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The Next Generation of Systems Engineering:
A Report by the GEIA G-47 Systems Engineering Panel

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The Next Generation of Systems Engineering:

A Report by the GEIA G-47 Systems Engineering Panel

GEIA-SE-0001

September 03

**GOVERNMENT ELECTRONICS AND
INFORMATION TECHNOLOGY ASSOCIATION**



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(Formulated under the cognizance of the GEIA Systems Engineering, G-47 Committee)

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**Government Electronics and Information Technology Association
(GEIA)**

**The Next Generation of Systems Engineering:
A Report by the GEIA G-47 Systems Engineering Panel
36th Annual Engineering and Technical Management Conference,
September 2002**

GEIA-SE-0001

Revision	Description of change	Date
-	Initial Release	9/6/03

Executive Summary

The purpose of this panel was to present a set of visions about **how Systems Engineering (SE) will transform the engineering of systems in the next decade** through development and application of concepts under current Research and Development (R&D). A survey was done of the most significant and innovative systems engineering **Initiatives and Technologies** covering:

- Processes
- Methods, techniques and standards
- Engineering environments and tools
- Modeling and simulation

Representatives of the most influential Initiatives and Technologies identified were invited to become panelists. Panelists presented an overview of their Initiatives or Technologies and engaged in question and answer periods to elicit further understanding. A final capstone session assessed the effectiveness of the approaches being taken by academia, government and industry.

The panel was structured along the themes of identifying those Technologies and Initiatives that best demonstrate the potential improvements in Systems Engineering in the following categories, organized for the three-day structure of the panel within the GEIA Conference:

- **Day 1 - Working Together:** Focused on methods to improve Community SE processes and business integration
- **Day 2 – Interoperability:** Focused on methods to improve the exchange of engineering information and to create integrated engineering environments
- **Day 3 – Modeling and Simulation:** Focused on individual tools and aggregate environments for modeling across the life cycle
- **Capstone Session:** This final session enabled the combined panelists to assess the directions being pursued and determine whether the results will transform Systems Engineering as desired.

The following table shows the characteristics and implications of SE evaluated by the panel:

Category	Characteristics	Implications
Processes	• Evolving from integrated processes and methods within each individual organization to integrated processes and methods across organizations	• Shifts definition of engineering and management processes from project level to enterprise level to community level • Need to define standardized processes flexible enough to adapt to specific circumstances
Methods	• System engineering, Software (SW) engineering and Hardware (HW) engineering have evolved along different paths • Most major system problems found during integration and verification when HW and SW are finally brought together and inconsistencies exposed	• New methodology needed that unifies System, SW, and HW engineering
Methods	• Modeling and Simulation (M&S) evolving from isolated specialty analyses to multi-dimensional and integrated suites	• M&S can reduce costs across system life cycle • M&S can support continuous evolution of system of systems design allowing full range of life cycle models from earliest parametric/analytical models to detailed simulations to HW-in-the-Loop (HITL)

Category	Characteristics	Implications
		Models evolve through concept evaluation, preliminary and detailed design analysis, verification, operational evaluation and training
Acquisition	Systems evolving from standalone with limited interfaces (ICDs) to system of systems with common communication and service-based information infrastructure	- Shifts infrastructure SE from Program Office to Service/Agency level - Shifts infrastructure SE from contractor to government - Shifts Acquisition from procuring complete systems to procuring subsystems and services
Acquisition	- Systems evolving into systems of systems - Rate of technology change differs between platforms, specialized subsystems and the IT that connects them	- Acquisition and Architecture strategies need to be integrated and shift to multi-tier “50 yr” Platforms can afford “15 yr” R&D “10 yr” Major subsystems can afford “3 yr” R&D “3 yr” Communications and Information Infrastructure requires continuous R&D and incremental fielding - Application of M&S technologies holds potential for transforming Acquisition process
Tools	- Tools evolving from project-level to enterprise-level - Add enterprise functions supporting <i>product lines</i> and <i>quantitative improvement</i> - Supply Chain Integration and e-Business markets emerging to provide infrastructure enabling Community System Engineering	- Integration of enterprise tools and e-Business exchange enables implementation of Community SE processes - Standards needed to define and transport engineering semantics - Tools/mechanisms needed to support use, reuse, and configuration control of engineering data within communities
Technologies	- Info systems evolving from exchange of raw/low-level data to high-level information that preserves semantic content - ASCII $\Rightarrow$ TeX $\Rightarrow$ HTML $\Rightarrow$ XML - Faxed drawing $\Rightarrow$ CAD file $\Rightarrow$ Intelligent schematic	- Open standards needed to define semantics for accurate, unambiguous engineering data exchange - Design and analysis tools and product data repositories needed that support intelligent data exchange within communities
Technologies	- Technologies used in government systems evolving from domination by government-funded R&D to commercial R&D - Technology shift follows market shift from government to commercial domination - Rate of technology change causes tension between modernization and readiness - If government takes 3 yrs to modernize, then government’s system is ready to operate at the same time that industry has depreciated investment and is ready to upgrade	- Design systems to accept upgrades gracefully during O&M - Design and cost systems to future standards vice current

Recommendations: The panelists concluded that the initiatives examined during this conference are largely complementary and non-conflicting. Multiple engineering environments are being developed for programs pursuing similar strategies. The panel recommends:

- A workshop should be conducted to bring tool vendors and engineering environment builders together.** Programs are developing support environments such as the Integrated

Digital Environment by assembling a diverse set of COTS, GOTS, and custom applications integrated into an environment with program resources expended to development custom interfaces and extensions. The programs developing these environments never share the extent of their environment requirements with individual tool vendors. Rather the programs evaluate tools for specific purposes and select the “best of breed” for each function. Regardless of how well an individual tool fits into the environment, the tool vendor seldom has an understanding of the extent of the program’s real needs while programs seldom provide adequate feedback to tool vendors about the integration into an overall suite of tools that may be program-specific. The result is that tool vendors fail to devise tools that meet program needs (especially large programs) while programs constantly fault vendors for failing to supply more robust solutions. A workshop that brings these two groups together could establish a venue for improving communications between the groups leading to improved engineering and program management tools.

2. **The GEIA G-47 System Engineering Committee should form a new Working Group to define and document a Vision of the next generation of SE capabilities.** The majority of panelists and attendees agreed to enter into discussions about creating a plan to realize the next generation of SE capabilities and parse the problem into assignable components that societies and consortia can cooperatively pursue. The initial or primary product of this Working Group is to be a document capturing the Vision of Capabilities of the Next Generation of System Engineering. Possible added products could include a Framework or Guidance document and a Technology Roadmap that lays out a plan for the R&D required to achieve this Vision. Panelists and attendees were aware of related activities occurring in other societies and associations and expressed the strong opinion that GEIA should coordinate its efforts with others rather than pursuing its own (stovepiped) Vision. Specific organizations were identified and volunteers agreed to act as the Points Of Contact to initiate this collaboration. Organizations include: INCOSE, NDIA, IEEE, the European Union, OSD/SEO, and NIST/NSF Roadmap for Affordable Manufacturing. Other stakeholders who should be invited to participate should include other government agencies, commercial industry (to involve domains other than government and government contractors), and representatives from across the system lifecycle (e.g., operations, maintenance, and logistics). The Working Group should create the Vision and implementation plan in a timely fashion to support government responses to recent reports citing deficiencies in SE such as the Moorman Report, National Academy of Engineering Report, and Defense Science Board (“Young”) Report. Panelists and attendees volunteered to support the Working Group including representatives from government, industry and academia including:

- Government: Department of Defense (Army, Air Force, and Navy), DOE, NASA
- Industry: Northrop Grumman, Lockheed Martin, Dynetics
- Academia: John Hopkins University, Georgia Institute of Technology

Conclusion: The G-47 SE Committee voted to implement the Next Generation SE Capabilities panel recommendations to initiate a new Working Group to define a Vision of next generation SE capabilities in coordination with other societies, consortia and stakeholders.

Acknowledgements

The Next Generation of Systems Engineering Panel was held at the 36th Annual GEIA Conference, 23-27 September 2002, in Snowbird, Utah. The following panelists made presentations, participated in the debate over the future of Systems Engineering, and submitted papers for these Proceedings:

Organization	Panelist
Northrop Grumman Information Technology TASC	James Schier, Panel Chairman and Editor
Naval Air Systems Command (NAVAIR)	Zig Rafalik
National Reconnaissance Office (NRO)	Steve Wall
National Aeronautics & Space Administration (NASA) Headquarters	Stephen J. Kapurch
Lockheed Martin Corporation	Paul Robitaille
Accenture	Tom Shaw
Lockheed Martin Enterprise Information Systems Company	Ron Schuldt
Vitech Corporation	Dr. Joe Skipper
Rockwell Collins	Raymond Jorgenson
Defense Information Systems Agency, Interoperability Directorate	Jerry Smith
CACI	Chris Kreider
MITRE Corporation	Dr. Glenda Hayes
Defense Advanced Research Projects Agency (DARPA)	Murray Burke
Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology	Steve French
Naval Surface Warfare Center, Dahlgren Division (NSWC-DD)	Dr. Harry Crisp, II
Northrop Grumman Ship Systems	Ron Wood
NASA Jet Propulsion Laboratory (JPL)	Mike Dickerson
Georgia Institute of Technology	Russell Peak
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The Johns Hopkins University Applied Physics Laboratory	Peter Eirich
EDS PLM Solutions, Inc.	Mark Sampson
Dynetics, Inc.	Alan Washburn
Department of Energy, Idaho National Energy & Environmental Laboratory	Dr. Sam Alessi

In addition, the following conference attendees participated in the Systems Engineering Panel:

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Naval Air Systems Command	Stan Caine
Naval Air Systems Command (NAW-CL)	Gene Pappé
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Northrop Grumman	Ambika Mehra
Defense Contract Management Agency	Gerald O'Neil
Naptheon Corporation	Linda Reed
Astrium North America	Mike Smith
U.S. Army STRICOM	Paul Smith
NATO Airbase Germany	Arnaud Verhagen
Thales	Fabrice Wendling

Table of Contents

Executive Summary	i
Acknowledgements	iv
1 Objectives of the Next Generation of Systems Engineering	1
1.1 Opportunities for Improving Systems Engineering, James Schier, Northrop Grumman Information Technology TASC	4
1.2 Naval Air Systems Command Systems Engineering Organizational and Process Initiatives, Zig Rafalik, Naval Air Systems Command	9
1.3 Agile Design and Development for Space Systems, Steve Wall, National Reconnaissance Office	11
1.4 NASA Systems Engineering Initiatives, Steve Kapurch, NASA Office of the Chief Engineer	15
1.5 Lockheed Martin's Integrated Engineering Process Overview, Paul Robitaille, Lockheed Martin Corporation	16
1.6 Impact of Information Technology Products on the Practice of Systems Engineering (Lean Infrastructure), Tom Shaw, Accenture	22
1.7 DoD Acquisition Improvement, Mr. Richard Sylvester, Office of the Secretary of Defense, Deputy Director of Acquisition Initiatives	25
1.8 AIA e-Business and the Metadata Harmonization Project, Ron Schuldt, Lockheed Martin Enterprise Information Systems	27
1.9 Unification of the Systems Engineering and SW Engineering Processes, Joe Skipper, Vitech Corporation	32
2 Interoperability - Day Two	40
2.1 Product Life Cycle Support (PLCS): Origins, Purpose and Progress, Jerry Smith, DISA and Chris Kreiler, CACI	40
2.2 DoD XML Management Strategy, Glenda Hayes, MITRE Corporation	44
2.3 DARPA Agent Markup Language: Enabling Dynamic Command & Control Via Agent- Based WWW Technologies, Murray Burke, DARPA	46
2.4 STEP: The STandard for Exchange of Product model data, Jim Schier, Northrop Grumman Information Technology TASC	51
2.5 DoD Integrated Digital Environment, by Steve French, Office of the Deputy Secretary of the Army (Acquisition, Logistics and Technology)	54
2.6 Navy Collaborative Engineering Environment, Harry Crisp, Naval Surface Warfare Center-Dahlgren Division (NSWC-DD)	58
2.7 NASA Advanced Engineering Environment Initiative, Steve Kapurch, NASA Headquarters	63

2.8	Navy Integrated Shipbuilding Environment, Ron Wood, Northrop Grumman Ship Systems	66
2.9	Standards Based Collaborative System Design across the Life Cycle, Mike Dickerson, JPL	69
2.10	Standards-Based Engineering Frameworks as an Enabling Infrastructure, Russell Peak, Georgia Institute of Technology	74
3	Modeling and Simulation – Day Three.....	81
3.1	Simulation Based Acquisition, Steve Olson, Systems Management and Integration, Inc. 81	
3.2	Future Combat System Distributed Product Development, Peter Eirich and Dr. James Coolahan, The Johns Hopkins University Applied Physics Laboratory; Ellen Purdy, FCS Program Office, DARPA.....	84
3.3	Guiding Principals for Next Generation SE Tools, Mark Sampson, EDS PLM Solutions, Inc.	89
3.4	Supporting Next Generation Systems Engineering: The CORE® Engineering Environment, Joe Skipper, Vitech Corporation.....	95
3.5	Modeling and Simulation using AP233, Jim Schier, Northrop Grumman Information Technology TASC	100
3.6	Methodology for Modeling and Analysis of Threat Models, Alan Washburn, Dynetics, Inc.	107
3.7	Deep Culture Social Engineering, Sam Alessi, DOE Idaho National Engineering and Environmental Laboratory, University of Idaho.....	109
3.8	Transformation: Putting It All Together	115
4	Conclusion	118
5	Acronyms.....	118

List of Figures

Figure 1. Objectives of the Next Generation of Systems Engineering Capabilities.....	1
Figure 2. Application Context for Engineering a System (from EIA-632)	4
Figure 3. Project with Multiple Environments forms the Extended Application Context.....	5
Figure 4. Benefits of Collaboration exist across the System Life Cycle	7
Figure 5. NAVAIR Parallel Leadership Organization.....	10
Figure 6. Sample Process from NAVAIR SE Guide	11
Figure 7. A 20000 m View of how Spacecraft could be Designed.....	12
Figure 8. Conceptual Phase: Demonstrated Results	13
Figure 9. Next Step: Rapid Synthesis-Analysis (Scenario Driving).....	14
Figure 10. Shape Deposition Manufacturing and Sample Results	15
Figure 11. Lockheed Martin Integrated Engineering Process Context Diagram.....	18
Figure 12. LM-IEP Product Suite	18
Figure 13. The Focus of Lockheed Martin's Efforts	19
Figure 14. LM-IEP Reference Architecture.....	20
Figure 15. Relationship to Command Media.....	21
Figure 16. LM-PAL is the IEP Delivery Vehicle	21
Figure 17. Functions involved in Manufacturing Resource Project (MRP) II report.....	22
Figure 18. ERP/PDM Relationship.....	23
Figure 19. e-Business replaces multiple interfaces with an industry-common middleware.....	24
Figure 20. Evolution of Business Solutions.....	25
Figure 21. AIA's e-Business (EB) Interoperability Framework.....	28
Figure 22. Metadata Harmonization Project Scope	29
Figure 23. UDEF Concept of Operation	30
Figure 24. UDEF Naming Convention	30
Figure 25. Goal - UDEF IDs Become Global Unique IDs (GUIDs)	31
Figure 26. Metadata Harmonization Project Roadmap.....	32
Figure 27. C4ISR Architecture Framework Views.....	35
Figure 28. Mapping C4ISR Architecture Framework to the SE Process	36
Figure 29. AP233 Engineering Repository Concepts	37
Figure 30. Example of Tailoring CMMI Model Using Vitech's CORE	38
Figure 31. Business Context and Major IT Domains for PLCS	40

Figure 32. The PLCS Vision.....	41
Figure 33. Inputs and Efforts Incorporated in the PLCS Initiative.....	42
Figure 34. Phased PLCS Capability Sets.....	42
Figure 35. DoD XML Registry Web Site.....	45
Figure 36. DoD XML Registry Communities of Interest.....	46
Figure 37. Engineering-level Processes to Maintain the XML Repository.....	46
Figure 38. DAML = XML + Ontologies.....	48
Figure 39. Example DAML Ontology on Terrorism.....	48
Figure 40. DAML Services Ontology.....	49
Figure 41. DAML-based Service Brokers Provide Access to Ontologies.....	50
Figure 42. Architecture of the many Parts of the STEP Family of Standards.....	51
Figure 43. AP209: Composite & Metallic Analysis & Related Design.....	53
Figure 44. Next Generation Systems Must Address the Entire Program Life Cycle.....	54
Figure 45. Layers and Components of an IDE.....	55
Figure 46. Life Cycle Slice of Standards and Tools to Support Program Functions.....	56
Figure 47. Multiview's EIA-927 Standard Establishes a Neutral Data Model.....	57
Figure 48. Overview of the Naval Collaborative Engineering Environment.....	58
Figure 49. NCEE's Integrated Engineering Environment.....	59
Figure 50. The Interchange System Information Repository.....	60
Figure 51. Composition of Engineering Models Using the IEE.....	60
Figure 52. Generating C4ISR Architectures from the Systems Engineering Process.....	61
Figure 53. IEE Integrates Simulation and Analysis with Design.....	62
Figure 54. Scope of NASA's Advanced Engineering Environment.....	64
Figure 55. ISE Test ship TWR 841.....	67
Figure 56. ISE Demonstrates Interoperability of Design and Engineering Data.....	67
Figure 57. ISE Architecture is Based on Open Industry Standards.....	68
Figure 58. ISE Structural Design Scenario Demonstrated in April 2002.....	69
Figure 59. JPL Project Life Cycle.....	70
Figure 60. System Development Processes.....	71
Figure 61. Computer Aided Engineering Tool Service at JPL.....	72
Figure 62. STEP in Spacecraft Development.....	73
Figure 63. How AP233 Could Work: STEP Tool Interfaces Transparent to Tool Users.....	74
Figure 64. Generic Product Model Content View of an EFW.....	75

Figure 65. Target Collaborative Engineering Environment (Advanced Interoperability).....	76
Figure 66. Multi-representation architecture and constrained object representation for analysis templates	77
Figure 67. Sources of CAD-CAE associativity gaps and their costs.....	80
Figure 68. SBA Operations Concept Illustration.....	81
Figure 69. Top-Level View of the SBA Systems Architecture	82
Figure 70. Example of Distributed Product Description – Change Assessment Process	83
Figure 71. Issues Associated with Transitioning to an SBA Approach.....	84
Figure 72. Future Combat System Approach	84
Figure 73. FCS Advanced Collaborative Environment Top-Level Concept.....	85
Figure 74. Boxed Set Concept Creates an M&S Package for a Specific Need	86
Figure 75. System Representation Concepts in the FCS Collaborative Environment.....	88
Figure 76. FCS DPD Logical Model Top-Level Structure.....	89
Figure 77. Corporate telegraph game.....	92
Figure 78. Who do you think will win?	93
Figure 79. Mockup of Teamcenter Requirements Data Navigation & Visualization.....	94
Figure 80. Visualization of Requirements Non-Compliance Superimposed on Design	95
Figure 81. Systems Engineering in Relation to other aspects of Engineering Systems	96
Figure 82. CORE: A Tool to Support Integrated Systems Engineering	97
Figure 83. Maintaining Design Consistency in CORE from the Engineering Repository	98
Figure 84. Mapping C4ISR Architecture Framework Views to CORE	99
Figure 85. Extensions of CORE’s Schema to Accommodate C4ISR Framework Views	99
Figure 86. System Engineering Concept Model (July 2002 Draft)	102
Figure 87. System Assembly of a Freight Locomotive from Lower Level System Assemblies	103
Figure 88. Locomotive Assembly Interconnections	103
Figure 89. SE Concept Model Relations Between System Assemblies and Properties	104
Figure 90. System Properties and Mathematical Model for the Locomotive	104
Figure 91. Example of Data Exchange for Locomotive Across Toolset Using AP233	106
Figure 92. Threat Modeling Architecture	108
Figure 93. N-Tiered Simulation Interface.....	109
Figure 94. Interactions between People, Process and Technology	110
Figure 95. Bateson’s Human Systems Change Model. Size of the arrow depicts the amount of information.....	112

Figure 96. Meta-Systems Engineering Context.....	112
Figure 97. Things vs Devices and their properties (Stong,).	113
Figure 98. ‘Thing-ineering’ involves integration of formal cultural understanding, systems engineering, and social experimentation.....	114

List of Tables

Table 1. Next Generation Systems Engineering Panel Organization	3
Table 2. Trends in Aspects of SE and their Implications	7
Table 3. Examples of Naming Conflicts Between Overlapping Standards	28
Table 4. Example UDEF Mappings.....	31
Table 5. Activities that are Integrating SE and SWE Processes and Methods	33
Table 6. Status of STEP Application Protocols	52
Table 7. Comparison of Current and Envisioned Design Environment Attributes	63
Table 8. Anticipated Benefits of Tomorrow’s SE Capabilities	63
Table 9. AEE Building Blocks.....	65
Table 10. Evolution in Advanced Engineering Environments	66
Table 11. What NASA Sees in STEP	73
Table 12. Partial “Parts Library” of Relevant EFW Standards.....	76
Table 13. Weapon Systems Analysis Framework	87
Table 14. A story of brake pedals.....	90
Table 15. Comparison of Design Representations vice User Expectations.....	98
Table 16. The Future of Engineering Environments	100
Table 17. Definition of Technical Performance Measures (from ANSI/EIA-632)	101

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1 Objectives of the Next Generation of Systems Engineering

Many efforts today are being directed at producing systems that are:

- **Better**, that is, improving:
 - Technical performance (e.g., Technical Performance Measures, Measures Of Effectiveness)
 - Management performance (e.g., Estimate At Complete, profit)
 - Cross-discipline/cross-system/cross-product integration and interoperability
- **Cheaper**, i.e., reduce acquisition, manufacturing, operational, and/or lifecycle costs
- **Faster**, for example by:
 - Reducing acquisition and/or manufacturing schedule
 - Reducing operational response time; and/or
- **Lower Risk**, that is, have a higher probability that delivered systems meet stakeholders' intentions in terms of cost, schedule, and performance.

Figure 1 shows this by using the figure from ANSI/EIA-632, *Processes for Engineering a System*, depicting the relationships between the major processes for engineering a system.

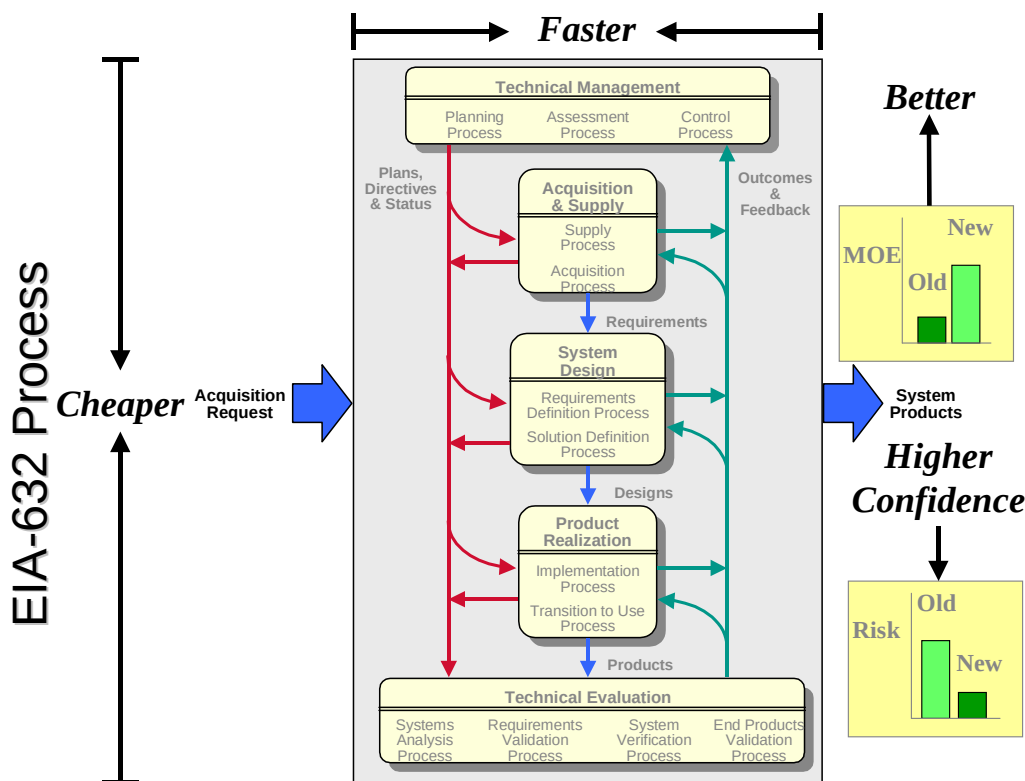


Figure 1. Objectives of the Next Generation of Systems Engineering Capabilities

The approach taken for this panel was to present a set of visions about ***how Systems Engineering will transform the engineering of systems in the next decade*** through development and application of concepts under current Research and Development. A survey was done of the most significant and innovative systems engineering ***Initiatives and Technologies*** covering:

- Processes
- Methods, techniques and standards
- Engineering environments and tools
- Modeling and simulation

Representatives of the most influential Initiatives and Technologies identified were invited to become panelists. Each panelist presented an overview of his/her Initiative or Technology. Panelists engaged in question and answer periods to elicit further understanding. A final capstone session of all panelists assessed the effectiveness of the approaches being taken by academia, government and industry.

The panel was structured along the themes of identifying those Technologies and Initiatives that best demonstrate the potential improvements in Systems Engineering in the following categories, organized for the three-day structure of the panel within the GEIA Conference:

- **Day 1 - Working Together:** Focused on methods to improve Community SE processes and business integration
- **Day 2 – Interoperability:** Focused on methods to improve the exchange of engineering information and to create integrated engineering environments
- **Day 3 – Modeling and Simulation:** Focused on individual tools and aggregate environments for modeling across the life cycle
- **Capstone Session:** This final session enabled the combined panelists to assess the directions being pursued and determine whether the results will transform SE as desired.

Table 1 shows the final panel structure. The following sections summarize the presentations.

Table 1. Next Generation Systems Engineering Panel Organization

Tuesday, 24 September	Wednesday, 25 September	Thursday, 26 September
Working Together: Management and Engineering Practices 1	Interoperability: Standards-based Data Exchange	SE Tools and Model-based SE
1.1 Next Generation SE Panel Introduction / Schier	2.1 Product Life Cycle Support / Smith and Kreiler	3.1 Simulation Based Acquisition / Olson
1.2 NAVAIR SE Improvement / Rafalik	2.2 DoD XML / Hayes	3.2 FCS Distributed Product Development / Eirich
1.3 NRO Agile Design & Development Program / Wall	2.3 DARPA Agent Markup Language / Burke	3.3 Guidelines for SE Tool Development / Sampson
1.4 NASA SE Initiatives / Kapurch	2.4 STEP Overview / Schier	3.4 Vitech CORE Strategy / Skipper
Working Together: Management and Engineering Practices 2	Interoperability: Engineering Environments 1	Model-based SE
1.5 Lockheed Integrated Engineering Process / Robitaille	2.5 Army Integrated Data Environment / French	3.5 ISO AP233 Standard / Schier
1.6 Implications of IT for SE based on Lean Aerospace / Shaw	2.6 Navy Collaborative Engineering Environment / Crisp	3.6 Threat & Vulnerability Modeling / Washburn
1.7 Acquisition improvement – open discussion	2.7 NASA Advanced Engineering Environment / Kapurch	3.7 Deep Culture Social Engineering / Alessi
Working Together: Business Integration and SE Methodology	Interoperability: Engineering Environments 2	Transformation
1.8 AIA e-Business & Metadata Harmonization / Schuldt	2.8 Navy Integrated Shipbuilding Environment / Wood	3.8 Capstone Panel/All Panelists How will these abilities transform the engineering of systems?
1.9 Unification of System and SW Engineering / Skipper	2.9 JPL Product Development Center / Dickerson	
1.10 Product Family Engineering / Jorgensen	2.10 Engineering Frameworks / Peak	

Topic 1.1, the Next Generation SE Panel Introduction, covered the introductory material in this report. The full presentations are available on the Compact Disk (CD) of the 36th Annual GEIA Engineering and Technical Management Conference.

1.1 Opportunities for Improving Systems Engineering, James Schier, Northrop Grumman Information Technology TASC

ANSI/EIA-632 defines the Application Context in which system engineering occurs as shown in Figure 2.

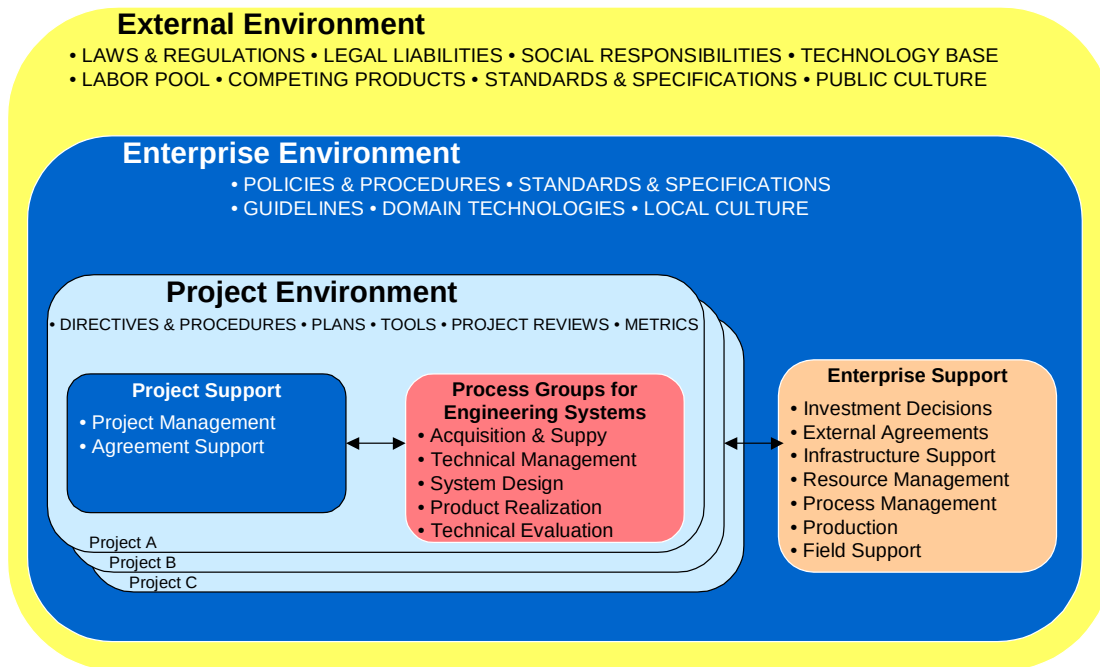


Figure 2. Application Context for Engineering a System (from EIA-632)

This oversimplifies the situation because a typical project is not performed by just one enterprise. The system is designed by a Supplier Enterprise and delivered to an Acquiring Enterprise. Both Supplier and Acquirer have their own respective environments as shown in Figure 3.

Furthermore, the Supplier may have subcontractors or subordinate suppliers, each of whom has his own environment. In the case of each enterprise participating in engineering the system, the external environment, enterprise environment, and project environment may be different.

Managing the efforts across these boundaries between different project environments requires establishing many interfaces, both between the Supplier (or system integrator) and subordinate suppliers as well as between the Acquirer and Supplier. We will refer to this more complex environment as the Extended Application Context.

The number and variety of interfaces encountered in this Extended Application Context suggest that the next round of time and cost reductions and performance increases can occur by applying intra-enterprise improvements, which have been the focus of the past decade, to the extended enterprise. We will call this extended, multi-enterprise effort to create a system Community System Engineering. It can be applied to all aspects of Systems: Acquisition, Engineering and Management Processes, Methods and Techniques, Training, and Tools. The focus of this panel will be on looking for the Technologies that offer opportunities to improve one or more aspects of Community System Engineering.

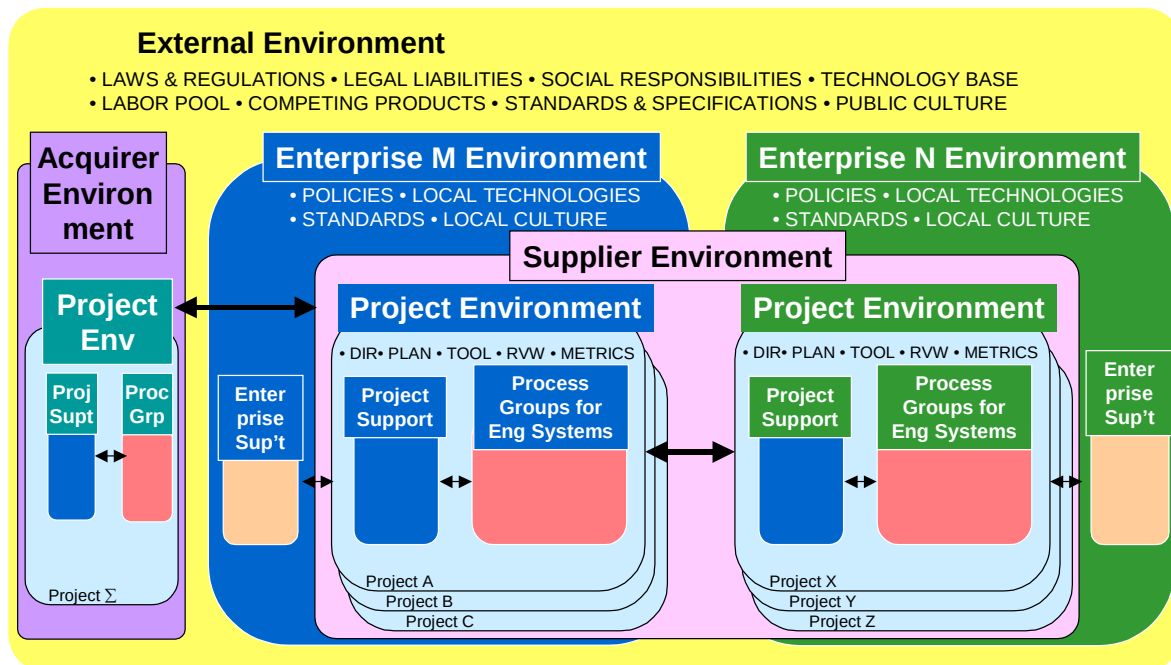


Figure 3. Project with Multiple Environments forms the Extended Application Context

1.1.1 Benefits of Collaboration

Improving these interfaces between enterprises requires collaboration. Previously, this collaboration occurred in a “stovepiped” fashion – either limited to the enterprises participating in development of a single system or limited to the point-to-point relationships between an individual enterprise and its immediate associates. A method with broader benefits and requiring broader participation began to emerge in the 1990’s based on improvements in communications and data exchange including broadband communications, the Internet, object-oriented software, and information modeling. To realize the potential benefits of these technologies, suppliers and acquirers as well as partners and competitors had to form bodies for standardizing the communication and information representations. Organizations such as the Electronics Industries Alliance (EIA), Internet Engineering Task Force (IETF), Object Management Group (OMG), and The Open Group became the places where leading edge technologies were translated into standards, tested and gained broad acceptance. Industry consortia formed to translate the need for common data exchange mechanisms into working protocols with readily available and interoperable software applications such as the International Organization for Standardization (ISO) family of Computer Aided Design and Manufacturing (CAD/CAM) standards known as the STandards for Exchange of Product model data (STEP).

Moving forward requires that we utilize these capabilities as the base for adding higher-level mechanisms for faster and more integrated operations within and between enterprises. Efforts initiated within the last five years in these areas include workflow management, Supply Chain Integration (SCI), and electronic business (e-business). Enterprise Resource Planning (ERP), long focused on the environment within an enterprise, is being revised to integrate with the ERP systems of associates in the Extended Application Context. These new technologies are successors to efforts such as Computer Aided Logistics Support (CALS) and Electronic Data Interchange (EDI). Although the bursting of the “dot com” bubble caused some of these efforts

to fail, the revolution in engineering and management methods enabling Community Systems Engineering is still taking place albeit at a slower pace.

Opportunities for collaboration can be characterized as falling into three types as shown in Figure 4. Customer collaboration occurs between the R&D, acquiring and operating organizations, primarily at the transitions between life cycle phases. Due to the separation between these organizations and the complex changes required in funding mechanisms, handoffs between life cycle phases have a high risk of failure and loss of accumulated information and expertise. Among government systems using the Department of Defense (DoD) as an example, R&D is handled by agencies like Defense Advanced Research Projects Agency (DARPA) and the Service research laboratories. Successful transition of technologies and capabilities requires careful preparation to find acquisition sponsors, adjust the R&D program to meet sponsor requirements, and transfer sufficiently mature capabilities to sponsors who must work to line up requisite funding. A period of 3-10 years is typically required to develop new technologies and reduce risk to a level acceptable for acquisition to begin. Similarly, transitioning from the acquiring enterprise to the operational enterprise requires a years-long joint effort to support operational test and evaluation, prepare sites, and establish training and logistics. These tasks present numerous opportunities for the R&D, acquisition and operational enterprises to work together to improve life cycle management and mission ability in the engineering of systems.

On the Supplier side, a similar set of events occurs to a potentially different set of enterprises. The actual R&D may be performed by academic institutions, outsourced to industrial contractors, or kept in-house at agencies such as DARPA. A complex and lengthy process accompanies the transfer of basic research results to prototype development, some of which occur within industrial contractors while other aspects are transferred from R&D to development enterprises. Other life cycle transitions involving transfer of responsibilities, knowledge and funding occur as the system moves into manufacturing and then into operations. As with the Customer Chain, the Supplier Chain has many opportunities to improve collaboration through improved product data management and improved life cycle infrastructure.

The third type of collaboration occurs within each phase of the life cycle between the appropriate Customer and Supplier enterprises. The nature of this collaboration differs considerably from the first two types by the frequency and volume of transactions and information exchange (day-to-day vice gradual over months) and is designed to control activities proceeding in parallel in enterprises jointly engaged in engineering the system. Opportunities exist here to improve Customer-Supplier Chain Collaboration through improved contracting and improved process and data integration.

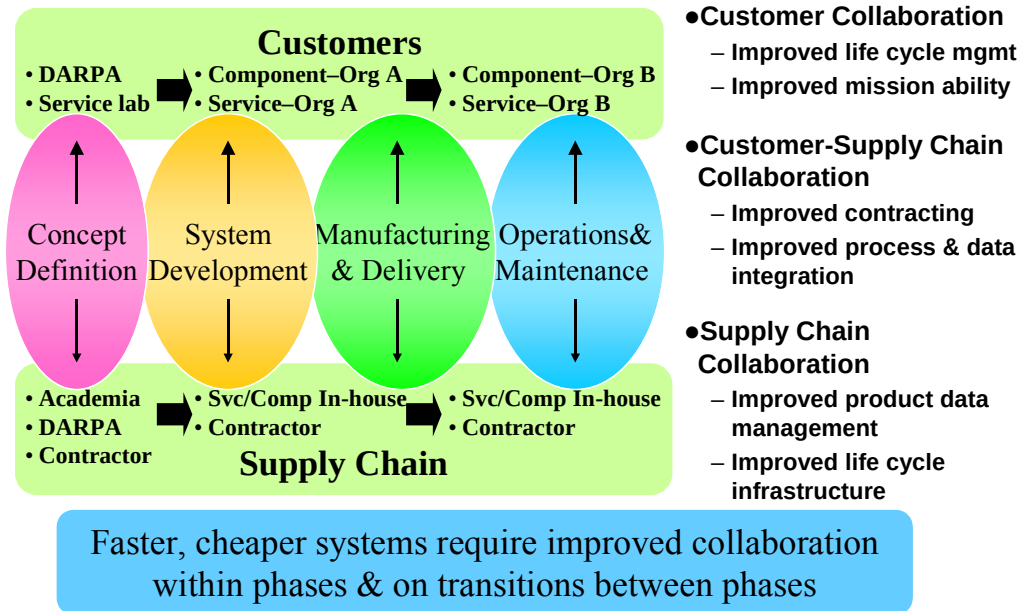


Figure 4. Benefits of Collaboration exist across the System Life Cycle

1.1.2 Trends and Their Implications

The general elements of Systems Engineering were assessed in terms of *processes*, *methods*, *tools* and *technologies* to identify current capabilities, trends in the evolution of SE, and the implications for SE capabilities that should be available to support the engineering of the systems within 3-10 years. In addition, methods of *systems acquisition* were determined to have a major impact on systems architecture as it is driven by the acquisition policies of government agencies. For example, the DoD 5000 series of acquisition policies are currently in the process of being extensively revised. Table 2 shows the characteristics and implications of the elements of SE that were evaluated by the panel.

Table 2. Trends in Aspects of SE and their Implications

Category	Characteristics	Implications
Processes	• Evolving from integrated processes and methods within each individual organization to integrated processes and methods across organizations	• Shifts definition of engineering and management processes from project level to enterprise level to community level • Need to define standardized processes flexible enough to adapt to specific circumstances
Methods	• System engineering, Software (SW) engineering and Hardware (HW) engineering have evolved along different paths • Most major system problems found during integration and verification when HW and SW are finally brought together and inconsistencies exposed	• New methodology needed that unifies System, SW, and HW engineering
Methods	• Modeling and Simulation (M&S) evolving from isolated specialty analyses to multi-dimensional and integrated suites	• M&S can reduce costs across system life cycle • M&S can support continuous evolution of system of systems design allowing full range

Category	Characteristics	Implications
		of life cycle models from earliest parametric/analytical models to detailed simulations to HW-in-the-Loop (HITL) Models evolve through concept evaluation, preliminary and detailed design analysis, verification, operational evaluation and training
Acquisition	Systems evolving from standalone with limited interfaces (ICDs) to system of systems with common communication and service-based information infrastructure	- Shifts infrastructure SE from Program Office to Service/Agency level - Shifts infrastructure SE from contractor to government - Shifts Acquisition from procuring complete systems to procuring subsystems and services
Acquisition	- Systems evolving into systems of systems - Rate of technology change differs between platforms, specialized subsystems and the IT that connects them	- Acquisition and Architecture strategies need to be integrated and shift to multi-tier "50 yr" Platforms can afford "15 yr" R&D "10 yr" Major subsystems can afford "3 yr" R&D "3 yr" Communications and Information Infrastructure requires continuous R&D and incremental fielding - Application of M&S technologies holds potential for transforming Acquisition process
Tools	- Tools evolving from project-level to enterprise-level - Add enterprise functions supporting <i>product lines</i> and <i>quantitative improvement</i> - Supply Chain Integration and e-Business markets emerging to provide infrastructure enabling Community System Engineering	- Integration of enterprise tools and e-Business exchange enables implementation of Community SE processes - Standards needed to define and transport engineering semantics - Tools/mechanisms needed to support use, reuse, and configuration control of engineering data within communities
Technologies	- Info systems evolving from exchange of raw/ low-level data to high-level information that preserves semantic content - ASCII $\Rightarrow$ TeX $\Rightarrow$ HTML $\Rightarrow$ XML - Faxed drawing $\Rightarrow$ CAD file $\Rightarrow$ Intelligent schematic	- Open standards needed to define semantics for accurate, unambiguous engineering data exchange - Design and analysis tools and product data repositories needed that support intelligent data exchange within communities
Technologies	- Technologies used in government systems evolving from domination by government-funded R&D to commercial R&D - Technology shift follows market shift from government to commercial domination - Rate of technology change causes tension between modernization and readiness - If government takes 3 yrs to modernize, then government's system is ready to operate at the same time that industry has depreciated investment and is ready to upgrade	- Design systems to accept upgrades gracefully during O&M - Design and cost systems to future standards vice current

1.2 Naval Air Systems Command Systems Engineering Organizational and Process Initiatives, Zig Rafalik, Naval Air Systems Command

The Naval Air Systems Command (NAVAIR) Systems Engineering Department provides the people, processes, tools, and facilities that convert operational mission needs into innovative, integrated, interoperable, effective, and sustainable naval air warfare systems. They define and lead engineering and scientific efforts across a broad spectrum of disciplines in the context of Naval Aviation's unique operating environment. They assess and quantify risk, interoperability, and technical performance, beginning at conception and continuing throughout the life cycle, thus enabling stakeholders and customers to deliver and maintain superior and affordable products to the warfighter.

In spite of this mission statement, NAVAIR was motivated to initiate a process improvement program when they uncovered a number of issues with performance including:

- Lack of clear, common definition of Systems Engineering
- Dynamic and rapidly changing discipline today
- Incompatibilities between customer and provider SE
- Poorly defined relationship between SE and Systems Architecture
- Disconnects between SE education and practice
- Poor initial program formulation
- Accountability & empowerment lacking.
- Lacking consistent and comprehensive SE assets (tools, guidance, training, etc.)
- Must consider systems of systems impacts

To address these issues, the department has implemented a parallel organizational construct to guide the new national organization well into the future. The parallel organizational construct is one that recognizes the value of, and promotes, a participative leadership and management approach that draws on all levels of the organization to participate in the process to define, plan and implement strategies that continually move the organization to a higher performance level. To implement this construct, the System Engineering Department has established Leadership/Management Teams that enable a diverse cross-section of the population, at all levels, to actively participate in the leadership and management of the organization. These teams are the: Strategic Alignment Team (SAT), Strategy Implementation Team (SIT), and Management Implementation Team (MIT).

As shown in Figure 5, these teams work to define strategic focus areas, develop actionable strategies, and provide measurable results using a balanced scorecard approach by coordinating systems engineering with parallel organizations across NAVAIR.

In addition, NAVAIR has implemented a series of related SE Initiatives including:

- Aviation/Ship/Warfare System Integration Process
- Common Configuration Control Board (CCB) Process
- Green Teams (SE Expert Teams)
- Risk Management Instruction

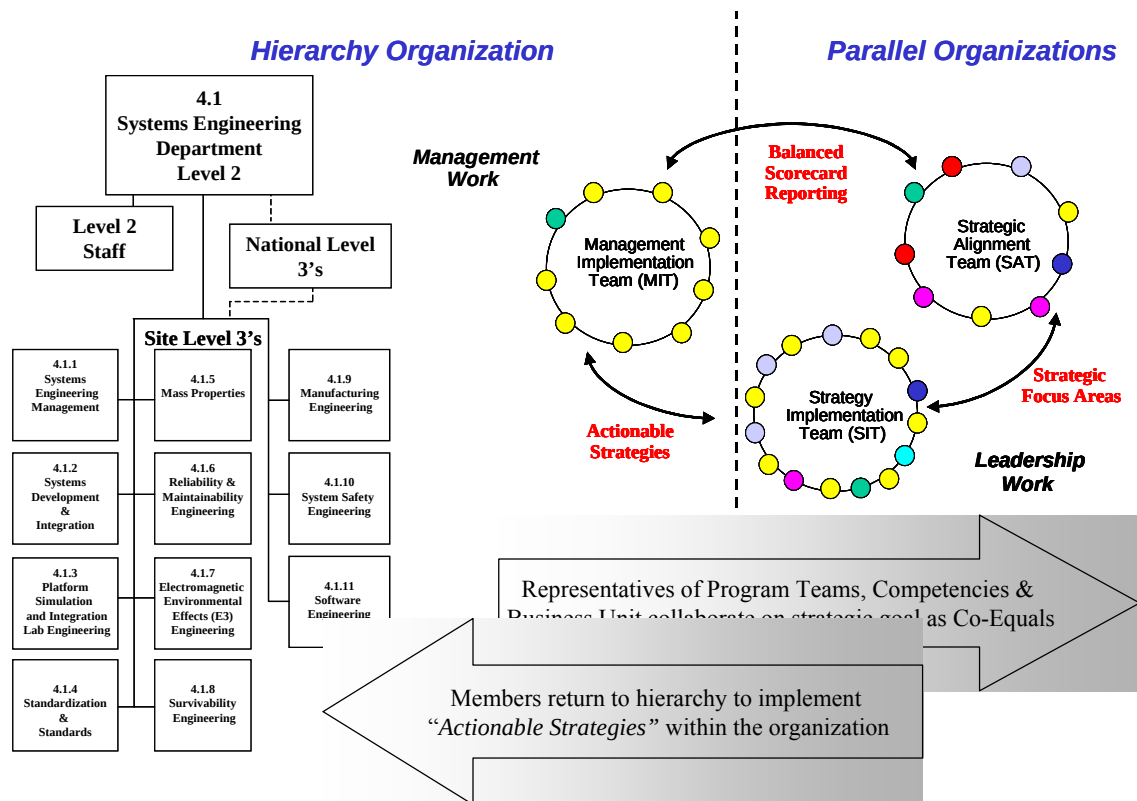


Figure 5. NAVAIR Parallel Leadership Organization

- **SE Technical Review Process:** The SETR is an incremental process that baselines technical risk and assesses design maturity throughout the acquisition process. All ACAT programs participate in the Systems Engineering Technical Review process that requires a risk assessment at each review and makes a readiness-to-proceed judgment based on expected design maturity for that phase in the program.
- **SE Community of Practice (CoP):** The objective of the SE CoP is to provide the Systems Engineering Community with a state of the art, integrated, interactive, online environment of tools, libraries, virtual team workspaces, information exchange facilities and web resource links that capture the current state of collective systems engineering expertise to ensure program success.
- **Common Systems Engineering Process for NAVAIR/NAVSEA/SPAWAR:** The Systems Engineering Process Working Group (SEPWG) was formed in Fiscal Year (FY) 2000 with the goals of documenting the overall NAVAIR TEAM systems engineering practices and processes, replacing existing processes (e.g., Mil-Std 499A/B), adopting industry best practices and tenets, and complying with DOD Instruction (DODI) 5000 requirements. An SE Guide was developed by SEPWG stakeholders that extends the ANSI/EIA-632 standard by incorporating NAVAIR policy, procedures, methods, and tools to define “How to Do It”. The SE Guide gives direction and guidance and provides a consistent structure for the development of programs. A sample (Figure 6) shows the original EIA-632 text in black and the added information about entry /exit criteria, inputs and outputs, interfacing processes, metrics and tools in the NAVAIR SE Process in blue.

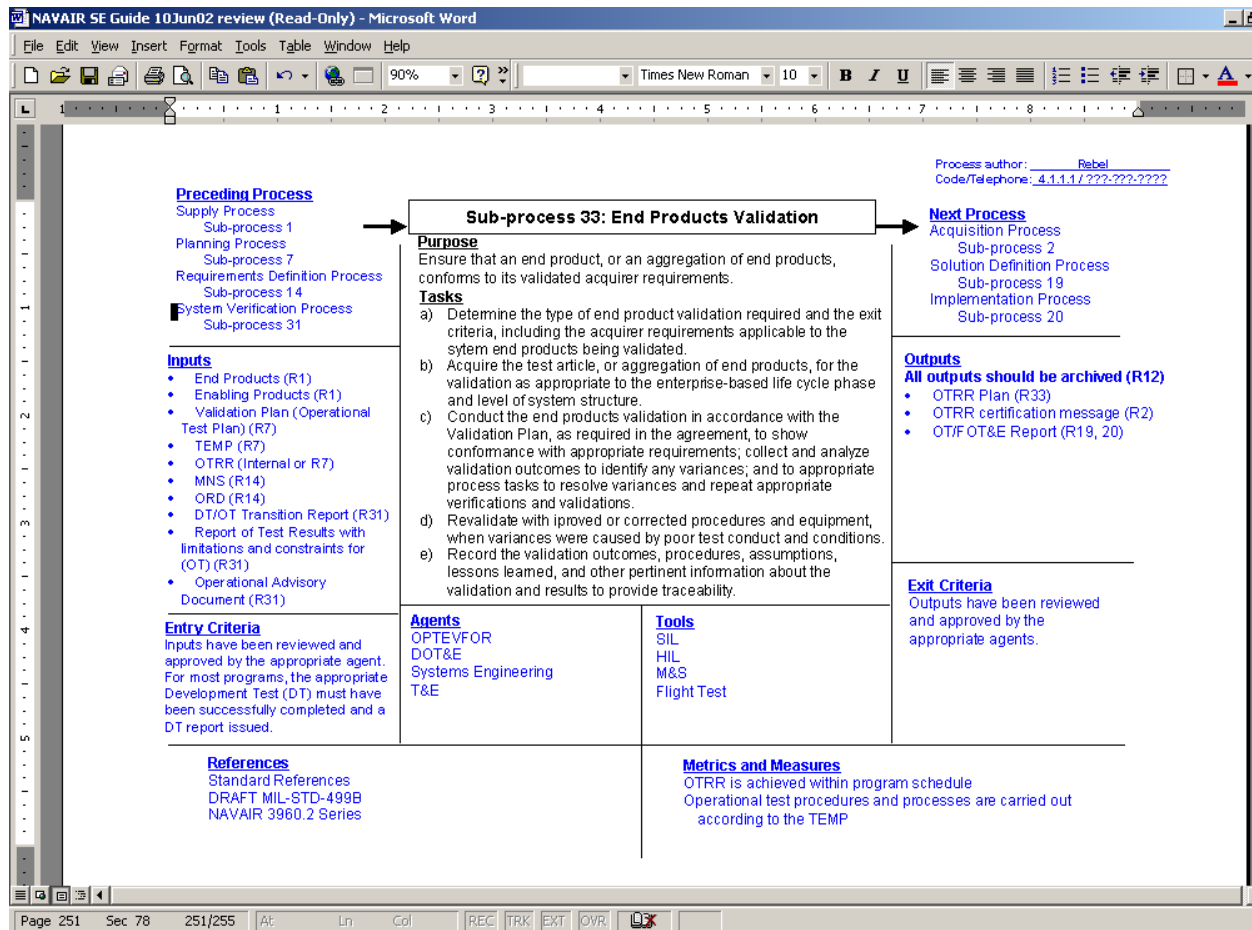


Figure 6. Sample Process from NAVAIR SE Guide

Status: The draft NAVAIR Systems Engineering Guide has been completed and review of the document is in progress. NAVAIR has invited limited external review by INCOSE, GEIA, and industry partners. NAVAIR received permission from GEIA to use EIA-632 copy righted material. A second review is scheduled for October 2002 with the first release scheduled for Winter 2002. In parallel, training will be developed with the Defense Acquisition University (DAU) in the Spring of 2003. The Air Force, NASA, NIMA, and NRO have expressed interest in NAVAIR's SE Guide.

1.3 Agile Design and Development for Space Systems, Steve Wall, National Reconnaissance Office

The NRO's Agile Design and Development program has a vision of What Could Be: *We could...design and build spacecraft in 12 months...fully explore design tradespaces...model our designs early and test them together.* Infusing new design methodology is a politico-technical-cultural-business process. Therefore, the Agile Program's approach encompasses a broad spectrum of elements including developing an overall system-level concept, establishing a steering group and multi-agency working group, using broad outreach to identify new and emerging ideas, creating university programs, providing research opportunities via broad agency announcements, keeping close contact with COTS tool vendors, doing rapid prototyping of

needed software/hardware, using prime contractors as partners, sponsoring demonstrations, and feeding lessons learned forward to the next iteration.

As Figure 7 shows, the Agile program focus is on conceptual design using a Conceptual Design Team such as the ones implemented at the Aerospace Concept Development Center, JPL Team X, and several others. The program is also focused on keeping a tight connection with rapid analysis capability, investigating innovative contracting methods, researching emerging manufacturing methods such as Touchless Manufacturing, and testing concurrent engineering, design visualization and teaming approaches.

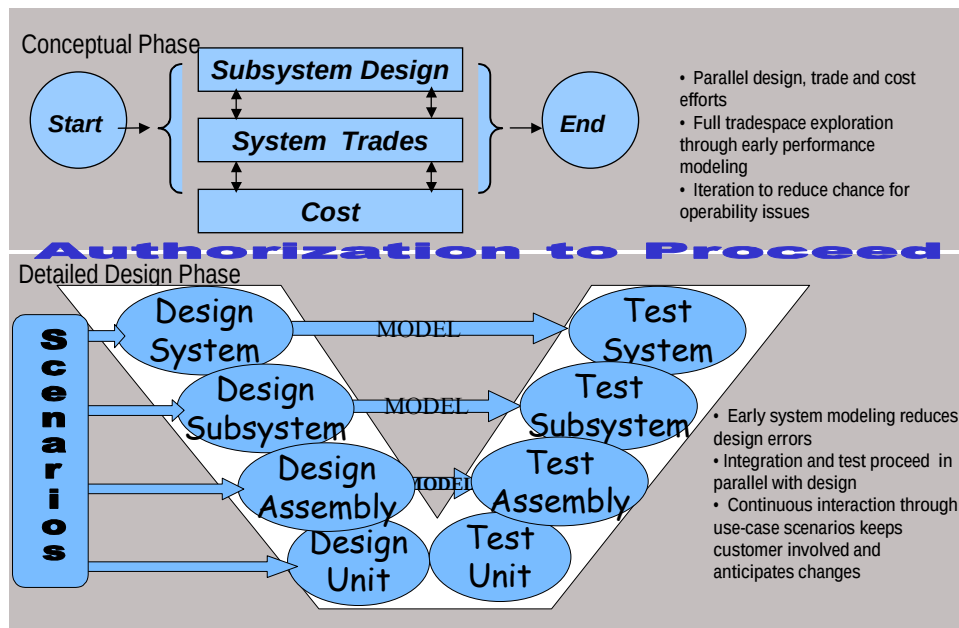


Figure 7. A 20000 m View of how Spacecraft could be Designed

Some of the results of applying this Conceptual Design Team approach with the integrated tool environment designed to support rapid analysis cycles in designing spacecraft mission concepts and vehicle configurations have been quantified. These are shown in Figure 8. Concept Design Centers focus on three aspects of system engineering to produce these spectacular results:

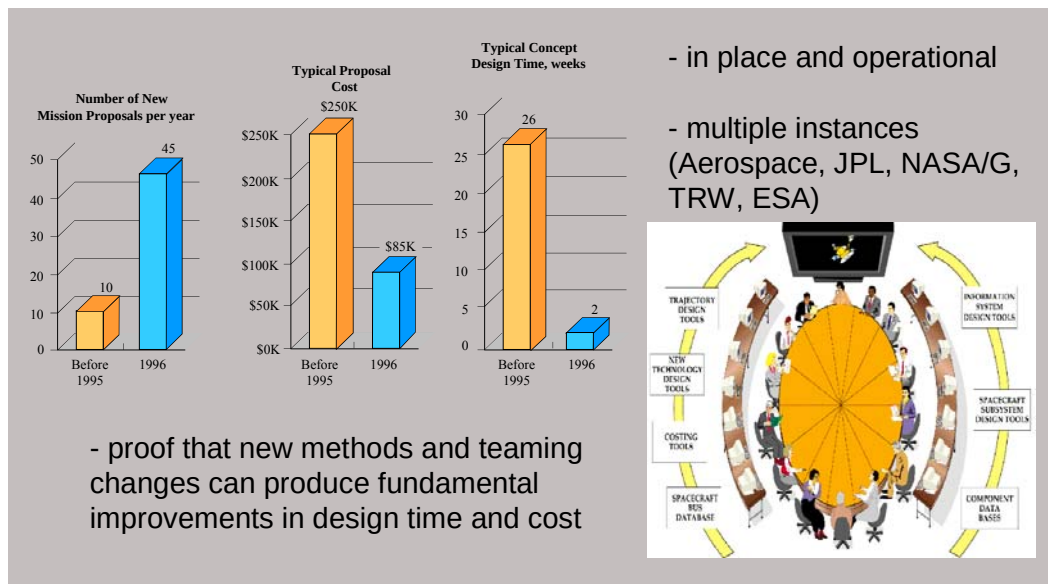


Figure 8. Conceptual Phase: Demonstrated Results

- Team:** Teams are either dedicated or on-call but execute analysis cycles frequently enough that they work together as a cohesive unit. They use well-defined Team “scripts” following a repeatable process. They perform an after-action assessment to identify potential improvements for subsequent cycles. This results in mission analysis turnaround in weeks vice the previous months long exercises. The design space exploration capability varies depending on how well defined the mission parameters are, allowing anywhere from dozens to hundreds of cycles of varying fidelity to enable the Team to converge on acceptable, then optimal solutions rapidly.
- Facility:** The Concept Design Center facility provides a situation room or operations center feel with surrounding screens depicting all facets of mission and configuration parameters and performance to be displayed simultaneously. This high level of visualization enables the Team to assimilate a gestalt impression of overall performance allowing people to use their human powers of intuition. Multiple displays also allow visiting customers to orient themselves rapidly to the situation helping them to focus on simultaneous design and team interaction.
- Tools:** Typically the tools provide level of data exchange equivalent to Excel or Access by using a linked set of spreadsheets or databases partitioned functionally to match the roles played by the Team members. The level of design tool fidelity varies considerably but is generally low-end for first order analysis. Online parametric cost models enable the Team to assess mission cost at the same time as the other performance factors allowing cost thresholds to be used to discard unacceptably expensive solutions.

The current work in improving Team X Design Space Exploration is following the process in Figure 9. This phase will provide the ability for the Team to rapidly enter or define mission and vehicle parameters, set up the mission outline as a scenario, drive through the mission scenario (which may cover years of simulated time for an interplanetary mission), and immediately analyze the results. Benefits of this approach include providing a full capability review with the customer, enabling the Team leader to quickly define and explore options including cost control

and bid point, and generate a final report and other products automatically. Experiments using this approach are underway and will be completed in 2002.

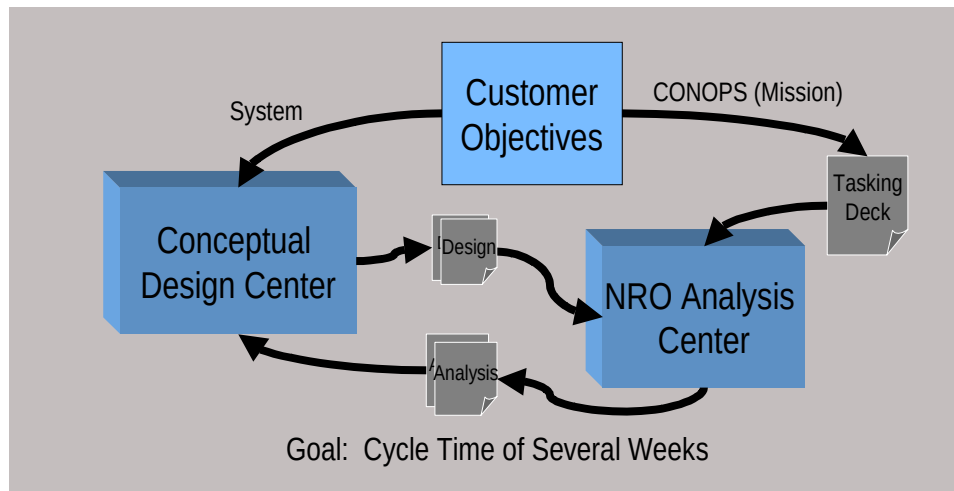


Figure 9. Next Step: Rapid Synthesis-Analysis (Scenario Driving)

Model-Based Contracting is the next step. In 2003, the Agile program will:

- Develop a major system specification in a set of requirements models;
- Submit these models as a mock Request For Proposals (RFP);
- Respond to the mock RFP with state-based models simulating contractor input; and
- Participate in a Government/Contractor Lessons Learned activity.

On another front, recent research shows that “touchless manufacturing”, wherein functional hardware may be deposited using laser and e-beam technologies, is within the 5-year horizon. The Agile program is sponsoring application of this research. The Agile program is funding research on engineering design tools that have impact on design methods similar in scope to the arrival of Computer Aided Design (CAD) tools. These will short-cut detailed design and go immediately from early models to manufactured item. Figure 10 shows the concept for Shape Deposition Manufacturing (SDM) and some of the results achieved using laser deposition of various materials. This technique can create components of any possible 3D shape with included void spaces. Materials can be changed at discrete points or varied continuously throughout the deposition process enabling a degree of control over materials properties previously unobtainable.

Applying SDM is another next step being taken through development of CUBESat. This small (12 cm) spacecraft is being built by students at Stanford University and will be launched via the Shuttle and Expendable Launch Vehicles through the Space Test Program. Lockheed Martin will build system models of the student-designed CUBESat. Stanford will build CAD models of the CUBESat bus with embedded power, data and thermal channels. The CAD models will be shape-deposited by Lockheed Martin. Stanford will build a unique, shape-deposited solar array mount and integrate the CUBESat with Lockheed Martin’s assistance. The first Agile spacecraft is planned for launch in 2003.

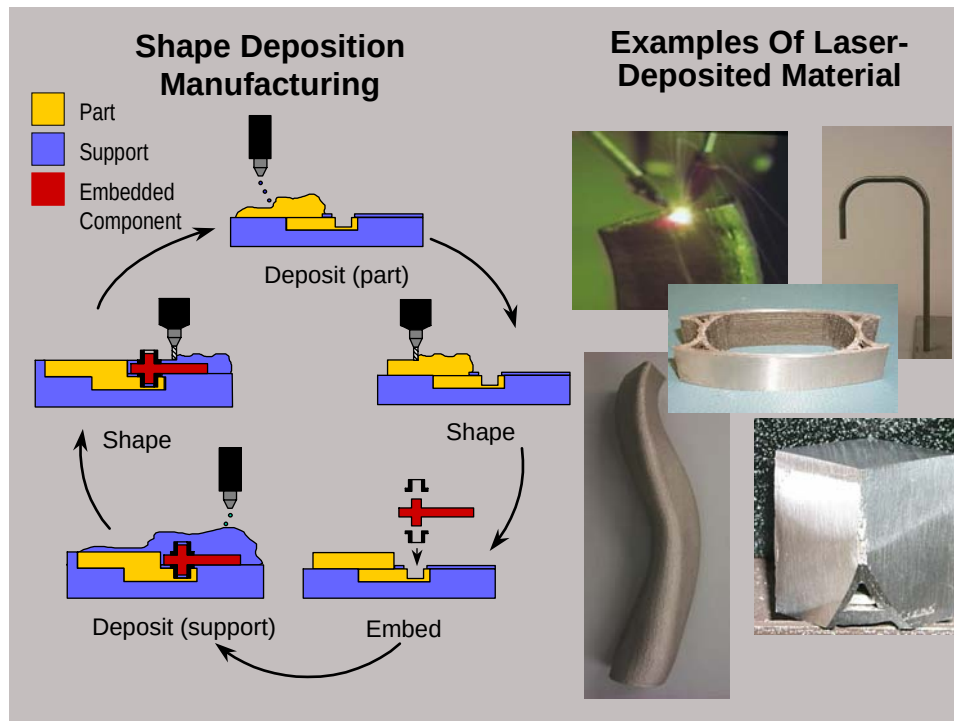


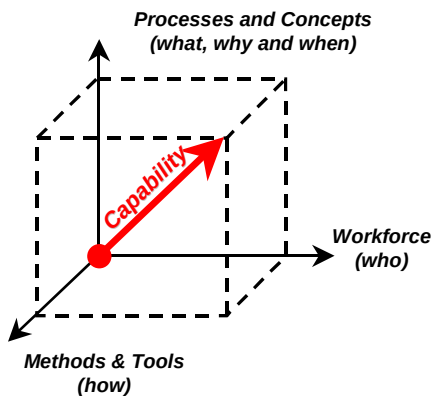
Figure 10. Shape Deposition Manufacturing and Sample Results

1.4 NASA Systems Engineering Initiatives, Steve Kapurch, NASA Office of the Chief Engineer

NASA expects the exponential growth in technical complexity and resulting potential program risk to continue, challenging our ability to engineer systems effectively. Systems engineering issues in programs have contributed to failures, schedule delays, and cost overruns. Systems issues have resulted in findings in several reports.

NASA's response is to develop an Agency-wide framework to guide production and oversight of aerospace products and capabilities from a technical/systems engineering perspective, provide continuous measurable improvement, and foster professional development of the engineering staff. NASA's goals are to:

- Ensure continuous improvement of the NASA engineering workforce through relevant education, training and work experiences;
- Ensure sound and effective systems engineering Agency-wide;
- Develop and implement an Advanced Engineering Infrastructure;
- Provide value-added cross-enterprise products and services that enable the infusion of technology, knowledge, and capabilities to support innovation in engineering and push the state of the art;
- Increase participation, membership, and leadership in recognized national and international engineering organizations; and
- Ensure effective integration of software into systems.



To accomplish this, NASA is instituting a Systems Engineering Framework aimed at achieving:

- Consistency in systems engineering approach at all levels;
- Culture based on rapid prototyping, modeling and simulation capability for development of multiple and diverse designs;
- Experienced, well trained engineers in application of process, methods, tools, and customer relationships/interactions; and
- Continuous improvement through self-assessment at the personal and organizational level.

The NASA Policy and Guidance (NPG) is a high level document to support Program and Project Management. It is process-oriented describing “What to do” vice “how to do it”. The enterprise policy is being updated to flow down to NASA Center directives while the Centers implement the policies consistently through coordinated products reviewed by the NASA System Engineering Working Group. The existing NASA System Engineering Handbook is being updated and expanded as part of this effort.

Another team is working to evaluate, document and recommend a suite of systems engineering tools to meet the NASA systems requirements for enabling and enhancing inter- and intra-NASA systems engineering excellence within the common framework. The lead activity here is focused on development of the Advanced Engineering Environment (AEE) (see presentation 2.4). The AEE is expected to utilize the AP233 Systems Engineering Data Exchange standard and other STEP and industry standards in an open architecture to enable maximum use of COTS tools combined with easy insertion of unique NASA capabilities.

NASA Engineering Training (NET) is being developed to educate the workforce on the Framework, policies, processes, and tools available. The training program is based on three legs: System Life Cycle, Center-level, and Enterprise-level views. The integration approach stresses the overarching Systems Engineering principles.

Assessments will be required to establish a systems engineering capability maturity methodology that enables continuous process improvements in the engineering of systems agency wide. This effort will establish the NASA maturity model, perform pilot assessments, monitor ongoing programs, feedback results, and provide updates as required.

The Way Ahead for NASA has short, medium and long-range objectives. In the short term, the NPG will be refined, and subgroup efforts for each element of the strategy will be defined and initiated. These efforts are being integrated with those of NASA’s Software Working Group. In the mid term, NASA will rollout the NPG and publish the updated Handbook. In the long term, the SE teams will fill in the SE framework, conduct pilots of the AEE, and conduct assessments establishing a baseline for SE performance.

1.5 Lockheed Martin’s Integrated Engineering Process Overview, Paul Robitaille, Lockheed Martin Corporation

The Lockheed Martin Integrated Engineering Process (LM-IEP) originated from work by the Joint Systems and Software Working Group to develop an integrated system and software

process, sponsored by the Lockheed Martin Corporate Vice President of Engineering & Technology. Initial architecture definition was completed in December 1999. In January 2000, Integrated Product and Process Definition (IPPD), Mechanical, and Electrical were included and the name was changed to LM-Integrated Engineering Process.

In parallel, government, industry and the Software Engineering Institute (SEI) were collaborating to develop the Capability Maturity Model Integrated (CMMI), an integrated framework for maturity models. The government has indicated that it plans to migrate to CMMI and may use CMMI ratings in future acquisition decisions. As the CMMI matured, it became obvious that the integration of all engineering disciplines should be a strategic focus for Lockheed Martin because it improves the ability to do the right job the first time. LM-IEP is Lockheed Martin's corporate response to CMMI and other emerging industry standards. The purpose of LM-IEP is to establish an integrated engineering process standard that applies systems engineering principles, a support infrastructure, and a measurement framework that enables collaborative, integrated engineering and enterprise environments. LM-IEP offers Lockheed an excellent opportunity to drive Lean Aerospace and Design For Six Sigma (DFSS) principles into engineering processes and supporting methods.

As shown in Figure 11, the LM-IEP is compliant with CMMI, ANSI/EIA-632, IEEE 1220, ISO 9001-2000, ISO 12207, and ISO 15288. The LM-IEP Product Suite, illustrated in Figure 12, includes integrated methods, work products, measurement and training in an advanced capability Process Asset Library (PAL).

The LM-IEP enables Lockheed, for the first time as a corporation, to establish a clear set of requirements for a Collaborative, Integrated Toolset. This toolset will take time to develop due to the wide range of computer-aided tools in use today across the corporation. An integrated environment is being developed as a separate activity (not part of the IEP project); so diverse tools can be accommodated. Over time, Lockheed Martin Corporation (LMC) will drive towards a more common tool set across the corporation, and in so doing, achieve further efficiencies.

Application of the LM-IEP will help raise the process maturity and performance of the entire engineering workforce (Figure 13). Additionally, LM-IEP establishes the common reference framework that is needed to enable our ability to achieve our goal of a Virtual Company that can move work and not people.

Some of the more common challenges that any project's process integration team must overcome to be successful include:

- Lack of shared vision for an integrated process across the corporation;
- Finding the right level of process description (breadth and depth);
- Ability to apply a common process standard to the broad range of heritage cultures, maturity levels, programs, product lines, and technologies;
- Ability to change stovepipe engineering processes and environments, which have been developed independently;

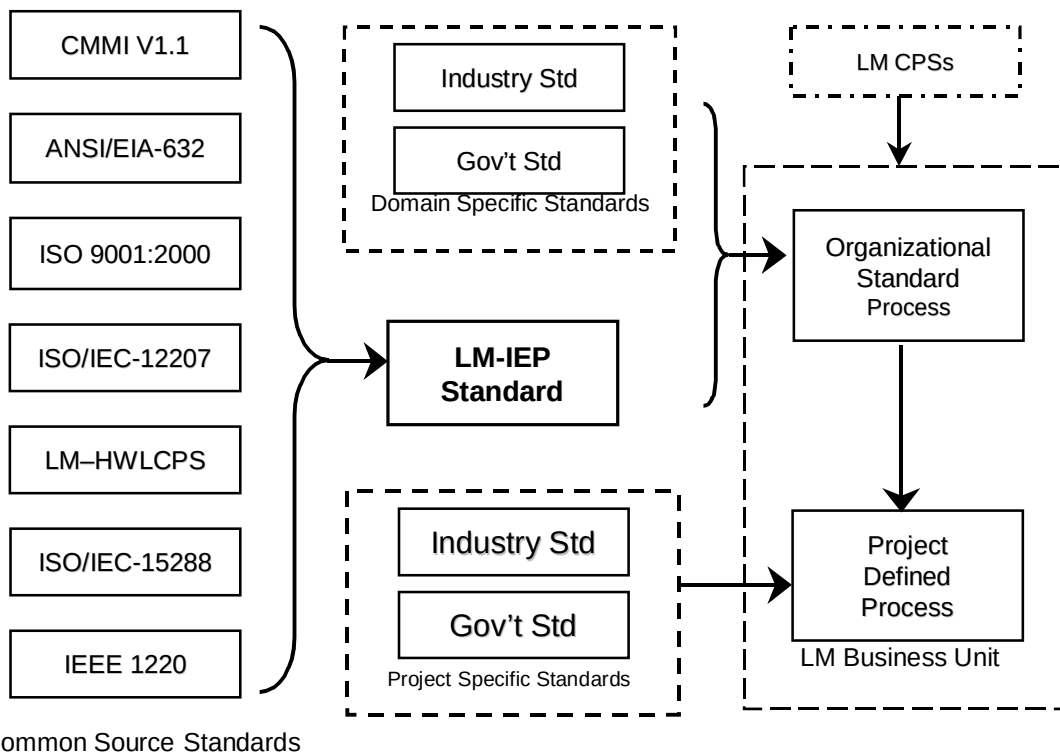


Figure 11. Lockheed Martin Integrated Engineering Process Context Diagram

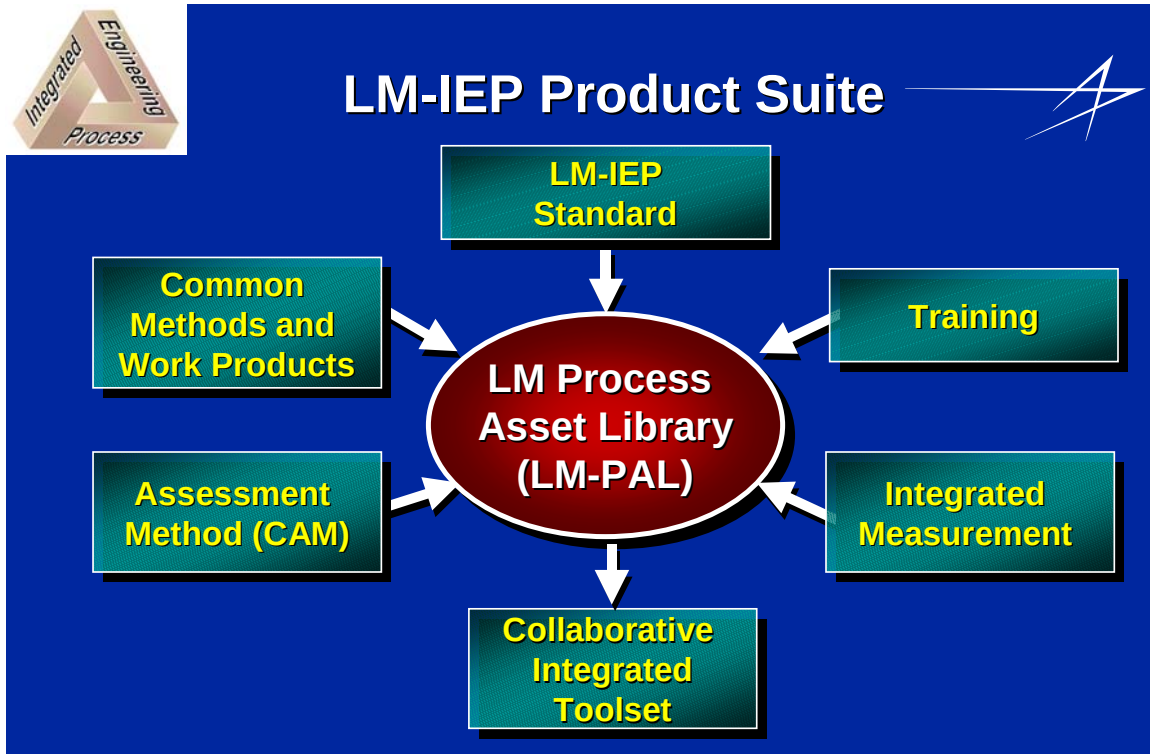


Figure 12. LM-IEP Product Suite

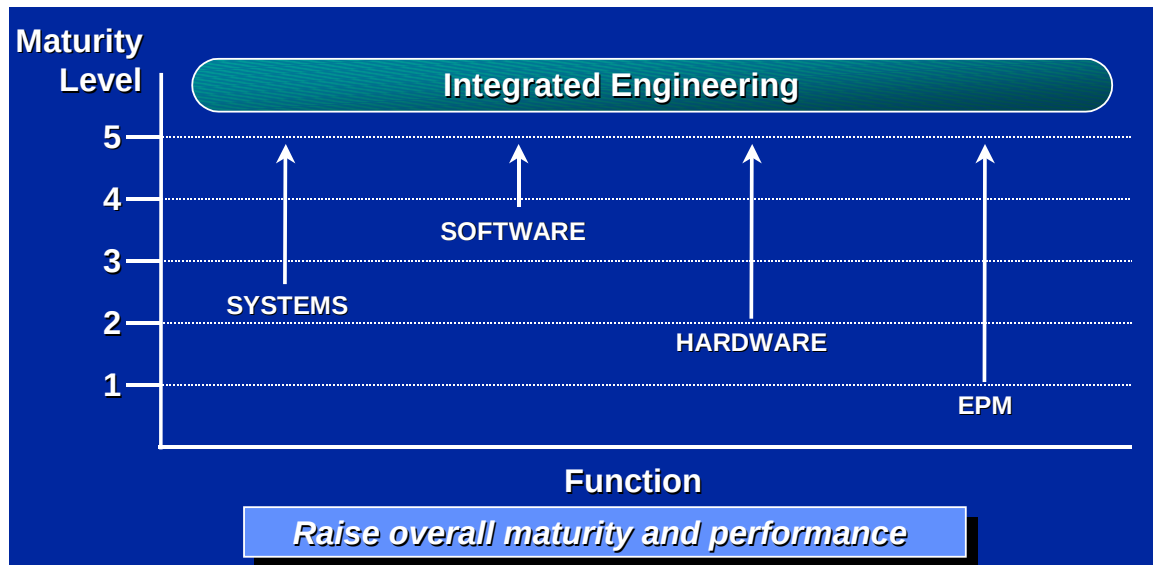


Figure 13. The Focus of Lockheed Martin's Efforts

- Ability to integrate engineering with the rest of the enterprise: Program Management, Business Development, Manufacturing, etc.;
- Establishing shared terminology and process representations; and
- Resource commitments to get the job done.

The LM-IEP has normative and informative aspects. Organizations are required to implement the normative requirements of the LM-IEP unless the requirement does not apply to that business. In these instances, requirements may be considered for exclusion providing that their exclusion does not compromise regulatory requirements of product quality AND the designated quality manager for that business approves these exclusions. Projects are required to generate a Project Plan which articulates customer and project needs and clearly states which aspects of the IEP compliant Organizational Standard Process (OSP) if any, have been tailored to meet the business needs of the project.

Figure 14 depicts the LM-IEP Process Architecture. It consists of *Enabling*, *Project Life Cycle*, *Management* and *Common Process* Architectural blocks. *Enabling Processes* are considered the essential enterprise functions required to allow projects to do work. For example, each project needs to have processes, a work environment (facilities, tools, etc.), technology, staffing, and training. In many sites these are considered the functional organizations. *Project Life Cycle* processes reflect the various life cycle phases normally associated with executing a project. These are applied to internal as well as externally contracted activities. *Management Processes* are cross-referenced (invoked) under the Enabling and Project Life Cycle Processes. *Common Processes* are the steps that apply to every other process block in the LM-IEP Process Architecture. They are separated only to help keep the LM-IEP standard compact.

The hierarchy of the LM-IEP is described in Figure 15. At the "A" level is the LM-IEP Standard, which is common across the corporation. The requirements of the integrated process standard are normative so they are color-coded green. At the "C" level of the chart are the Organizational Standard Processes (OSP) or "command media" for the companies/operating units within the corporation. The OSP contains Policies, Procedures, and Practices. OSP's are normative. The normative requirements of LM-IEP drive changes into the OSP's to ensure compliance.

The LM-PAL is an important part of the LM-IEP Product Suite. LM-PAL, illustrated in Figure 16, is a web-based process asset library that will enable sharing of processes, methods, work product templates, general information and more across the corporation. The LM-IEP Project Team is loading the LM-PAL with an initial set of process assets that will facilitate the implementation of LM-IEP at Lockheed Martin business units. This initial set of assets will be augmented, over time, as integrated processes, methods, work products and training are updated or developed on projects across the corporation. The LM-PAL will be accessible from every business unit and will have the ability to query and download to local PALs across Lockheed Martin.

Planned future enhancement of the LM-IEP Product Suite include developing a set of temporal process flows, expanding the scope to address the rest of the business enterprise, extending measurement beyond engineering to include program management and updating the training.

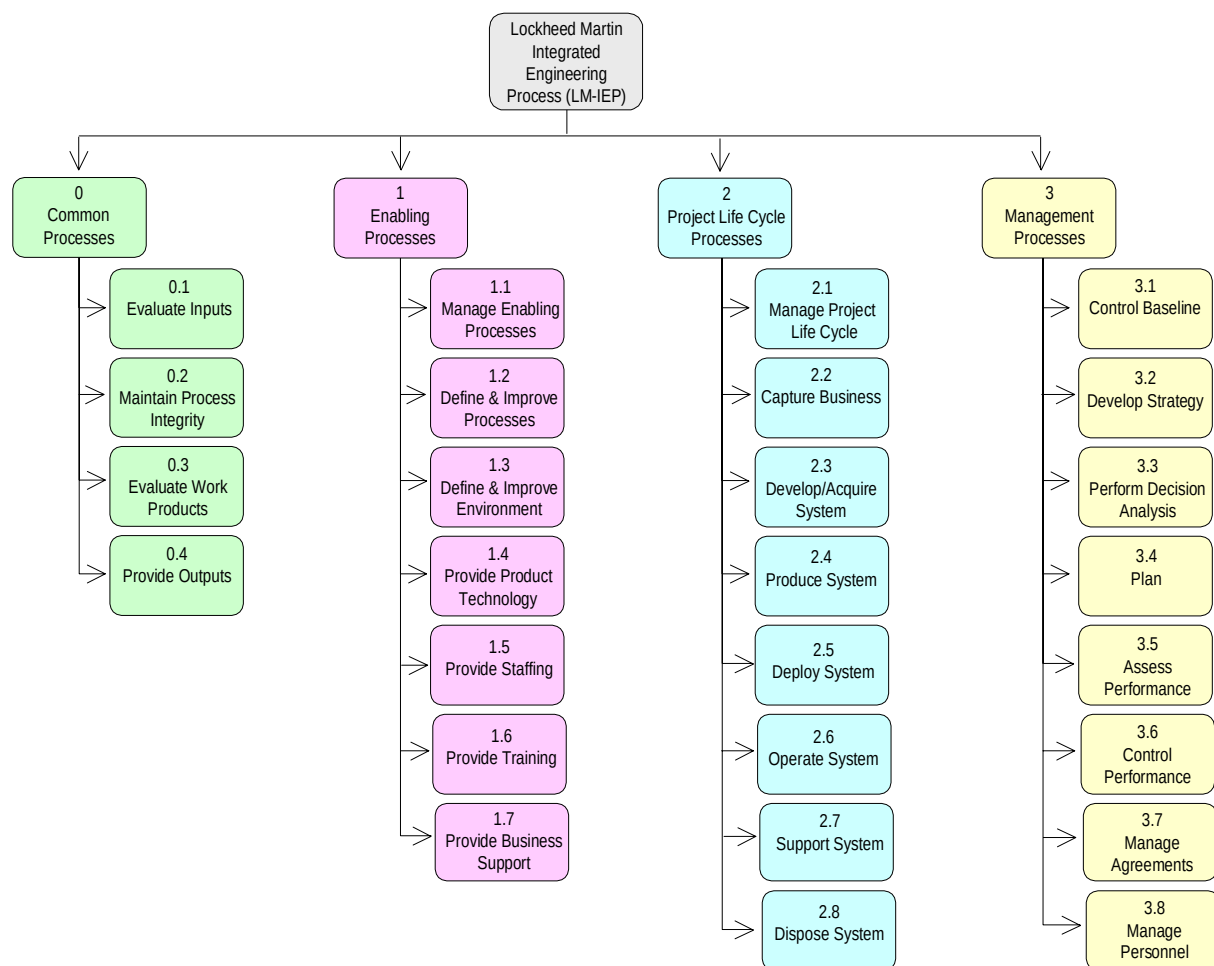


Figure 14. LM-IEP Reference Architecture

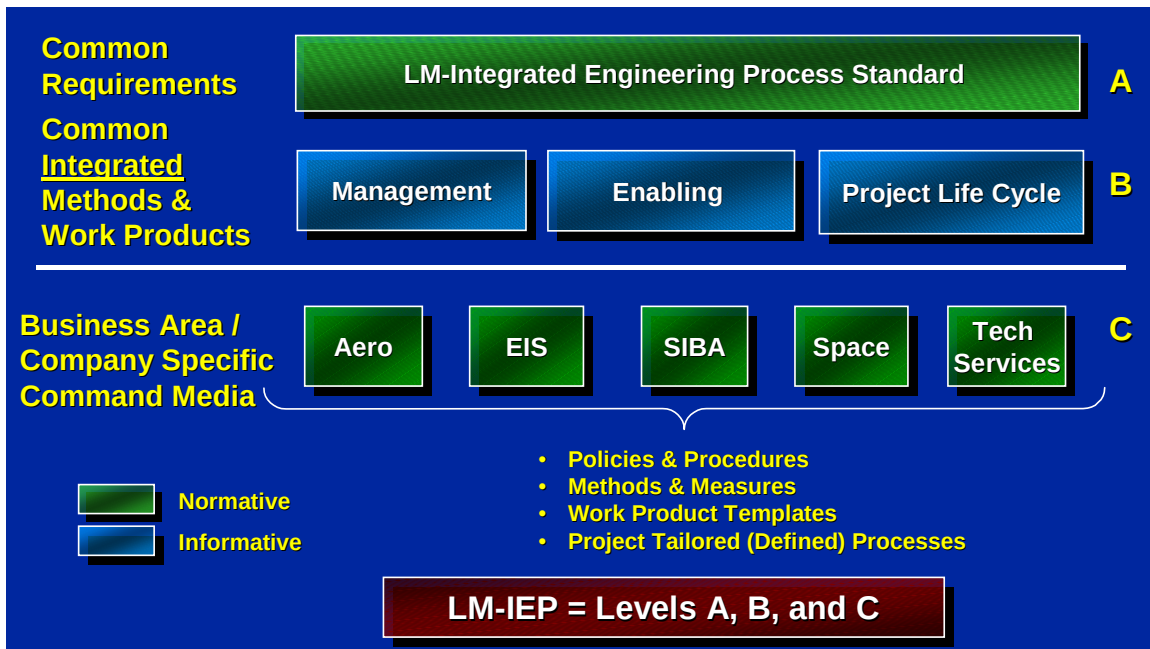


Figure 15. Relationship to Command Media

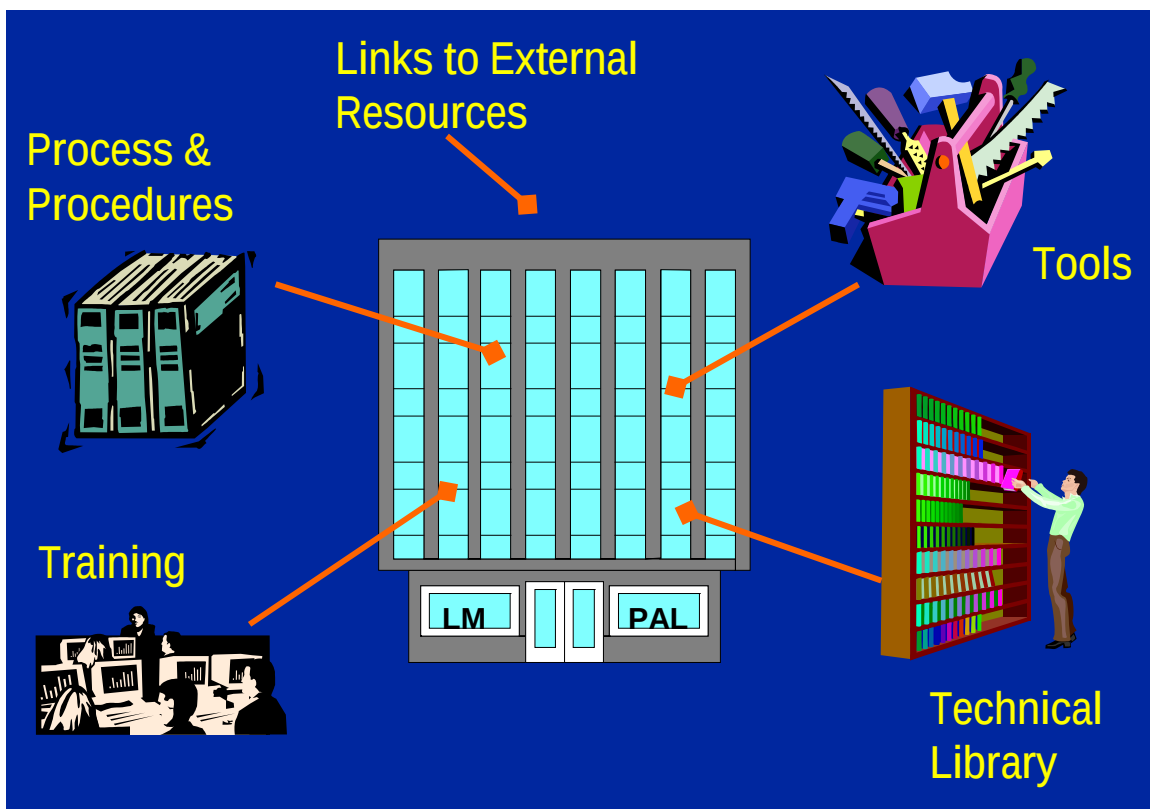


Figure 16. LM-PAL is the IEP Delivery Vehicle

1.6 Impact of Information Technology Products on the Practice of Systems Engineering (Lean Infrastructure), Tom Shaw, Accenture

Enterprise Resources Planning (ERP) is defined as a method for the effective planning and controlling of all sources needed to take, make, ship and account for customer orders in a manufacturing, distribution or service company including: typical Manufacturing Resource Project (MRP) II functions (defined in Figure 17), sales force automation, engineering functions/Product Data Management (PDM), advanced manufacturing function, distribution/logistics functions, quality functions, field service functions, complete financial functions, human resources functions, and management reporting.¹ The union of ERP and PDM systems produces an integrated capability unified by the set of interoperable, shared resources (Figure 18). However, PDM is typically file-based while ERP is data-based, so interoperability between the two types of systems is an issue. Types of ERP systems include: a) modular (pick best of breed tools); b) integrated (e.g., SAP). Integrated systems may only have 80% of the functionality of modular systems but are better integrated.

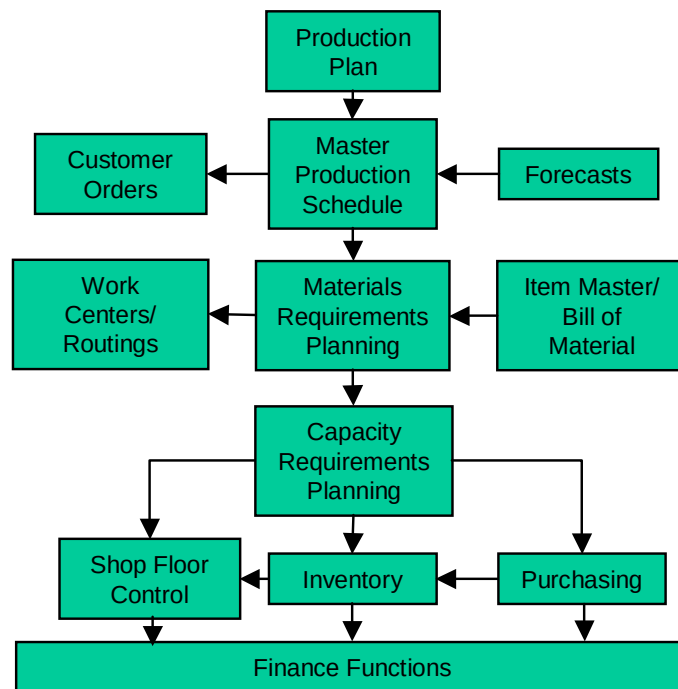


Figure 17. Functions involved in Manufacturing Resource Project (MRP) II report

The vision of Collaborative Business is that *Everyone Shares Information* – customers, employees, suppliers and business partners working together as one successful entity. Personal, collaborative solutions should be available on demand with the following characteristics:

- Marketplaces would be linked by collaboration hubs;
- Workplaces would be linked for personalized, universal, role-based access;

¹ Source: APICS Complex Industries Special Interest Group

- e-Business Applications would exist providing e-Commerce, Customer Relationship Management (CRM), Supply Chain Management (SCM), Business Intelligence, Logistics, Financials, Human Resources and other collaborative capabilities; and
- Application hosting would enable retention and access to information throughout the solution life cycle.

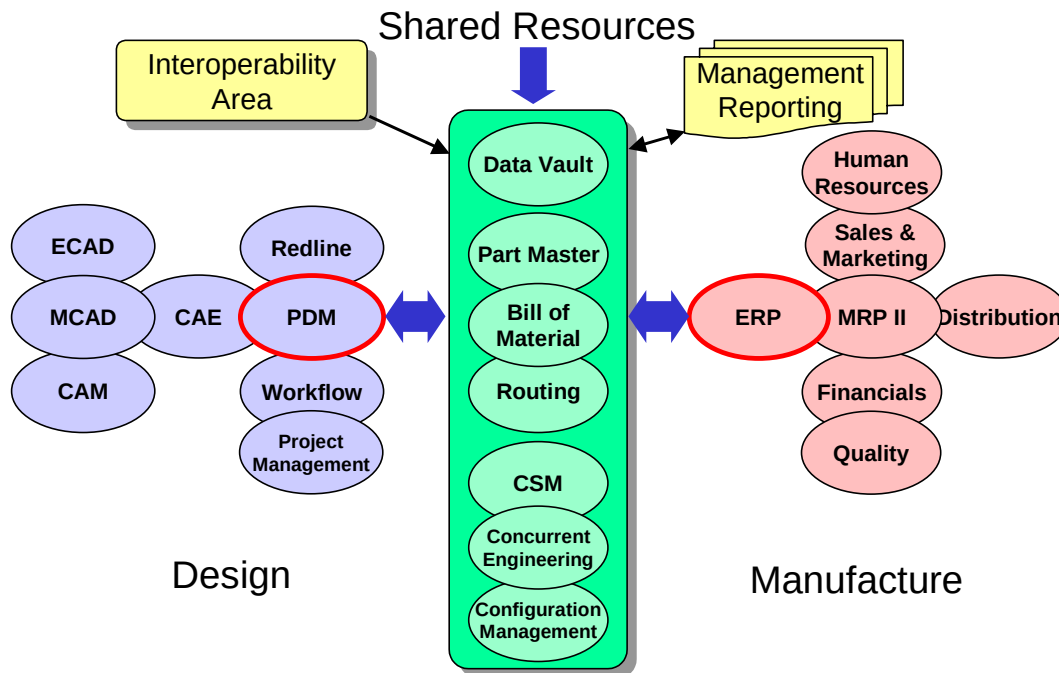


Figure 18. ERP/PDM Relationship

To support this, a new type of inter-enterprise application is emerging whose components are migrating into marketplaces and serving multiple companies at a time (Figure 19). Being developed and marketed by data exchange companies and consortia, these applications are hosted to provide ubiquitous, personalized access to information across business boundaries. Partner software is built-in and integrated with back-end applications. Through their scalability, performance, availability and security, they provide extensive support to an organization's Lean Infrastructure. They are being used in Supply Chain Optimization (MRO procurement, direct procurement, planning and optimizing, analysis) and Relationship Management (sales, service, and marketing).

Business solutions evolve driven by the basic objectives of reducing cost, improving efficiency, increasing automation, and adopting the best practices found within industry. Tighter integration of business processes meets these objectives when they are oriented towards processes that achieve consensus standards-based definitions of terminology and workflow.

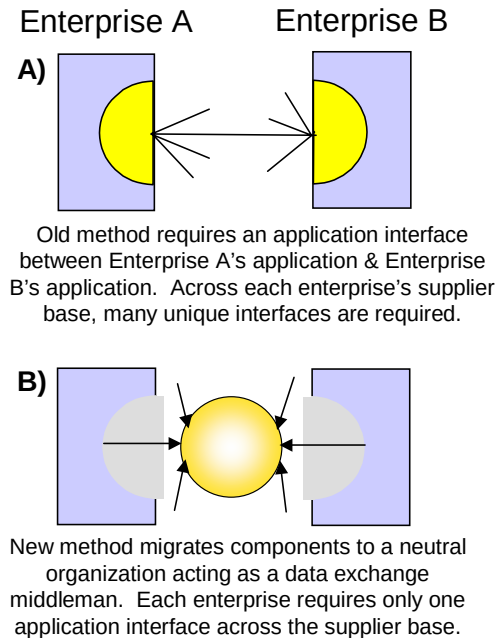
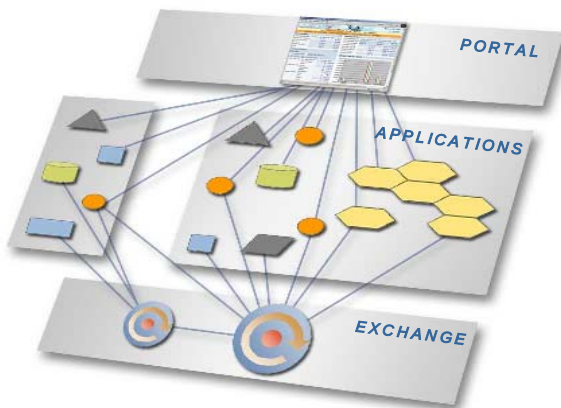


Figure 19. e-Business replaces multiple interfaces with an industry-common middleware



* Example mySAP Technology

Enterprise Resource Planning (ERP) is the prerequisite for getting to effective collaboration as shown in Figure 20.

Inter-Enterprise Cooperation is the next step and can be achieved by extending ERP through standards allowing direct interchange between suppliers and acquirers, through the use of neutral data exchange e-business organizations, or a combination of the two. This enables the creation of virtual market solutions based on an open architecture. Business Community Collaboration is the goal and requires additional extending e-business applications to provide greater flexibility

and value-added services within broad business communities such as aerospace, military, and automotive markets. Open E-business Collaboration builds on a three-fold foundation:

- **Portals** provide for user-centric collaboration empowering the individual. A portal offers an open framework that allows integrating any content from any application(s) or Web resource(s). Unification abstracts the different underlying resources to provide a consistent view for the user. Device-independent presentation technology assembles different user interface elements to personalized role-based pages regardless of end-user devices.
- **Applications** provide business functionality based on Web services through open standards. Applications build on an open Web standards based infrastructure to power collaborative Web services. They are designed to operate in heterogeneous environments integrating any application from any vendor in any technology environment.

- **Exchanges** provide for application independent process-centric collaboration driving end-to-end business processes. An exchange provides an open environment for message-based open integration. It provides common business process semantics to ease integration of external and internal components. It drives the actual execution of processes and handles the messaging among components.

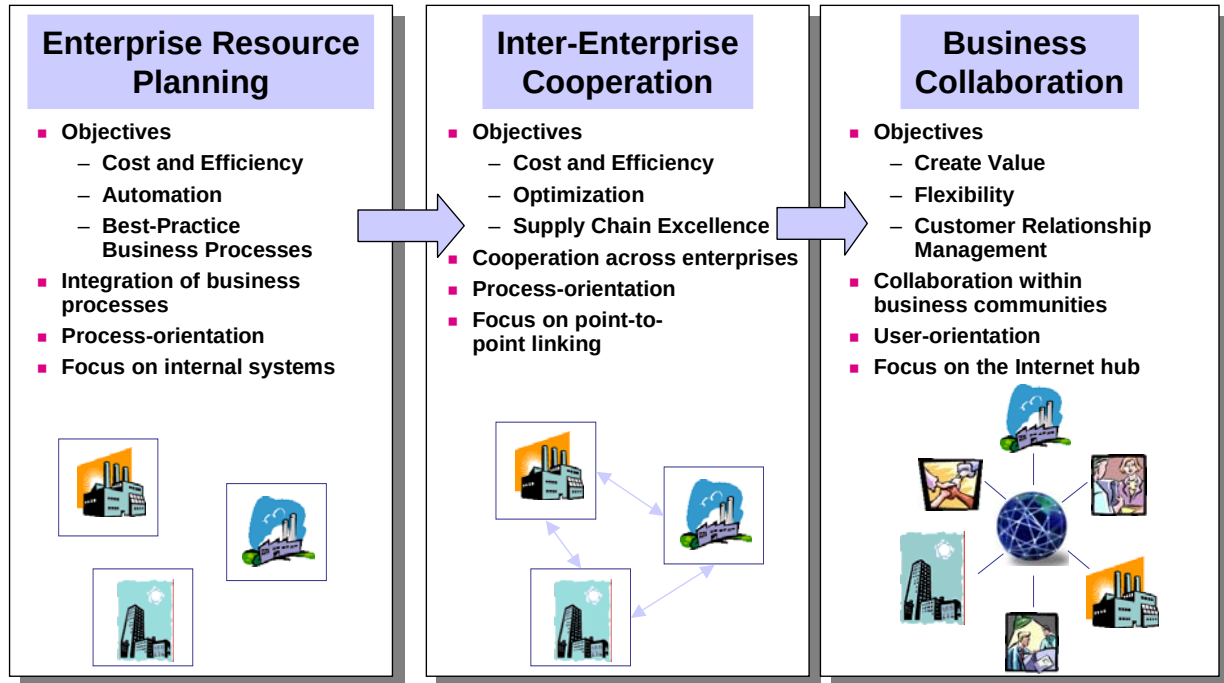


Figure 20. Evolution of Business Solutions

The impacts of this new set of IT capabilities on Systems Engineering include:

- Map personnel skills and organization profiles to Lean Processes and IT Technology (Life Cycle, Enterprise, Integrated Teams, Collaborative Methodologies)
- Focus on process-oriented value-added roles (e.g., Statistical Process Control or SPC, 6 Sigma, Risk Management)
- Include IT systems knowledgeable and experienced Subject Matter Experts on IPPD teams, but
- Retain the fundamental human role and contribution of systems engineering managers and staff.

1.7 DoD Acquisition Improvement, Mr. Richard Sylvester, Office of the Secretary of Defense, Deputy Director of Acquisition Initiatives

Mr. Richard Sylvester provided the Conference Keynote Presentation on Acquisition Excellence. Mr. Sylvester briefed two major initiatives engaging the Department of Defense: the Battle on Bureaucracy and Transformation.

The need for the Battle on Bureaucracy was made clear by Secretary of Defense Donald Rumsfeld on September 10, 2001: “In this building, despite this era of scarce resources taxed by mounting threats, money disappears into duplicative duties and bloated bureaucracies – not because of greed, but gridlock. Innovation is stifled – not by ill intent, but by institutional inertia. ... That’s why we’re here today challenging us all to wage an all-out campaign to shift

the Pentagon's resources from bureaucracy to the battlefield, from tail to tooth." On Transformation, Secretary Rumsfeld said: "We must change for a simple reason – the world has – and we have not yet changed sufficiently. The clearest and most important transformation is from a bipolar Col War world where threats were visible and predictable, to one in which they arise from multiple sources, most of which are difficult to anticipate, and many of which are impossible even to know today."

This has prompted Under Secretary of Defense for Acquisition, Technology, and Logistics, USD(AT&L), Pete Aldridge to change the DoD's strategy from Acquisition Reform to ***Excellence in Acquisition, Technology, and Logistics***. There are five priorities in the plan: (1) Continue progress on the five goals that USD (AT&L) set in May 2001; (2) Re-engineer the AT&L organization; (3) Develop an "Acquisition Excellence" Plan for all major weapon systems; (4) Complete the Plan for the "Future Logistics Enterprise"; and (5) Accelerate the flow of technology to the warfighter. Under Secretary Aldridge's five goals are: (1) Achieve credibility and effectiveness in the acquisition and logistics support process; (2) Revitalize the quality and morale of the DoD Acquisition, Technology, and Logistics workforce; (3) Improve the health of the defense industrial base; (4) Rationalize the weapon systems and infrastructure with defense strategy; and (5) Initiate high leverage technologies to create the warfighting capability, systems, and strategies of the future.

Key objectives in this plan include: reducing cycle time, improving logistics responsiveness and Supply Chain Integration, reforming acquisition of Services and DoD's support for small business, improving training and education, establishing a life-cycle civilian workforce management approach, using outreach and communication strategies to speed implementation, adopting commercial practices, creating efficient infrastructure, and leveraging commercial technology. To accomplish this, the AT&L organization has to be re-engineered to: eliminate marginal activities, transfer functions that can be better accomplished elsewhere, enhance higher priority activities, improve responsiveness and efficiency, and emphasize policy and oversight versus management. One aspect of this re-engineering of AT&L includes re-establishing the DoD System Engineering Office, which may be staffed up to the 20 person level seen 10 years ago.

Application of these strategies and objectives has resulted in development of the Acquisition Excellence Plan with the following elements: (1) Apply new acquisition rules to all systems to reduce cycle time, minimize program risks, and maintain stability; (2) Keep Joint Strike Fighter on-track; (3) Implement a deployment plan for missile defense; (4) Decide on the architecture for the Future Combat System; (5) Establish the development plan for the DD-X next generation destroyer; (6) Develop a balanced program for Information Dominance; (7) Rationalize the next generation of platforms for strategic forces posture; (8) Complete the roadmap for Unmanned Aerial Vehicles (UAV) and Unmanned Combat Aerial Vehicles (UCAV); and (9) Complete the plan for precision munitions. Although these goals are focused on specific programs, OSD is working across the entire joint service base. The tri-service Integrated Digital Environment (IDE) is in work and will get more funding and emphasis. There are three legs to their approach: e-Business, improved SE, and industry outreach.

Streamlining acquisition rules has resulted in rewriting the DoD 5000 series of acquisition policies. DoD 5000 is being revised to remove overly prescriptive wording and make policy more flexible to allow management more latitude to make good decisions. The same topics are being addressed but emphasis is shifting from specifying "how" to "what" has to be done. DoD

is spending over 50% of its contract dollars on service contracts, consequently attention is being focused on improving how services are contracted and executed. The DoD believes in Capability Maturity Models (CMM) and other best practices. The issue is how to encourage these through acquisition policy. The new DoD 5000 policy will retain the same objectives but be less strict in prescribing exactly how to do things. Thus, CMM is allowed but so are other methods that achieve the same result. Interoperability will continue to be a focus and OSD will continue to impose standards to achieve this objective. They are trying to get out of locking into things that change and finding better ways of standardizing. The shift will be to emphasize principles and leave more room for flexibility and judgment.

We will realize the future logistics enterprise by developing and implementing the approach for “end-to-end” distribution, reducing customer wait time, maximizing customer satisfaction, reducing costs, minimizing inventories, and determining the proper organizational structure. At the same time, we will bring new technology to the warfighter by expanding the use of Advanced Concept Technology Demonstrations (ACTD), revitalizing the Technology Transition Office, increasing the budget for Science and Technology, restoring DARPA to a high risk/high payoff focus, continuing to identify counter terrorism technologies, and supporting expanded joint experimentation. In summary, Mr. Sylvester concluded that we can achieve excellence by:

- Changing the environment
- Improving the process
- Linking human resources, and
- Monitoring progress with metrics.

1.8 AIA e-Business and the Metadata Harmonization Project, Ron Schuldt, Lockheed Martin Enterprise Information Systems

The Aerospace Industries Association (AIA) Executive Committee agreed to establish a corporate-level e-Business Steering Group (eBSG) whose membership includes: AAI, BAE Systems, Boeing, Exostar, Goodrich, General Dynamics, Honeywell, Lockheed Martin, MOOG, Northrop Grumman, Parker Aerospace, Raytheon, Rolls Royce, Textron, TRW, United Technologies, and Vought Aircraft. The eBSG developed an e-Business (EB) Interoperability Framework shown in Figure 21 in an attempt to define practical industry-level interoperability enabled by a common framework that defines the scope and elements of the multi-organization “Information Backbone”. The AIA e-business workgroups are aligned with the Framework.