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Science and Technology

Systems Engineering

SYSTEMS ENGINEERING FOR NEW DEVELOPMENT

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Type of Issuance: Initial

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SUMMARY: This instruction specifies the functions and evaluation criteria for the systems engineering associated with new development and relates to Policy Directive 80-3 *Systems Engineering*. The instruction is intended to apply to the emerging Operations and Services Improvement Process (OSIP), although one may recognize standard systems engineering principles that could be applied to other processes.

Signed by October 14, 2004
John L. Hayes Date
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and Technology

Systems Engineering for New Development

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Systems Engineering for New Development

1. Introduction. The systems engineering function provides:

- System functional and performance requirements analysis
- Architecture and system analyses
- Tradeoff analyses between effectiveness and cost
- Analysis of technical support throughout the system life cycle

Outcomes of an effective systems engineering process are efficient functional, performance, and process-related specifications for a complete solution. The resulting complete solution reflects the requirements to support efficient management, planning, and execution of the program. The program or project encompasses the design, development, test and evaluation of the solution and associated systems.

New development comprises major and visible changes to the enterprise architecture that affect the performance of existing mission critical systems, or adds a new mission critical system to the enterprise. Mission critical systems are those systems that are essential in the performance of a mission objective that if lost, would cause failure to meet or support the mission objective. Systems Engineering is required in all stages of new development of mission critical systems.

This instruction provides guidance on systems engineering for new development.

The following references pertain to this instruction:

- Systems Engineering Fundamentals, Defense Acquisition University Press, 2001
- IEEE Std. 1220-1998 Standard for Application and Management of the Systems
- Engineering Process, 1998
- INCOSE, Systems Engineering Handbook: A “How to” Guide for all Engineers, Version 2.0, July 2000

2. Purpose and Scope. This instruction specifies the functions and evaluation criteria for the systems engineering associated with new development. An overview of a systems engineering process is shown in Appendix A, Figure 1. This instruction focuses on creating and operating effective systems analysis and control functions; the other functions are specified in other procedural directives.

3. Program Product Standards. The following section will provide the following:

- A definition of the systems engineering approach (per INCOSE)
- A definition of the systems engineering role
- Operations and Services Improvement Process (OSIP) (refer to Appendix B - References) gate criteria and the associated systems engineer’s role

- OSIP Gate Criteria with associated systems engineering evaluation criteria

3.1 Systems Engineering Approach: The systems engineering approach is an interdisciplinary approach intended to enable the realization of successful systems. Systems engineering:

- Encompasses the scientific and engineering efforts related to the development, manufacturing, verification, deployment, operations, support, and disposal of system products and processes
- Develops needed user training equipments, procedures, and data
- Establishes and maintains configuration management of the system
- Develops work breakdown structures and statements of work
- Provides information for management decision making

3.2 Systems Engineer's Role. The systems engineer's role includes defining, clarifying, and documenting requirements; performing (or insuring his/her team performs) the necessary parametric analysis and tradeoffs; recognizing when interface impacts might occur and taking early action to avoid problems. The systems engineer should have a good overall perspective of the system to help interpret and explain motivations for requirements to his team members and thereby gain their acceptance and commitment to objectives.

3.3 Systems Engineer's Role as Related to OSIP Gate Criteria. The systems engineer's primary role starts after OSIP Gate 1- Need Approval and Validation Resourcing. The roles in support of OSIP Gates 1, 2, 3, and 4 are as follows:

Gate 1 - Need Approval and Validation Resourcing

- Develops or participates in development and review of needs, particularly needs associated with technology opportunity

Gate 2 - Validation Approval & Research and Analysis Resourcing

- Develops or participates in development and review of requirements
- Develops or participates in development of the conceptual architecture
- Conducts initial trade-off analysis
- Conducts risk identification

Gate 3 - Research and Analysis Approval & Operational Development Resourcing

- Uses a systems engineering perspective
- Leads the decomposition of requirements
- Develops the architecture
- Conducts trade-off analyses

- Conducts risk identification and mitigation

Gate 4 – Operational Development Approval and Deployment Decision & Resourcing

- Identifies a systems engineering process
- Assures that a product is built that adequately meets the requirements
- Oversees the development test and evaluation effort
- Supports the operational test and evaluation effort

3.4 Systems Engineering Evaluation Criteria Associated with OSIP Gates. Table 1 specifies the OSIP gate products and the associated systems engineering gate evaluation criteria. The OSIP gate products are documents that are to be completed as gate criteria. The systems engineering evaluation criteria specify what will be used to evaluate the gate documents. For example, the Gate 2 Operational Requirements Document (ORD) will be evaluated and analyzed by determining if the requirements listed in the ORD are both feasible and achievable. Continuing with the example, the Gate 3 Requirements Specification will be evaluated by determining if the operational requirements are adequately decomposed to system requirements such that a product may be built.

Table 1. OSIP Gate Products and associated Systems Engineering Evaluation Criteria

OSIP Gate Products	Systems Engineering Evaluation Criteria
G1 Criteria:	
1. Need Input Document (NID)	(1) Evaluate NID, considering similarities to other technical projects and alternatives
G2 Criteria:	
1. Statement of Need (SON)	(1) Evaluate and analyze SON to support requirements formulation (2) Identify alternative SONs
2. Concept of Operations (CONOPS)	(1) Evaluate and analyze CONOPS to support requirements formulation
3. Operational Requirements Document (ORD) (Initial)	(1) Evaluate and analyze ORD for feasibility and achievability (2) Identify trade-offs (3) Identify risk areas
4. Program Plan	(1) Review the plan to support program lifecycle
G3 Criteria:	
1. SON	(1) Evaluate and analyze to support requirements formulation (2) Identify alternative enterprise architecture approaches or solutions
2. CONOPS & ORD	(1) Evaluate and analyze to support requirements

OSIP Gate Products	Systems Engineering Evaluation Criteria
	formulation (2) Refine and revise CONOPS & ORD
3. Requirement Specification	(1) Develop system requirements (first cut) (2) Evaluate and analyze for feasibility and achievability (3) Identify trade-offs (4) Identify risk areas, risks, and mitigation approaches
4. Business Case Analysis (BCA)	(1) Support business case development including assessments of alignment to goals, current and future states, gaps, alternatives, benefits, costs, architecture, risks, acquisition strategy, regulatory compliance, schedule development, and requirements baseline
5. Operational Development Project Plan (ODPP)	(1) Support detailed program planning (2) Support requirements allocation (3) Support alternative selection (4) Select development approach, e.g. - Incremental - Spiral - Prototyping (5) Support critical milestone definition (6) Support schedule definition (7) Identify schedule trade-offs (8) Develop ODPP
G4 Criteria:	
1. Operational Development Evaluation	(1) Lead operational development evaluation (2) Establish verification program
2. Integrated Logistics Support Plan (ILSP)	(1) Support ILSP development including reliability, maintainability, availability estimation and planning, logistics planning, and support planning
3. Deployment Plan	(1) Support deployment planning
4. Responsibility Transfer Plan (RTP)	(1) Lead responsibility transfer planning
Deploy, Maintain, and Assess	(1) Support deployment execution, transition to maintenance, and system assessment

Appendix A – Systems Engineering Process

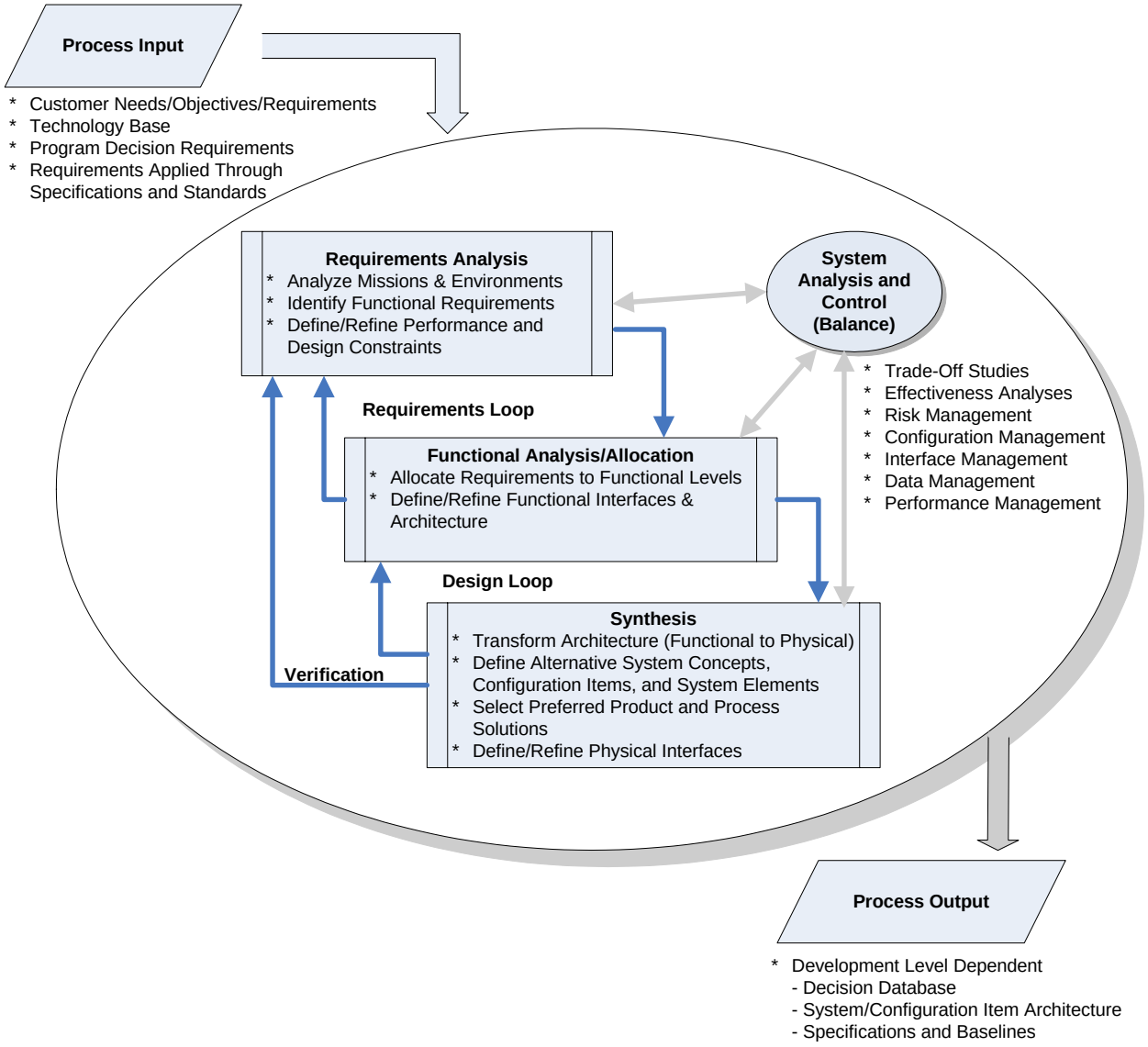

Figure 1. The Systems Engineering Process, Excerpt from *Systems Engineering Fundamentals*, p 31

Appendix B - References

1. NWS Policy Directive 10-1 *Operations and Services Improvement Process* (in process)
2. NWS Policy Directive 80-3, *Systems Engineering*.