Systems Engineering, Program Management conjoined Disciplines over the Project Life Cycle

NDIA 8th Annual Systems Engineering Conference

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Agenda

- Understand the SE & PM Relationship, Roles, & the Project Team
  - Overview of SE & PM Processes & Responsibilities
  - PM/SE Relationship
  - The Project Team

Discuss 4 areas where SE/PM Cooperation is key
1. Collaborating to achieve desired customer participation
2. Managing risks, issues, and action items
3. Governing project to meet milestones
4. Integrating & optimizing other project disciplines

Summary and Q&A
The Systems Engineer Responsibilities Include...

managing technical requirements thru life cycle milestones

1 = Business Requirements Review (BRR)
2 = System Requirements Review (SRR)
3 = Preliminary Design Review (PDR)
4 = Critical Design Review (CDR)
5 = Test Readiness Review (TRR)
6 = Production Readiness Review (PRR)

Time to Market – COTS System

20% 80%

Incremental System Engineering Vee Model

ORS

1

Mission Requirements & Concept of Operations

SyRS

Validate

Component Design

Component Test & Integration

“Code To” and “Build To” Documentation

System Requirements & Architecture

SRS, IRS, HCIS

2

Validate

SRVM

SRVM

Validate

System Integration & Verification

System Demonstration & Validation

Increment I

RTM

Increment II

Deploy

Support

Upgrades

Retire

Retire

Systems Engineering Domain

Component Engineering Domain

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The Project Manager Responsibilities Include...

- Managing program thru life cycle milestones

1 = Customer Interface
2 = Contract Management
3 = Program Planning & Control
4 = Baseline Control
5 = Performance Monitoring
6 = Program Reporting

**Customer Authority**
- Contract
- SOW
- TLR

**Program Planning**
- Contract Compliance
- Ownership
- Resources
- Support Relationships
- Budget Allocations
- Scheduling
- Control & Reporting

**Requirements Flow-Down Traceability**

**Dashboard Metrics**

**Program Baseline**
- PMP
- SDP
- SEMP
- RMP
- SPECs
- OMI
- ICD
- DESIGN B/L

**Performance Monitoring**
- Program Reviews
- Risk Management
- Technical Reviews
- Working Groups
- Scheduling System
- Earned Value Reporting

**Planning**

**Reporting**

**Program Baseline**
- WBS
- BUDGET/SCHEDULE
- COST ACCT PLANS
- PMP’s WORK AUTHORIZ.

**Program Baseline**
- BRR
  - Sys Design
  - Subsys Specs
  - H/W & S/W Design Specs

**Program Baseline**
- SRR
  - PDR
  - CDR
  - TRR
  - PRR
  - SAT
  - Subsys Integ
  - Dev Tests

**Dashboard Metrics**

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SE & PM Relationship Involves...

- Systems Engineer (In particular the Chief Engineer)
  - PM’s Technical Arm
  - Key technical resource
  - Understands Total Contract
  - Monitors Technical Performance
  - Interfaces to team leads from Other Disciplines
  - Interfaces to Customer Technical Leads
  - Addresses Technical Risks/Issues/Action Items

- Program Manager
  - Conducts Program Planning
  - Understands Technical Content
  - Authorizes Work & Distributes Budget
  - Interfaces to Customer/Stakeholder Management
  - Manages the Business
    - Monitors the Performance of the Project
    - Initiates any Re-Planning or Re-direction
  - Leads Project Management Reviews to Customer Management
    - Programmatic and Technical Status (Schedule/Budget)
    - Risks/Issues/Action Items
  - The PM & SE have experienced leadership skills & project team co-leaders

SE/PM drive 9 Design Considerations to be Factored into Architecture Definition

1. Operational Use
2. Functional Domains
3. Physical Domains
4. Technology Domains
5. Reliability/Maintainability/Availability
6. Development Approach
7. Future Growth/Expandability
8. Security
9. Cost
The Project Team includes many disciplines...

- Systems Engineer
- Program Manager

**Technical Disciplines**
- Software Engineering
- Hardware Engineering
- Test Engineering

**Configuration Management**

**Business Disciplines**
- Program Control
- Subcontractor
- Contracts
- Legal
- Finance
- Procurement
- Business Disciplines
Four Key Areas Requiring SE/PM Cooperation

The SE and PM must work closely together over the project life cycle for a successful project.

Four (4) key ways they can do this is by:

1. Collaborating with the Customer as a team to obtain desired participation ending with system acceptance
2. Managing risks, issues, and action items
3. Governing all aspects of the project to define, schedule and meet all milestones
4. Integrating and optimizing the use of all of the other project disciplines
Collaborating to Achieve Desired Customer Participation - 1

- A close relationship involving regular one-on-one communications between the PM & SE and their customer counterparts to discuss/resolve differences is essential – a first line of collaboration
  - PM has the overall responsibility for the program and is the primary interface to the customer managing the business baselines
  - The SE is the primary interface to the customer in managing the technical baselines

- Customer expectations are managed by both the PM & SE
  - Realistic schedules and technical baselines are provided
  - Milestones are used to pace system design and development
  - Technical concerns are addressed expeditiously with strong back-up and open discussions
  - Management of information presented to stakeholder organizations requires them being vetted with the customer
Collaborating to Achieve Desired Customer Participation - 2

- The initial Requirement Baselines and Initial Capabilities Document are collaborative products involving many resources from both organizations and stakeholders reaching agreement.

- **Metrics** for Baseline Reviews are agreed upon early in project:
  - Processes to be followed
  - Artifacts to be provided
  - Cost & schedules
  - Action Items resulting from reviews have an agreed upon closure plan

- PM maintains insight into **customer needs** and understands “big picture”

- When an Issue occurs that requires analysis and possibly an alternative path for the project, the customer is kept informed by the PM or SE conducting the trade-offs.

Establish a collaborative Baseline Change process and control mechanisms for BCRs
Surprises are BAD for a project!...risky!

Start early during the proposal effort to identify track, and manage risks, issues, and action items that could impact project success.

Implement your Risk Management CMMI process or define one for the project early

- Establish a Risk Issue Review Board (RIRB) to manage risks/issues
- Define risk mitigation plans and criteria before risks become issues
- Insist that project teams identify risks early
- Track them and involve your customer in process
- Apply metrics to risk assessment and focus on high impact – high probability of occurrence risks

Schedule weekly team meetings (max 90 minutes) between project disciplines – PM or SE chair

- Document captured Risks, Issues, and Action Items
- Number/Track action items and capture disposition – hold to due dates.
Managing Risks, Issues, and Action Items - 3

- Risk Identification and Assessment

- Risk Mitigation
  - Identify Alternatives
  - Establish Technical Performance Measures to Determine Probability of Successful On Current Path
  - Establish Milestones/Decision Points to Transition from Current Path to Alternative Path…Adhere to the Transition Plan

- If a Risk matures and becomes an Issue
  - Assign an Issue #, Identify a closure plan, and continue track until closed

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Managing Risks, Issues, and Action Items - 4

- Know the Overall Risk Trend (Sum) for the Project

Ex: Trend plot reflects an improving project risk picture

- Manage Action Items at the project level
  - Identify & track short term actions relative to project performance
  - Assign team leads & closure dates and then document disposition

<table>
<thead>
<tr>
<th>Action Item #</th>
<th>Action Item Description</th>
<th>Assignee</th>
<th>Status</th>
<th>Open Date</th>
<th>Close Date</th>
<th>Progress/Disposition</th>
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<tbody>
<tr>
<td>241</td>
<td>ID resource to do trade study #9</td>
<td>Jones</td>
<td>Closed</td>
<td>9/8/05</td>
<td>9/28/05</td>
<td>Holdbrook designated</td>
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<td>245</td>
<td>Order SW for imaging</td>
<td>Smith</td>
<td>Open</td>
<td>9/10/05</td>
<td></td>
<td>PO in progress</td>
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<tr>
<td>246</td>
<td>Arrange for stakeholder briefing for November</td>
<td>Blanton</td>
<td>Open</td>
<td>9/15/05</td>
<td>9/30/05</td>
<td>Scheduled at Hyatt</td>
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<tr>
<td>253</td>
<td>Schedule customer pre-review of PDR material</td>
<td>Jeter</td>
<td>Closed</td>
<td>9/21/05</td>
<td></td>
<td></td>
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<tr>
<td>255</td>
<td>Determine cost of requested new task</td>
<td>Bonds</td>
<td>Open</td>
<td>9/29/05</td>
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<tr>
<td>260</td>
<td>Identify SEMP backup plan</td>
<td>Marino</td>
<td>Open</td>
<td>10/5/05</td>
<td></td>
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</table>
Governing Project to Meet Major Milestones

- PM & SE should regularly communicate with Customer in technical & business meetings to maintain a strong communications conduit.
- The SE collaborates with the customer to agree upon the product artifacts that comprise each of the project baselines – in itself a business baseline artifact.
- PM/SE collaborate to define metrics (schedules, budgets, artifacts, incentives, etc.) to make major milestones.
- PM/SE collaborate to:
  - Tailor project processes (CMMI, project unique) to be followed.
  - Identify/acquire the tools (development, cost, schedule, etc.) to perform the processes.
  - Define the training & techniques to develop the work products and deliverables.
- PM/SE chair the different baseline reviews with the Customer.
  - Use baselines to pace system development.
Baselines & Reviews identify Key Milestones

- Need / Opportunity Identification
- Conceptual System Specification
- Design
- Development
- Test & Production System Update
- New Production System

- Customer Baseline
- System Baseline
- Component / Application Baseline
- Design Baseline
- Test Baseline
- Production Baseline

- Business Requirements Review (BRR)
- System Requirements Review (SRR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Test Readiness Review (TRR)
- Production Readiness Review (PRR)

- Business Requirements Specification
- System Architecture
- Component Requirements
- Component Architecture
- Data Migration
- Test Strategies
- Test Architecture
- Component Level Design
- Component Test Plan
- Test Plans
- Test Cases
- Test Data
- Release Content
- Move to Production Plan
- Deployment & Migration Plans
Integrating Project Disciplines - 1

- PM is the Project Leader in all respects [“buck stops here!!”]
  - Facilitator and coordinator within the project team
  - Bridge between Engineering and other disciplines
  - Enforces controls and processes of project disciplines
  - Final arbiter to adjudicate disputes within the team
  - Buffer the engineering team from churn from external sources
  - The team motivator and effective user of rewards & recognition
  - Customer interface for project control information to/from disciplines

- SE is the technical adviser within the project team
  - Monitors overall technical performance of disciplines
    - Defines detailed requirements to be implemented by team
    - Conducts work product reviews of disciplines
    - Lead Systems Engineer is PM’s day-to-day interface to engineering team
    - Lead SE has authority to speak & commit for SE team
  - Customer interface for technical information to/from disciplines
  - Manages interaction between technical disciplines

PM and SE communicate the Program goals and determine the team progress
Critical that processes and plans by disciplines get defined early in project...are reviewed and adhered to...how business is conducted
- SEMP
- Software Development (SDP)
- CMMI Processes
- Configuration Management Plan, etc.

Discipline Team Leads must actively participate in internal project status meetings...and be held accountable for making milestones

Open division of responsibility integrating disciplines (See chart #6)
- SE primarily oversees the Technical Disciplines
- PM primarily oversees the Business Disciplines

Disciplines must perform within allocated budget and schedule that they committed to...PM assist in obtaining necessary resources

A Subcontract management team should be formed to oversee subcontractors performance and needs

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Summary

- Successful completion of large complex systems requires a strong, effective, and cooperative leadership over the entire life cycle of a project.

- That leadership is in the form of a closely aligned Customer, Project Management, and Systems Engineering team.

- The SE and PM leverage their relationship to improve effectiveness of the project team by:
  - Collaborating with the Customer to achieve acceptance of project products.
  - Managing risks, issues, and project action items.
  - Governing the project tightly to meet all milestones.
  - Integrating and optimizing all of the project disciplines.
## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>BCR</td>
<td>Baseline Change Request</td>
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<tr>
<td>BRR</td>
<td>Business Requirements Review</td>
</tr>
<tr>
<td>CDR</td>
<td>Critical Design Review</td>
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<tr>
<td>CMMI</td>
<td>Capability Maturity Model Integration</td>
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<tr>
<td>COTS</td>
<td>Commercial Off-the-Shelf</td>
</tr>
<tr>
<td>HCIS</td>
<td>Hardware Critical Item Specification</td>
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<tr>
<td>ICD</td>
<td>Initial Capabilities Document</td>
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<tr>
<td>IRS</td>
<td>Interface Requirements Specification</td>
</tr>
<tr>
<td>OMI</td>
<td>Operator Machine Interface</td>
</tr>
<tr>
<td>ORS</td>
<td>Operational Requirements Specification</td>
</tr>
<tr>
<td>PDR</td>
<td>Preliminary Design Review</td>
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<tr>
<td>PM</td>
<td>Program Manager</td>
</tr>
<tr>
<td>PMP</td>
<td>Program Management Plan</td>
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<tr>
<td>PRR</td>
<td>Production Readiness Review</td>
</tr>
<tr>
<td>RMP</td>
<td>Requirements Management Plan</td>
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<tr>
<td>RTM</td>
<td>Requirements Traceability Matrix</td>
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<tr>
<td>SDP</td>
<td>Software Development Plan</td>
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<tr>
<td>SE</td>
<td>Systems Engineer</td>
</tr>
<tr>
<td>SEMP</td>
<td>Systems Engineering Management Plan</td>
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<tr>
<td>SRR</td>
<td>System Requirements Review</td>
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<tr>
<td>SRS</td>
<td>Software Requirements Specification</td>
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<td>SRVM</td>
<td>System Requirements Verification Matrix</td>
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<td>SyRS</td>
<td>System Requirements Specification</td>
</tr>
<tr>
<td>TRR</td>
<td>Test Readiness Review</td>
</tr>
<tr>
<td>WBS</td>
<td>Work Breakdown Structure</td>
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