Systems Engineering Awareness

MFPT 2019

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King of Prussia, PA
May 16, 2019
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Question to audience

• Why are we sitting here?

Possible Answer

• Seeking greater success in project endeavors.

Proposed solution

• Performing activities defined by Systems Engineering methods will greatly increase project success.
Introduction

History – Wikipedia

1. Systems Engineering can be traced back to Bell Telephone Laboratories in the 1940s

2. The development and identification of new methods and modeling techniques


4. The conception, design, development, production and operation of physical systems
Definitions and Terms

System:

• NASA: A set of interrelated components which interact with one another in an organized fashion toward a common purpose.

• DOD: An integrated composite of people, products, and processes that provide a capability to satisfy a stated need or objective.

• INCOSE: A construct or collection of different elements that together produce results not obtainable by the elements alone.
Definitions and Terms

Systems Engineering:

- MIL-STD-499B: An interdisciplinary approach encompassing the entire technical development effort to evolve and verify an integrated and life-cycle balanced set of system, people, product and process solutions that satisfy customer needs.

Systems engineering encompasses:

- Technical effort (develop, manufacture, verify, operate, etc)
- Define and manage the system configuration
- Translate the system to a work breakdown structure
- Develop information for decision making.
Definitions and Terms

Systems Engineering:

- **INCOSE**: An interdisciplinary approach and means to enable the realization of successful systems, focusing on customer needs early in the design cycle, document requirements and proceed to design synthesis and system validation. Consider the complete problem: operations; performance; test; mfging; $ and time; training/support; disposal.
Definitions and Terms

Systems Engineering:

- NASA: Requires the application of a systematic, disciplined engineering approach that is quantifiable, recursive, iterative, and repeatable for the development, operation, maintenance and disposal of the systems integrated into a whole throughout the life cycle of a project or program. The emphasis is on achieving stakeholder functional, physical, and operational performance requirements in the intended use environments over the system’s planned life within cost and schedule.
# Definitions and Terms

**Systems Engineering is:**
- Multidisciplinary
- Systematic
- Processes
- Development/operation
- Complex product
- Limited resources
- Constraints

**Process:**
- Complex work activity
- Transforms inputs into outputs
- Consumes resources
Definitions and Terms

Three Types of Systems Engineering:

1. **Product Systems Engineering (PSE)** is the focus on the design of physical systems consisting of hardware and software.

2. **Enterprise Systems Engineering (ESE)** pertains to the view of enterprises, that is, organizations or combinations of organizations, as systems.

3. **Service Systems Engineering (SSE)** has to do with the engineering of service systems.
Benefit of SE

Planning

Cost

Time
Definitions and Terms

Systems Engineering Leadership:

- Knowledge base
  - What do you know about the subject?
- Engineering judgment
  - Experience, successes
- Effective Communication
  - Written, verbal, diplomacy
- Systematic Processes
  - Company policy
  - Examples: CMMI, ISO, NPR 7123.1A
Definitions and Terms

Interaction of PM, SE, and TL = WBS creation:
SE Dilemma

MUST BALANCE
Risk (R)! Performance (P)! Cost (C)!
\[ C \times R = P \]

1. Reduce C at constant R = P drops
2. Reduce R with constant C = P drops
3. Reduce P at constant C = Risk drops
4. Reduce P at constant R = Cost drops
5. Reduce C at constant P = Risk increase
6. Reduce R at constant P = Cost increase
7. Etc.
Design Engineering Dilemma

Engineers want a solution NOW!

- General statements lead to detailed design on first step.
- Difficult to step back and look at BIG picture
- Up front requirements definition and systems engineering planning are PARAMOUNT before designs start getting built.
- Late design changes cost $$$$$
- Communication is KEY.
NASA Procedural Reqmt. 7123.1A
NASA/SP-2007-6105
Rev1

NASA
Systems Engineering Handbook
This handbook consists of six core chapters:

(1) Systems engineering fundamentals discussion
(2) the NASA program/project life cycles
(3) systems engineering processes to get from a concept to a design
(4) systems engineering processes to get from a design to a final product
(5) crosscutting management processes in systems engineering
(6) special topics relative to systems engineering
MFPT 2019 – Systems Engineering Awareness

Systems Engineering Focus Group
Purpose of PDR

• To determine the feasibility and desirability of a suggested new major system and establish an initial baseline compatible with strategic plans.

• Develop final mission concept, system-level requirements, and needed system structure technology developments.

• Mature requirements for all products in the developing product tree, develop ConOps, preliminary designs, and perform feasibility analysis of the verification and validation concepts to ensure the designs will likely be able to meet their requirements.
Output of PDR

End products in the form of mockups, trade study results, specification and interface documents, and Prototypes.
How to get to PDR

• Concept of Operations
• Develop High Level Requirements
• Identify Key Driving Requirements
• Define Verification Methods
• Identify Design Solutions
• Perform Trade Studies
• Develop a Work Break Down Structure (Product Based)
• Cost and Schedule
• Risk Management and Mitigation
• Technical Performance Measures
• Configuration Management
Most “key” valuable lessons

- Techniques on calling, holding, and archiving meetings/action items
- Human interface, stakeholder education for synthesis of requirements document (design by requirements is bad)
- Functional Analysis (gives insight, interfaces, WBS, PBS based on product architecture)
- Clarity (no vague requirements wording)
- Plan to iterate
- Diplomacy
- One shall per requirement
- Validate – use it
- Verify – feasible and affordable
Most “key” valuable lessons

• Golden Rule of Requirements – who is going to pay?

• Integration and test – plan what to test, test it, plan early (test what you fly, fly what you test)

• Trade Study Methodology– always iterate

• WBS – product oriented, based on architecture

• PLAN EARLY !!! System Engineering Management Plan (SEMP)
Keys to Success

• Strong SE effort early in project

• Plan and Baseline at each step

• Iterate often

• Strong Risk Management Plan

• Keep an eye on Technical Performance Measures
Conclusions

• Proper application of SE methods upfront in a project life cycle will greatly increase success.

• Paying close attention to the Stakeholder Analysis will greatly increase project success.

• Performing activities defined by SE methods will increase chances of obtaining funding to complete your project.

• Verification and Validation is key at every level in the project.