DoD Systems and Software Engineering

The National Academies
Committee on Systems Engineering

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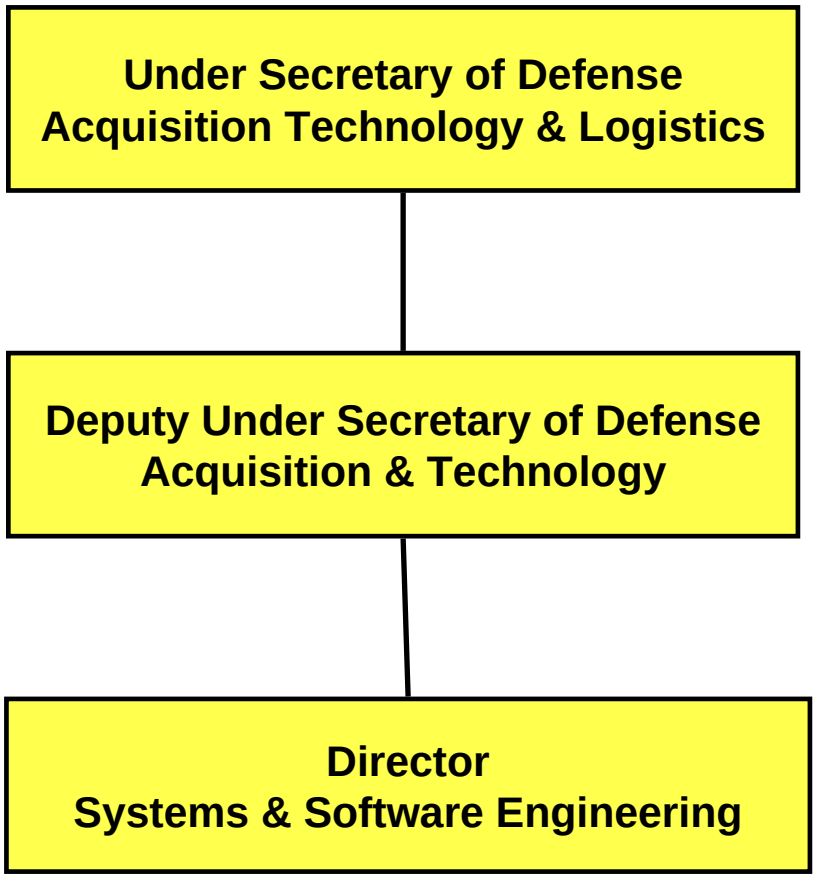
Recent Acquisition & Technology Reorganization



as of June 1, 2006

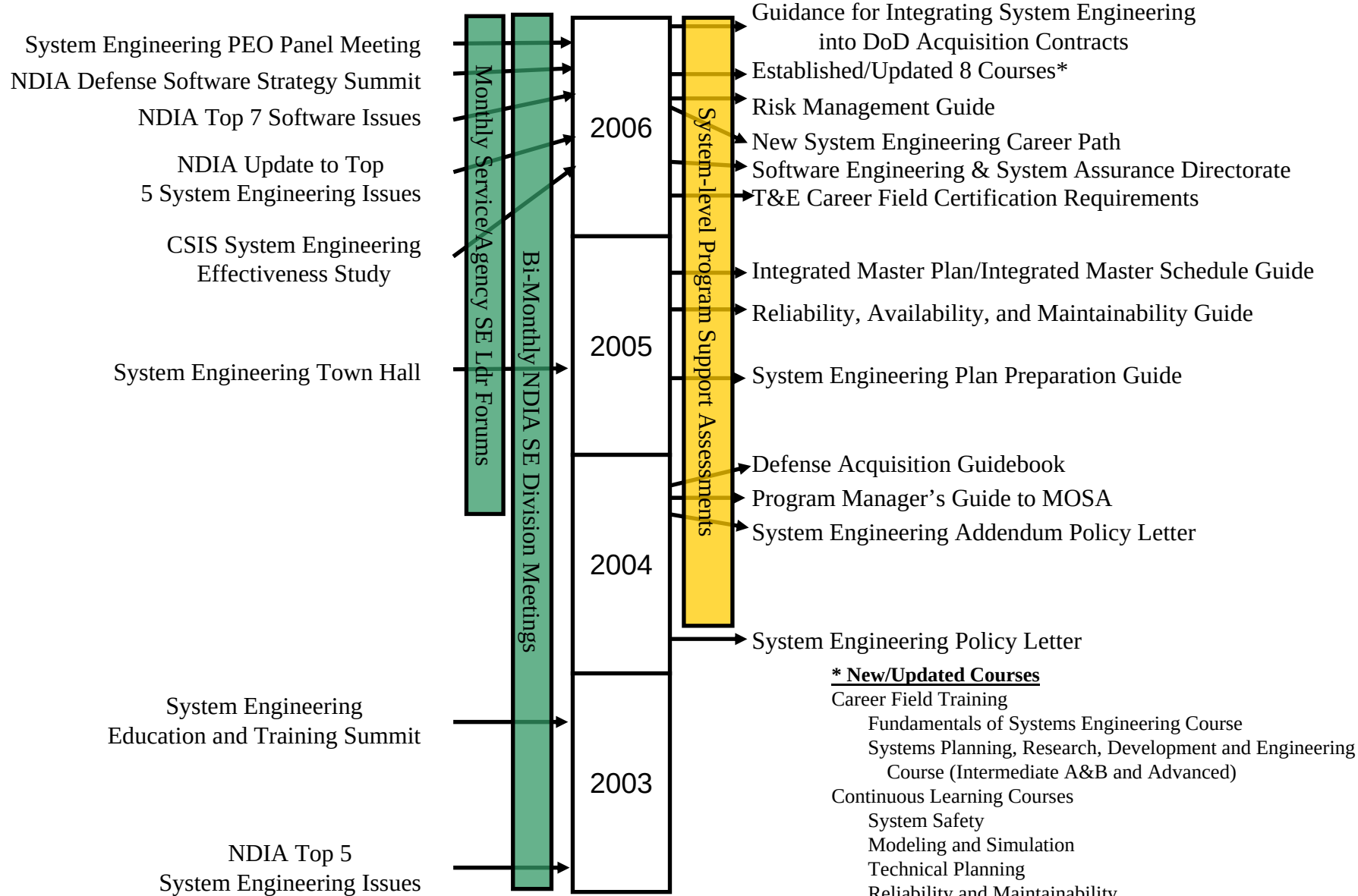
Systems Engineering is well positioned in DoD

Systems and Software Engineering Mission Statement

- Shape acquisition solutions and promote early technical planning
- Promote the application of sound systems and software engineering, developmental test and evaluation, and related technical disciplines across the Department's acquisition community and programs
- Raise awareness of the importance of effective systems engineering and drive the state-of-the-practice into program planning and execution
- Establish policy, guidance, best practices, education, and training in collaboration with academia, industry, and government communities
- Provide technical insight to program managers and leadership to support decision making

Evolving System Engineering Challenges

Systems Engineering Revitalization Effort



*** New/Updated Courses**

Career Field Training
- Fundamentals of Systems Engineering Course
- Systems Planning, Research, Development and Engineering Course (Intermediate A&B and Advanced)

Continuous Learning Courses
- System Safety
- Modeling and Simulation
- Technical Planning
- Reliability and Maintainability
- Technical Reviews

Driving Technical Rigor Back into Programs
"Portfolio Challenge"

- Systems and Software Engineering have been tasked to:
  - Review program's SE Plan (SEP) and T&E Master Plan (TEMP)
  - Conduct program support reviews
- Portfolio of major acquisition (ACAT ID and IAM) programs, supporting 10 Domain Areas:
  - Business Systems (3%)
  - Space Systems (7%)
  - C2ISR Systems (10%)
  - Fixed Wing Aircraft (21%)
  - Unmanned Systems (2%)
  - Rotary Wing Aircraft (21%)
  - Land Systems (16%)
  - Ships (7%)
  - Munitions (3%)
  - Missiles (7%)

and Software

Systems Engineering and T&E Support to Over 150 Major Programs in 10 Domain Areas

Top 10 Emerging Systemic Issues

1. Management	• IPT roles, responsibilities, authority, poor communication • Inexperienced staff, lack of technical expertise
2. Requirements	• Creep/stability • Tangible, measurable, testable
3. Systems Engineering	• Lack of a rigorous approach, technical expertise • Process compliance
4. Staffing	• Inadequate Government program office staff
5. Reliability	• Ambitious growth curves, unrealistic requirements • Inadequate “test time” for statistical calculations
6. Acquisition Strategy	• Competing budget priorities, schedule-driven • Contracting issues, poor technical assumptions
7. Schedule	• Realism, compression
8. Test Planning	• Breadth, depth, resources
9. Software	• Architecture, design/development discipline • Staffing/skill levels, organizational competency (process)
10. Maintainability/Logistics	• Sustainment costs not fully considered (short-sighted) • Supportability considerations traded

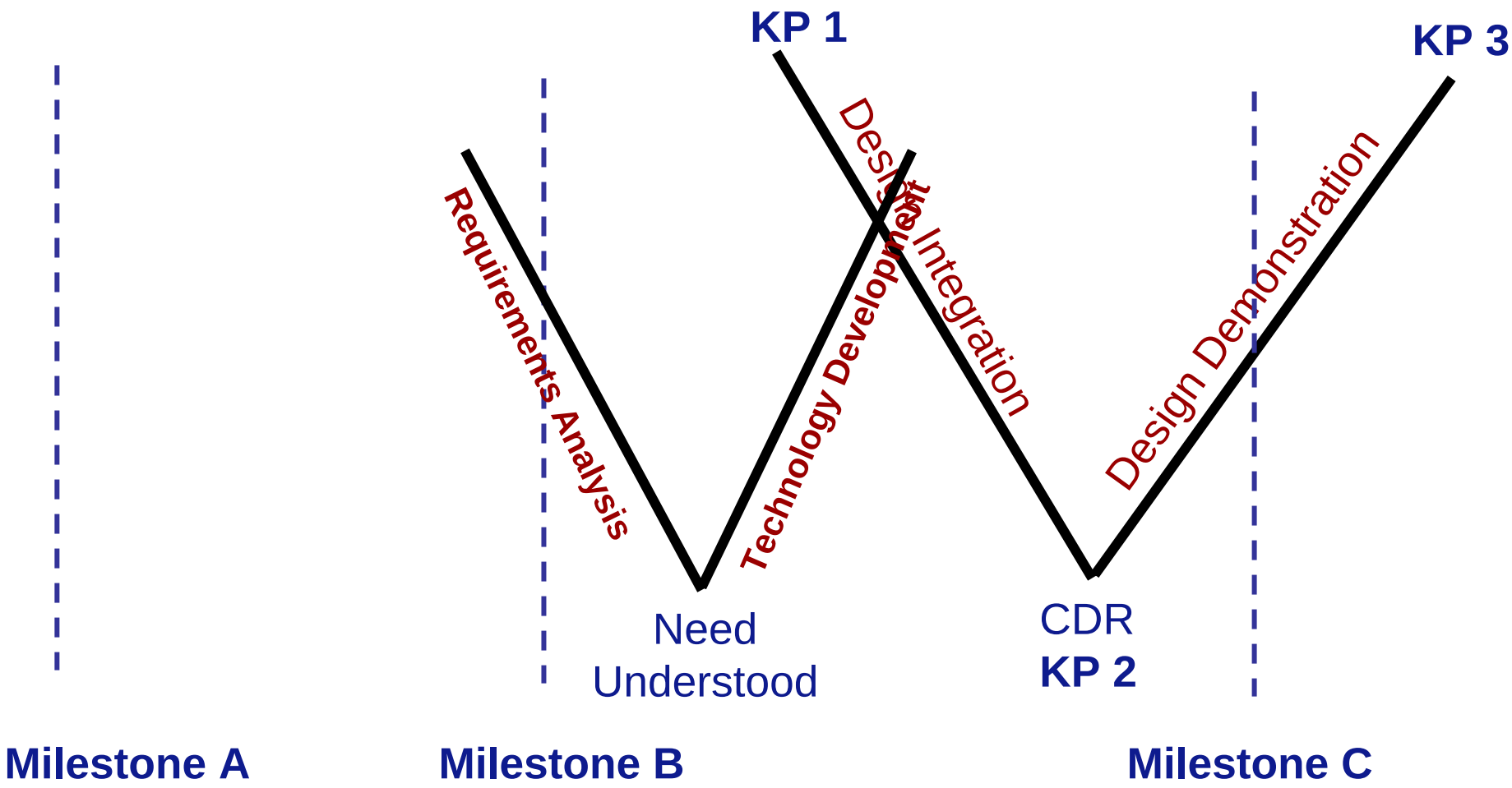
Major contributors to poor program performance

- We have revitalized Systems Engineering Policy, Guidance, Education and Training
- We have driven good systems engineering practices back into the way the acquisition community does business, and have had a positive impact on programs
- We have a rigorous process to capture what went wrong...
- ***We have identified, but failed to change root cause behavior that leads to programs that do not meet cost, schedule, and performance expectations***

Call for Attention

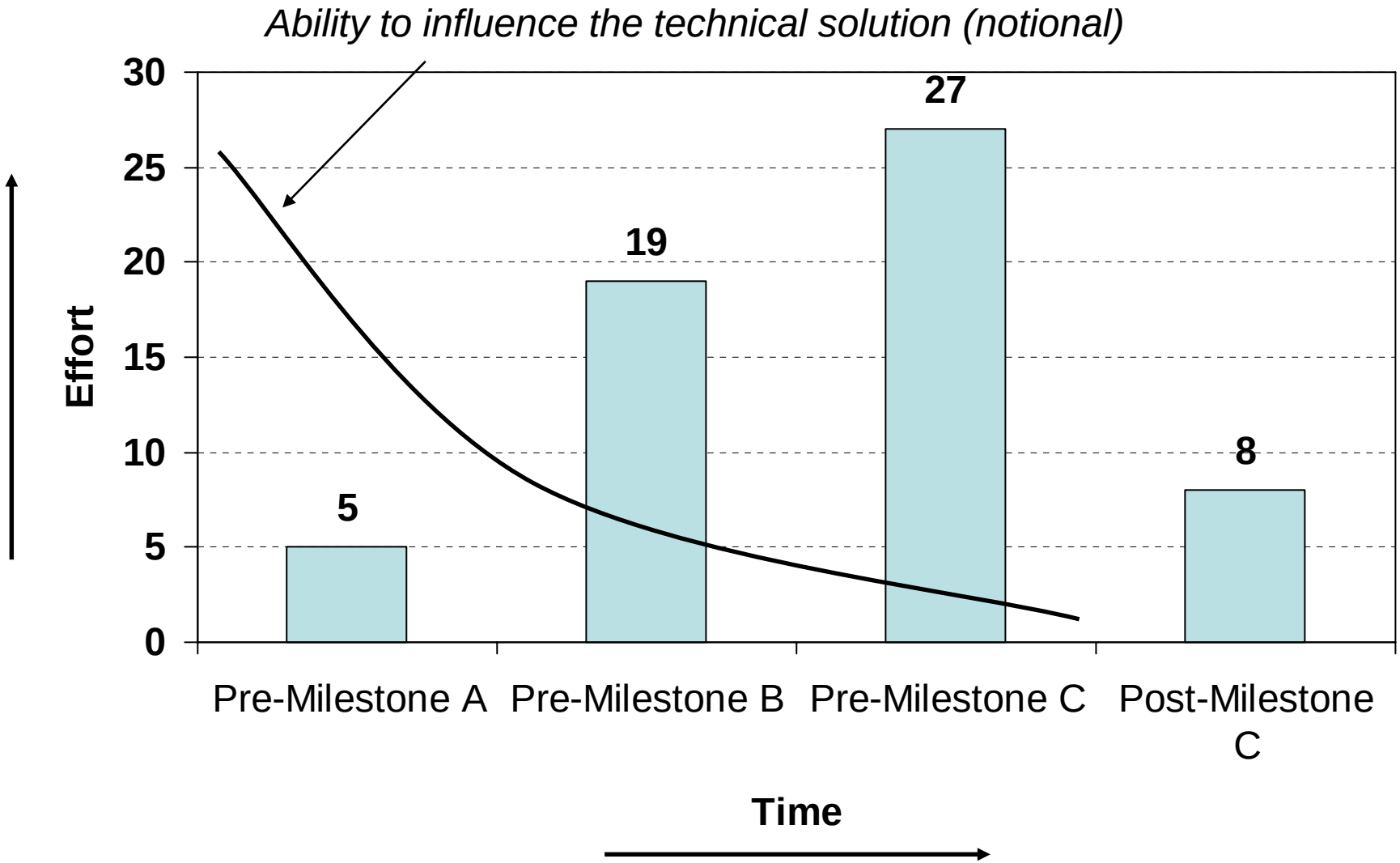
- GAO
  - Most programs proceed with low levels of knowledge resulting in cost/schedule increases.
    GAO presentation to QDR IPT 5, 16 August 2005
- AT&L
  - "What we have missed so far is the integration of requirements, acquisition and resources -- working together -- to permit early and regular trade-offs between cost, performance and schedule. USD(AT&L) testimony, SASC, 27 September 2005
  - We must have "Improved Centers of Excellence for Systems and Software Engineering" USD(AT&L), October 2006
- Congress
  - "The Committee is concerned that problems continue to undermine performance of major weapons systems…problems occur because DoD weapon program do not capture early on the requisite knowledge that is needed to efficiently and effectively manage program risks" Senate Report 109-069 – S1042 Title VIII – Acquisition Policy, Acquisition Management and Related Maters – p.341
  - The USD(AT&L), in collaboration with the JROC, should reemphasize the need to focus on best value as it relates to accomplishing current and future DoD missions"
    House Armed Services Committee - Committee Defense Review Report, December 2006
- DoD observations
  - Selected Acquisition Report (SAR) data forecasted $802B in expenditures, initial assessment indicates that overruns are $382B

Actual Acquisition Strategies Do Not Align with Systems Engineering

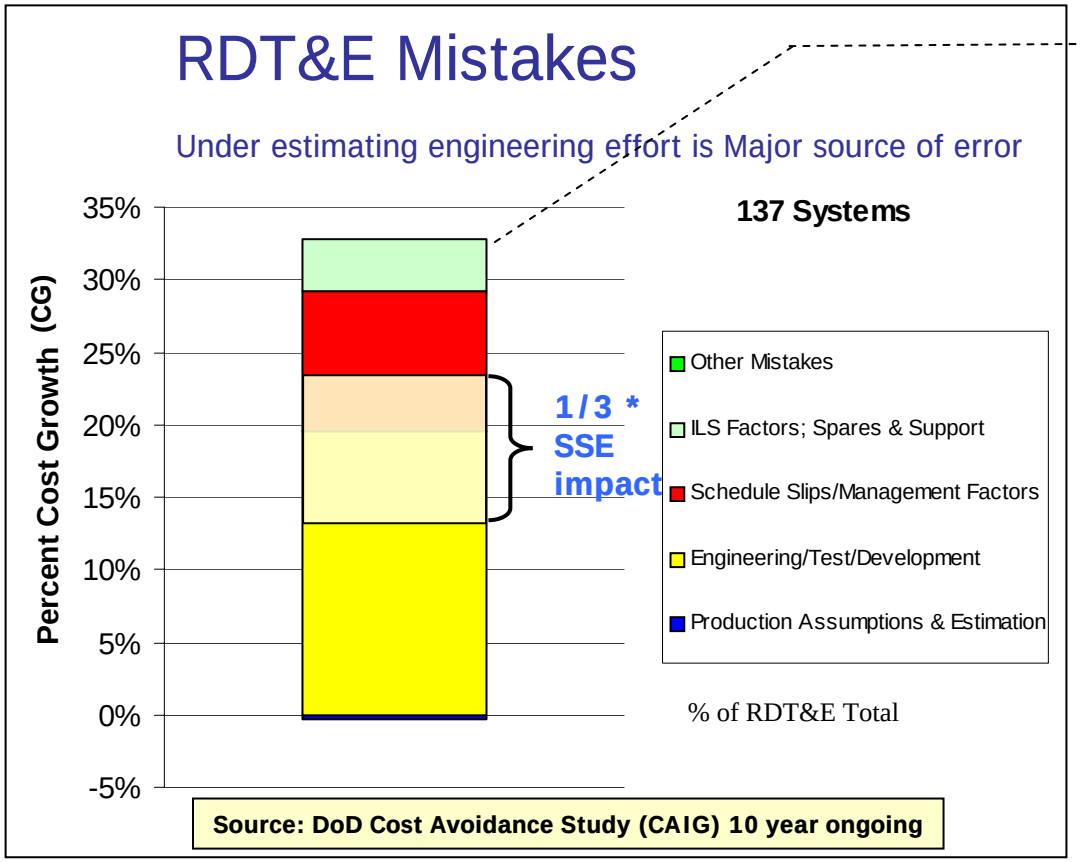


Excerpt – GAO presentation to QDR IPT 5 – 16 Aug 2005

Program Support Review Activity by Milestone



Systems and Software Engineering in Programs Reduces Costly Mistakes



33% historical RDT&E **Cost Growth**

Applied to

$222.8B RDT&E FYDP**

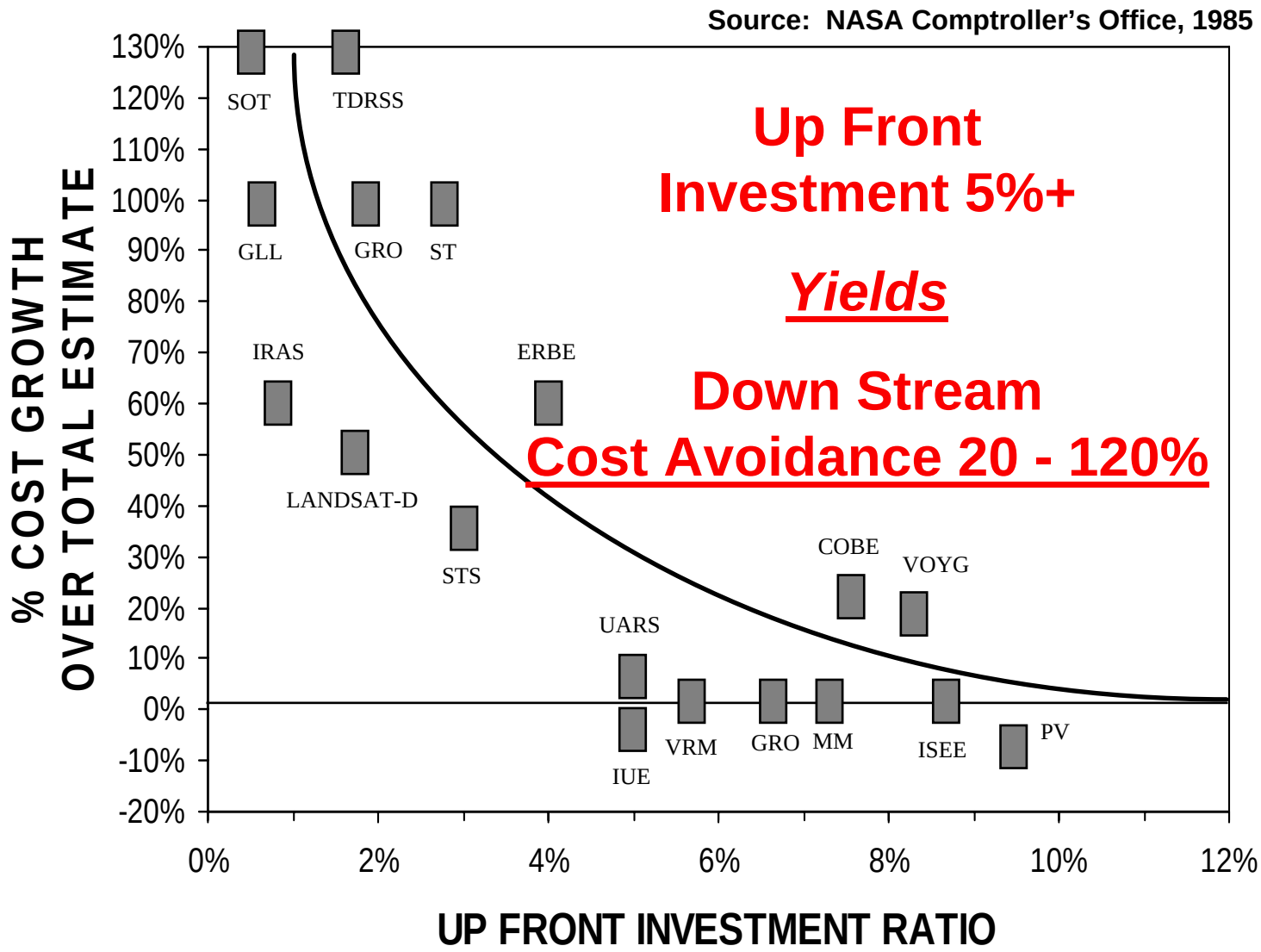
Yields a Potential → $73.52B **RDT&E Cost Growth FYDP**

* SSE positive impact on just 1/3 of RDT&E mistakes (11%)

Yields a Potential → $24.51B **RDT&E Cost Avoidance FYDP**

****SAR data for MAIS and MDAP programs under OSD Systems Engineering Oversight**

Systems Engineering - Key Results



Initiatives For Strategic and Tactical Acquisition Excellence

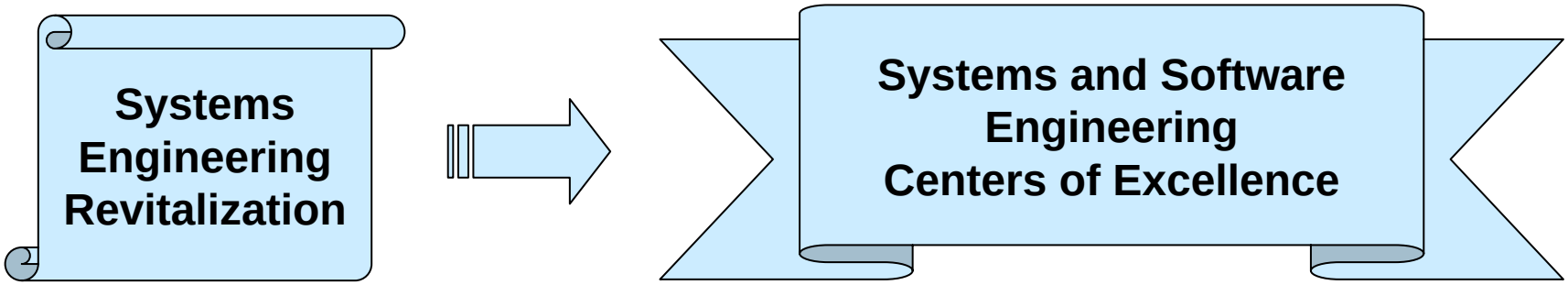
STRATEGIC
"Big A"

"Little A"
TACTICAL

OBJECTIVES	INITIATIVES
Making Decisions that Balance the Trade-Space • Affordable, Feasible Investments	• Portfolio Management • Tri-Chair Concept Decision / Time-Defined Acquisition • Evaluation of Alternatives • Synchronize Existing Processes • Tri-Chair Investment Balance Reviews
Starting Programs Right • Improved, Up-Front Planning • Awareness of Risk / Improved Source Selection • More Responsive Acquisition Solutions	• Risk-Based Source Selection • Small Business Innovative Research • Acquisition of Services Policy • Systems Engineering Excellence • Award Fee and Incentives
Process efficiency • Tailored, agile, transparent	• DAB / OIPT Process Optimization • Common Data / DAMIR • Restructured DAES
Program Stability • No Downstream Surprises • Issue Awareness	• Program Baseline Assurance • Capital Accounts

Improving the Full Range of Acquisition Execution

Vision for Systems Engineering and Software



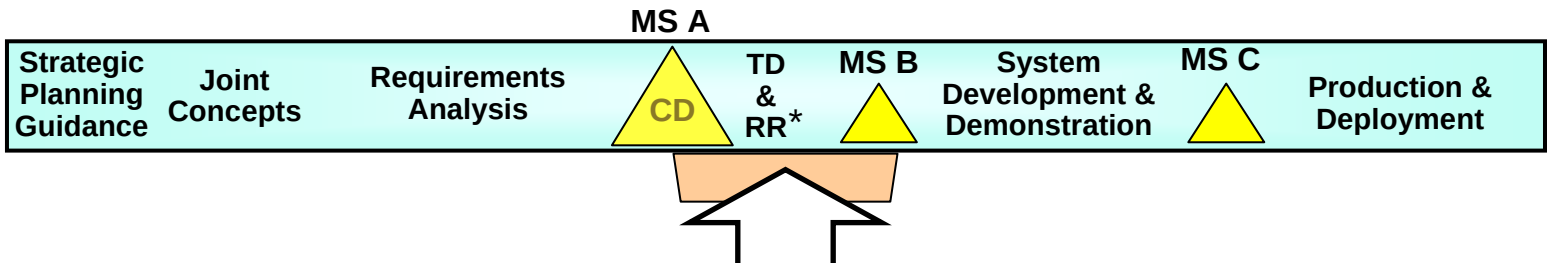
- **Competencies Improved**
- **Delivered Product Suite**
  - Courseware
  - Policy/Guidance
  - Program Support methods
- **Elevated Stature**
- **Raised Awareness**
- **Positive Influence**

- **World class leadership**
- **Broaden to Software Engineering, System Assurance, Complex Systems-of-Systems, Test & Evaluation**
- **Responsive and agile, technical discipline to shape acquisition solutions**
- **Ensure appropriate human capital needs are met**

. . . the Technical Foundation that Enables Acquisition Excellence

Starting Programs Right
Shaping Systems Acquisition Solutions

- System Level
  - Application of System Engineering principles contributes to successful program execution
  - Leverage System Engineering relationship to cost, schedule, and performance
  - Ensure enabling disciplines are in concert with technical planning
- Ensuring program and milestone reviews are informed by technical planning, verification and validation, and complementary business rules

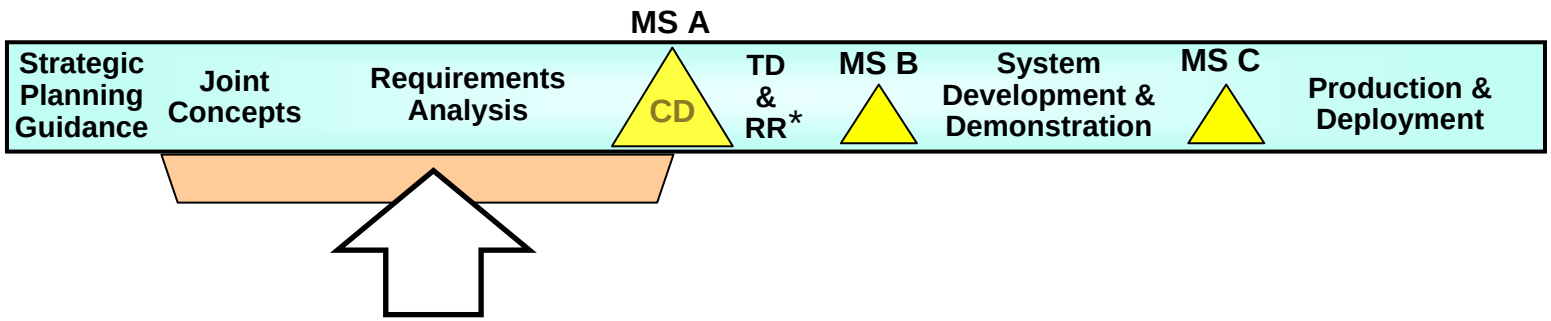


Driving Technical Excellence into Programs – Milestone B

Topic	Systems Engineering	Test & Evaluation	Risk Management	Exit Criteria	Acquisition Strategy
Focus Areas	System Requirements	V&V Traceability	Risk ID	Thresholds & Objectives	KPPs/KSAs
	Organization & Staffing	Test Resources	Risk Analysis	Life Cycle Cost	Defined Budget & Schedule
	Technical Reviews	Test Articles	Risk Mitigation Planning	Technical Maturity Level	Industrial Base
	Technical Baseline	Evaluation	Risk Tracking	Material Readiness	Development & Demonstration
	Linkage w/ Other Program Mgmt & Controls	Linkage w/ Other Program Mgmt & Controls	Program/ System Dependency	Net Centric	Risk-based Source Selection
Product	SEP	TEMP	RM Plan	Phase Exit Criteria	Contract Scope, ASR

Make Decisions that Balance the Trade Space Early Lifecycle Planning

- Early lifecycle involvement of Systems Engineering:
  - Inform evaluation of alternatives with technical insights
  - Ensure solutions balance requirements with technical feasibility
  - Ensure solutions can be validated and verified
  - Use Modeling & Simulation to help refine warfighter concept of operations/system requirements, evaluate design alternatives, and identify potential technology/human interface constraints
- Appropriate resourcing (personnel/funding) required



*Technology Development and Risk Reduction

Driving Technical Excellence into Programs – Milestone A

Topic	Systems Engineering	Test & Evaluation	Risk Management	Exit Criteria	Acquisition Strategy
Focus Areas	Operational Requirements	V&V Traceability	Risk Drivers	Draft KPPs/KSAs	CONOPS
	Budget/ Schedule Realism	Test Resources	Risk Analysis	ROM Cost & Schedule	Bounded Solution
	Technical Planning &Trades	Parametric Models	Technology Maturity	TRL	Technology Base
	Technical Constraints	M&S	Risk Planning	EOA	Risk Reduction
	System of Systems Integration	Joint/Interop Test Planning	Program/ System Dependency	SoS Architecture	Incremental Strategy
Product	Concept SEP	TES	Risk Mitigation Strategy	Phase Exit Criteria	Draft RFP, ASR

Enabling Systems Engineering Activities to Develop Products and Knowledge

PRE-MILESTONE A

- Interpret User needs, analyze operational capabilities & environmental constraints
- Develop concept performance (and constraints) definition, and associated verification objectives
- Decompose concept performance into functional definition and verification objectives
- Decompose concept functional definition into component concepts and assessment objectives
- Develop component concepts, i.e. enabling/critical technologies, constraints, and cost/risk drivers
- Assess/Analyze enabling/critical components versus capabilities
- Assess/analyze system concept versus functional capabilities
- Assess/analyze concept and verify system concept's performance
- Analyze/assess concepts versus defined user needs and environmental constraints

PRE-MILESTONE B

- Interpret user needs, refine system performance specs and environmental constraints
- Develop system functional specs and system verification plan
- Evolve functional performance specs into configuration item (CI) functional (design-to) specs and CI verification plan
- Evolve CI functional specs into product (build-to) documentation and inspection plan
- Fabricate, assemble, code to "build-to" documentation
- Individual CI verification
- Integrated DT&E, LFT&E and OAs verify performance compliance to specs
- System DT&E, LFT&E and OAs verify system functionality and constraints compliance to specs

<u>NOTE:</u> Activities are further detailed in the Defense Acquisition Guidebook Chapter 4. These are listed in the order of completion (vice initiation).

Way Ahead for Systems Engineering

- Systems Engineering Revitalization
  - Policy Guidance, Education, Training, Program and Decision Support, Outreach
  - Positive impact to MDAPs and MAIS programs on an individual basis
  - Much has been accomplished….
- Taking Systems Engineering to the Next Level
  - Early life-cycle involvement key to program success
  - Solid technical foundations for alternatives and solutions
  - Impact programs early -- maximize flexibility; minimize cost-to-change; expand to ACAT IC and below