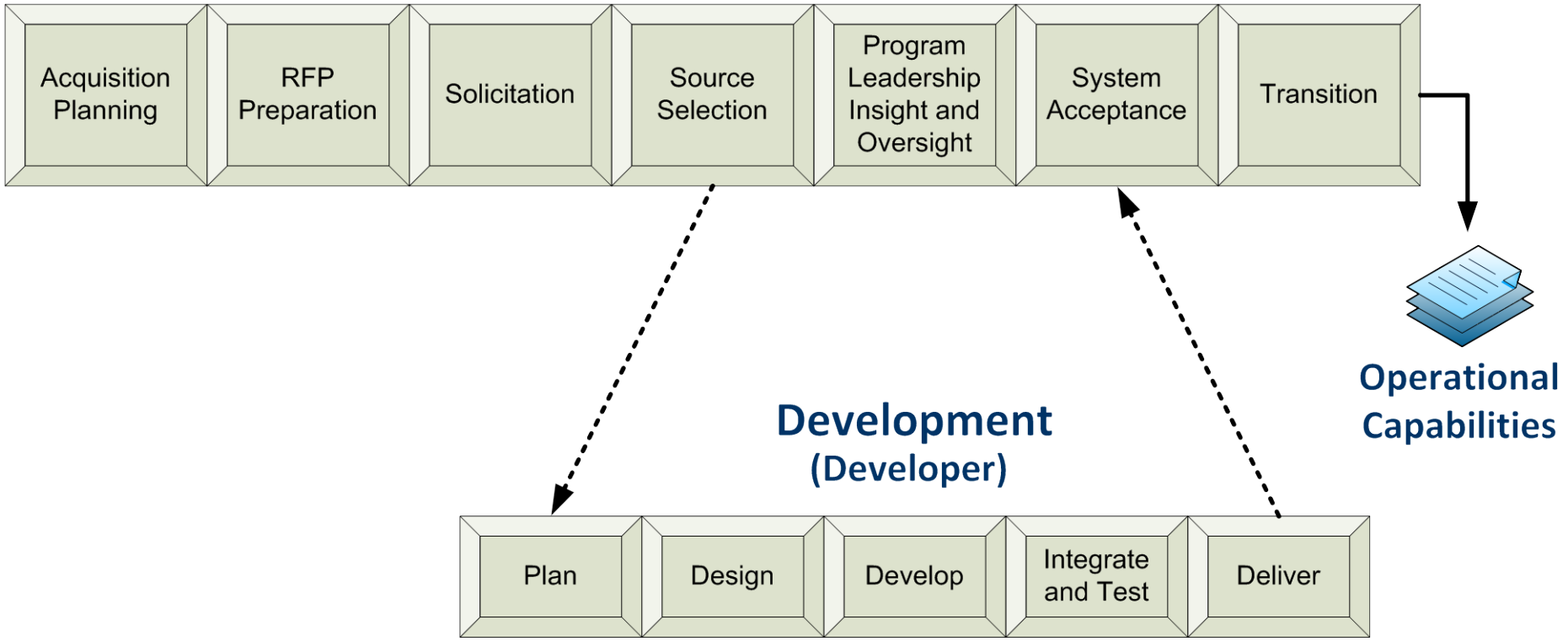
During assessment Phase 1 project objectives were formulated in terms of five questions

- Do coverage gaps exist in the training of acquisition best practices?
- Do gaps exist in acquisition training on the unique aspects of the client's system acquisitions?
- Do gaps exist in the training of the client's acquisition lifecycle framework and processes?
- Do best-practice gaps exist in the client's organizational training processes?
- Do gaps exist in identifying training requirements for satisfying the acquisition workforce core competencies?

Assessment Framework: *CMMI®-ACQ*

Operational Need

Focus on Acquisition Best Practices
(Acquirer)



CMMI® -ACQ categories and process areas

Category	Process Area
Acquisition	**Agreement Management (AM)** **Acquisition Requirements Development (ARD)** **Acquisition Technical Management (ATM)** **Acquisition Validation (AVAL)** **Acquisition Verification (AVER)** **Solicitation and Supplier Agreement Development (SSAD)**
Process Management	Organizational Innovation and Deployment (OID) **Organizational Process Definition (OPD)** Organizational Process Focus (OPF) Organizational Process Performance (OPP) **Organizational Training (OT)**
Project Management	**Integrated Project Management (IPM)** **Project Monitoring and Control (PMC)** **Project Planning (PP)** Quantitative Project Management (QPM) Requirements Management (REQM) Risk Management (RSKM)
Support	Causal Analysis and Resolution (CAR) Configuration Management (CM) Decision Analysis and Resolution (DAR) Measurement and Analysis (MA) Process and Product Quality Assurance (PPQA)

CMMI® -ACQ model was developed to codify best practices to help organizations improve acquisition processes

CMMI® reference models have gained significant traction across commercial and defense community and are widely used throughout world [CMMI Product Team 07]

Summary of Results

- Strengths
- Areas for Improvement
- Lessons Learned

Results – General Overall Strengths

- Excellent coverage in the training of acquisition best practices
- Adequate number and variety of course offerings
- Simple but adequate training facilities
- Consistency of course material & presentation layout & style
- Variety of media used for announcing upcoming courses
- Scope and breath of Earned Value programs
- Knowledgeable SME* teach classes
- Talented instructor workforce
- Intelligent student population
- Professionalism of the training staff
- Desire to improve

Representative Results: *Question 1*

Question 1: Do Coverage Gaps Exist in the Training of Acquisition Best Practices?

Findings

- **Detailed findings awaiting client approval**

Impacts

- Missing opportunities to
  - ~ attract more students
  - ~ provide training on the most relevant issues
  - ~ effectively plan
  - ~ save resources
  - ~ provide a richer variety of courses
  - ~ continuously improve training processes

Recommendations and Considerations

- Conducting a review to assess use of web-based and non-traditional acquisition training

  Consider: Leveraging of efforts by DAU, commercial industry and academia
- Conducting a review of best practices for training among different types of acquisitions

  Consider: Developing and teaching approaches that focus on agile and SOA acquisition approaches
- Making a better use of repository information

  Consider: *Using* DAU's Acquisition Best Practices
- Putting a systematic process improvement program in place

  Consider: Using CMMI-ACQ and IDEAL
- Developing a strategic plan

  Consider: Socializing plan among relevant stakeholders

Results

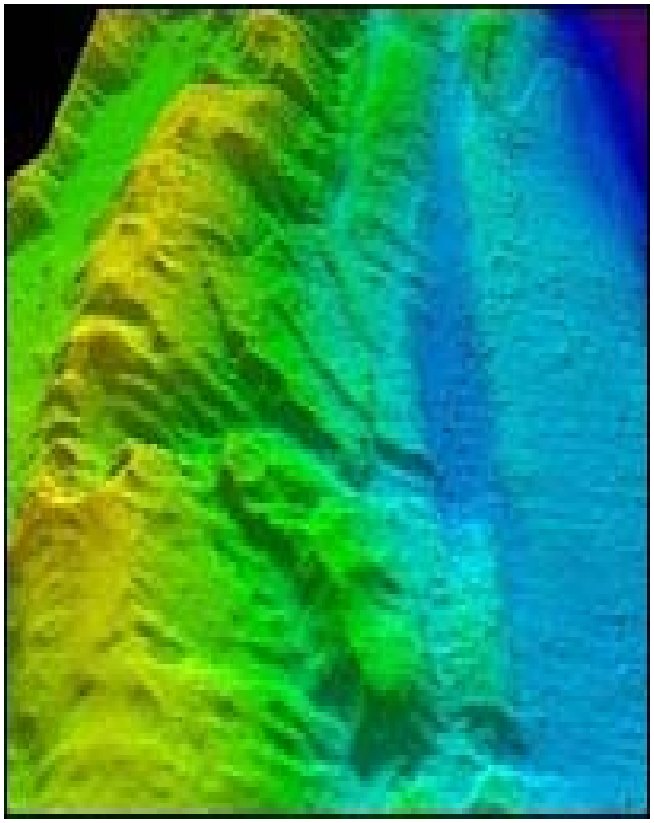
Findings	25
Impacts	20
Recommendations	23
Considerations/ Potential Solutions - ways to address some of the recommendations	40

Systematic Improvement in Client's Organizational Training Processes Needed

Lessons Learned

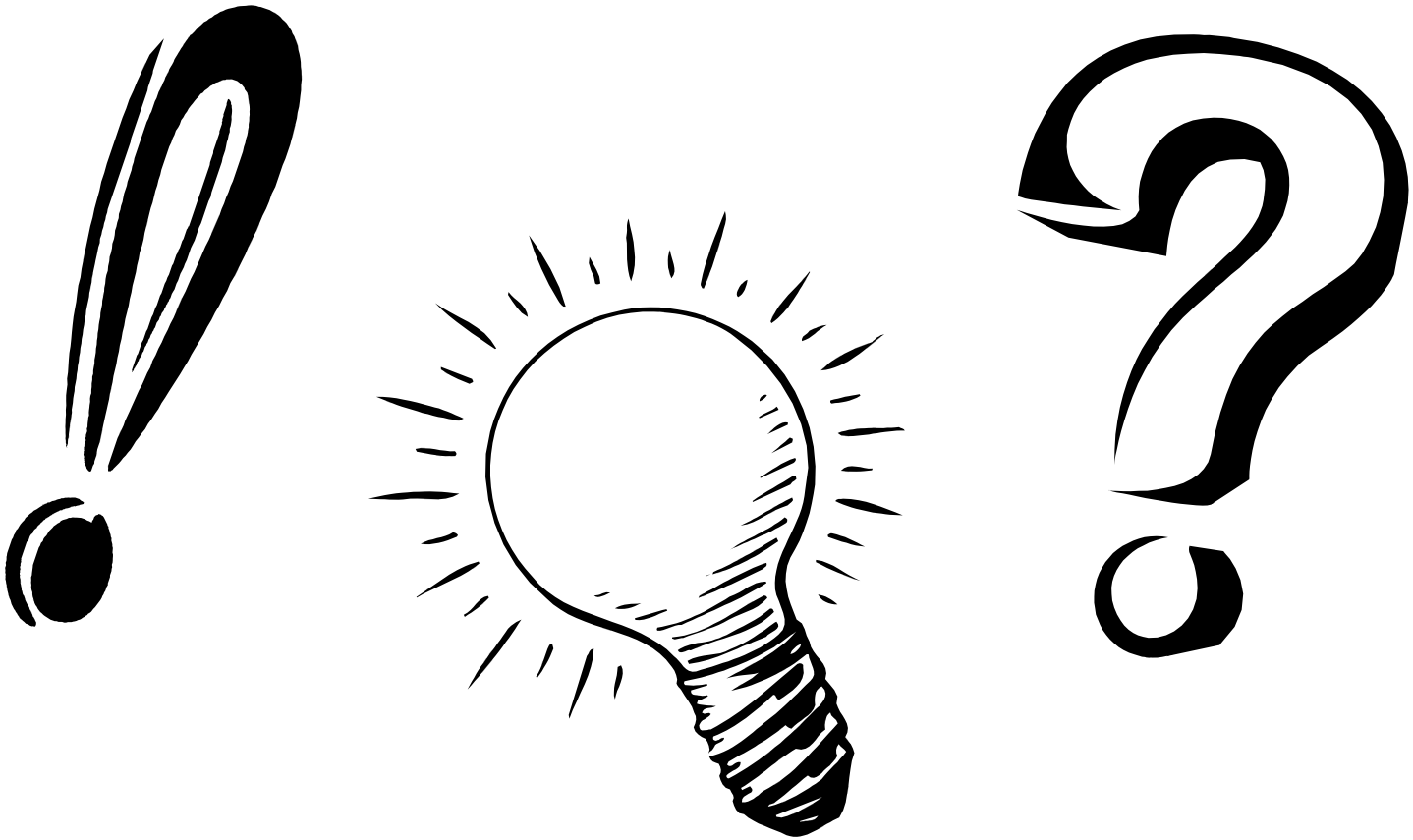
Tsunami

- Tsunami-like impacts on new acquisition training requirements
  - Rapid, large-scale disturbance of current training needs envisioned
  - Forces will include technological, human capital, external and government needs
- Training departments have incorporated best acquisition practices into their training courses; however
  - Mapping of core competencies to training courses needs to be done
  - Training architectures needed
- Developers of organizational training processes could benefit from the application of systems engineering



Images of the Ocean Floor

Wrap Up



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Fax: + 1 703-908-9317

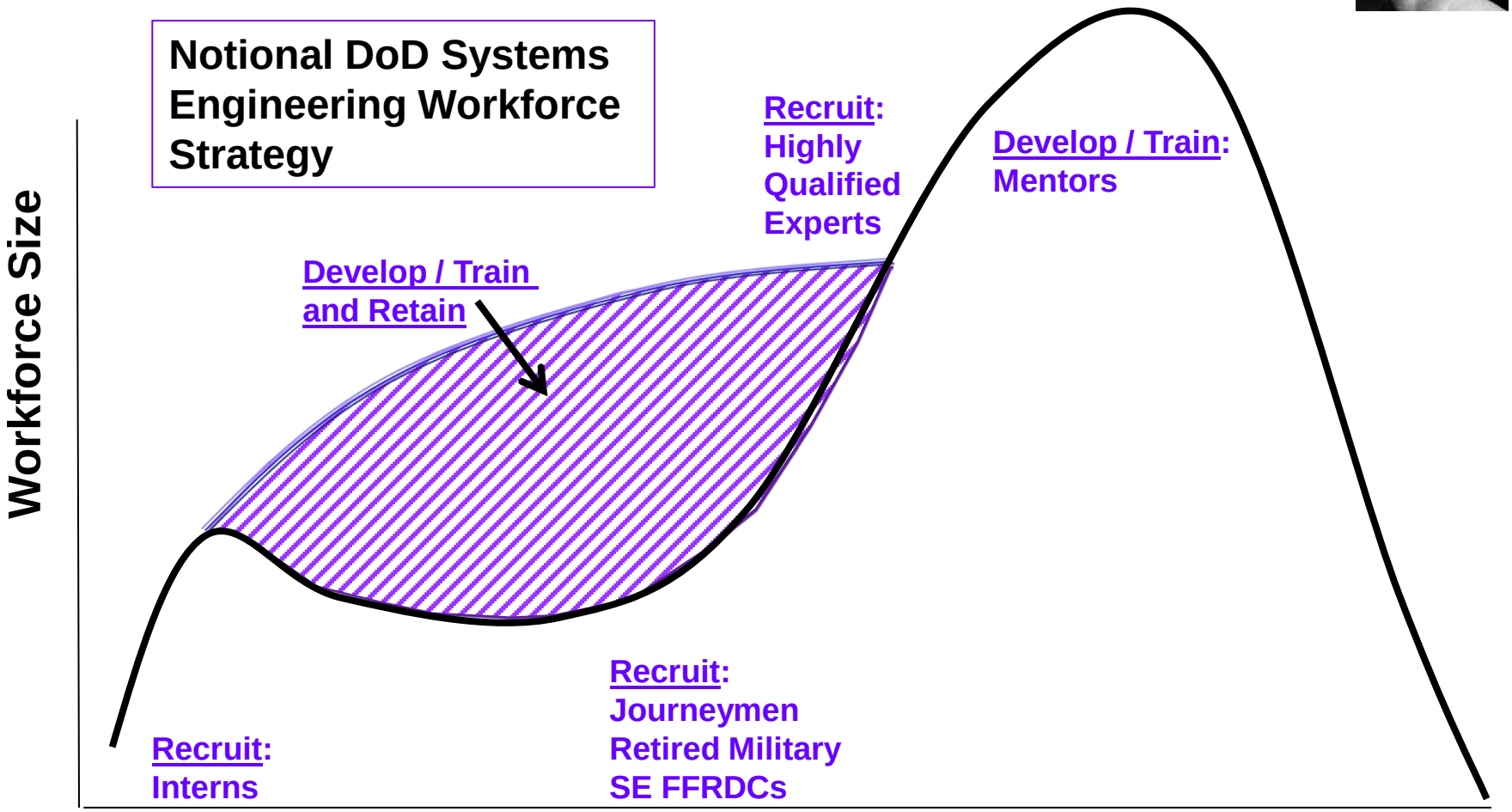
Email: nidiffer@sei.cmu.edu

Systems Engineering Drivers for Improving Acquisition Excellence

- External Forces
- Technological
- Human Capital
- Client Unique

External Forces

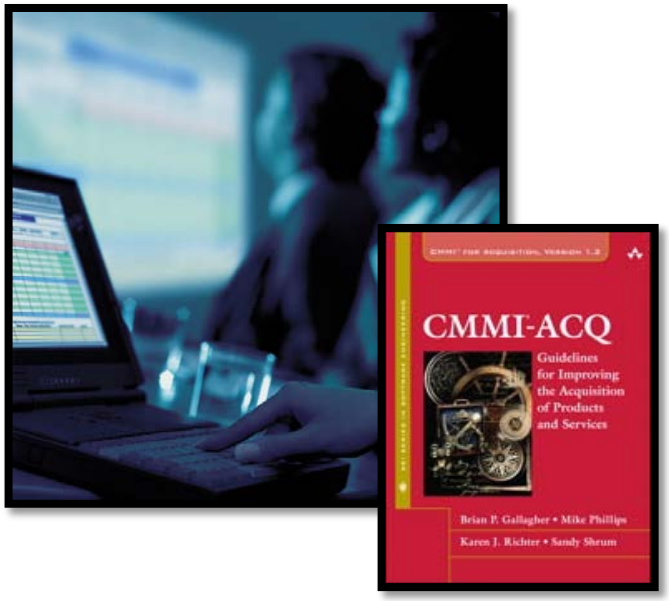
Notional DoD Systems Engineering Workforce Strategy



Source: OSD (DDR&E)

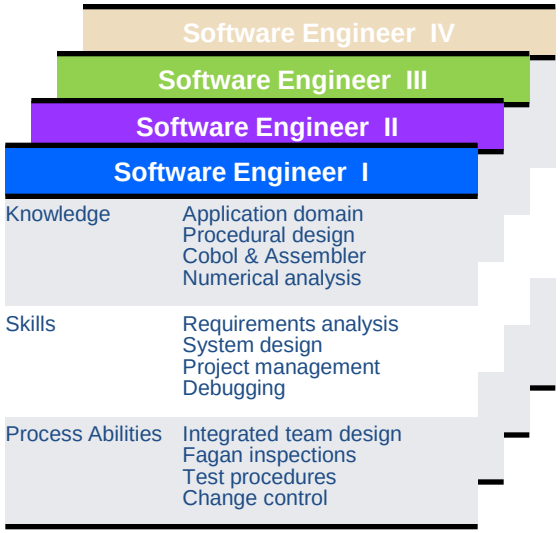
Reference Model

Evaluated client's acquisition training program components using Capability Maturity Model Integration® for Acquisition (CMMI® -ACQ) as reference model

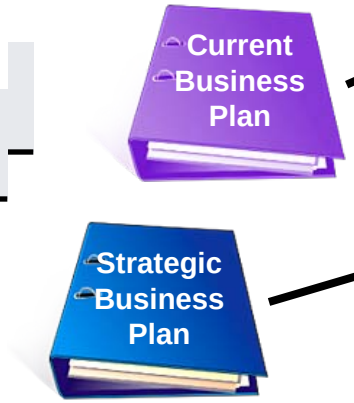


Human Capital: Using Core Competencies

- Accurate identification of required competencies are important to support the curriculum review and development effort needed to ensure the best and most relevant training.



Competency Family
Software Engineering



Current Resource Profile (initial inventory)

Workforce Competency	Staffing by Capacity Level			
	I	II	III	IV
Software Engineer	17	25	12	5
User Training	2	8	4	1

Current Resource Needs (one-year cycle)

Workforce Competency	Current Staffing Level Needed			
	I	II	III	IV
Software Engineer	23	30	15	7
User Training	4	9	6	2

Strategic Workforce Needs (2-5 year)

Workforce Competency	2010Staffing Level Needed			
	I	II	III	IV
Software Engineer	31	35	18	9
User Training	4	10	8	3

NO WARRANTY

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