Systems Engineering for Software Intensive Projects Using Agile Methods

The Role of Systems Engineering in Large Scale Agile Projects

Gundars Osvalds, CSEP
Praxis Engineering
gundars.osvalds@incose.org
Agenda

What is —

Traditional Systems Engineering provides value to systems development

What could be —

Systems Engineering support of agile software development on large systems

How can Systems Engineers join the party?
Case for Change – Agile Benefits

What it could be —

<table>
<thead>
<tr>
<th>Metric</th>
<th>Year One</th>
<th>Best in Following Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less cost</td>
<td>20–40%</td>
<td>100%</td>
</tr>
<tr>
<td>Less time to market</td>
<td>20–50%</td>
<td>60%</td>
</tr>
<tr>
<td>Better quality at delivery</td>
<td>20–30%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Based upon metrics from 550 traditional projects, 250 agile projects over 10 years in 60 organizations Ten “Take Aways” from the Reifer “Quantitative Analysis of Agile Methods” study Donald J. Reifer on Aug 12, 2013

Agile methodology shows promise in delivering value
Systems Engineering Discipline

What is —

› “Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems”
   INCOSE Systems Engineering Handbook

What could be —

› Expand traditional scope of SE to enhance successful agile SW implementation on large programs

SE supporting agile SW development can coordinate user needs and system capabilities
Is There a Way to Satisfy Customer Needs?

What is —

» Programs have contractual requirements that must be met, however
» At delivery the customer may not be satisfied
  ◦ requirements not met
  ◦ requirements incorrect
    • OBE – Overcome By Events

What could be —

» Use agile software development methodology
» Involve the customer in decisions to deliver what is need

Stakeholders provide feedback during development
The Promise of Agile Software Development Process

What is —

- Employing agile process in commercial environments has provided fast, lean and flexible approaches to developing software

What could be —

- Application of agile software development to larger and more complex projects may provide more value at lower cost

How can Systems Engineers contribute?
What is —

- Traditional (DoD, Federal) programs use a waterfall model as a sequential design process

What could be —

- Adopt agile software methodologies to SE to provide an iterative convergence approach to development

With agile process the SE can manage technical risk and benefits from early iterations
Develop a System That Satisfies Customer Needs

What is —

- Waterfall based projects typically have only one cycle to get it right
- Optimized for NO change
  - rework
  - scope
  - funding

What could be —

- Agile teams working together with customer decisions guide iteration plans
  - start with needs
  - interactively converge
  - customer decides scope and priorities

How to define agile based completion?
Need an agile aware acquisition process!
How do SE Work With Software Engineers

What is —

- Typical programs have a handoff between SE and SWE
  - formal specifications
  - formal requirements
  - formal architecture
  - formal gates

What could be —

- Use of agile methodology the SE and SWE and developers work together
  - user needs
  - user stories
  - architecture vision
  - software design

SE balances key attributes of requirements and architecture
SE are embedded in agile teams
How Can SE Support Agile SW Development?

What is —

- Large programs: Industry and federal programs lack a formal approach on how SE can support the agile SW methodology.

What could be —

- We proposed an Agile SE Framework to guide the SE and SW teams in agile project development.

Use the Agile SE Framework
Agile SE Framework

Architecture Teams maintain system Architecture as the detail design evolves.
SE Must Adapt to the Agile Way

What is —

› The challenge for the SE to carry out the essential work in agreement, rather than conflict with the agile software development teams

What could be —

› To achieve this end the systems engineering processes must be adapted to support the agile software design and development methods

SE need to tailor their architecture and requirements efforts prior to the first iteration
The Agile SE Framework Process

- **Pre-planning —**
  - Provides a broad scope of requirements to allow agility in the implementation

- **First iteration —**
  - The planning and architecture team provide initial requirements and architecture to the implementation team

- **Next iteration —**
  - Uses feedback from customer and guidance from SE to update architecture and review requirements allocation

- **Next+1 iteration —**
  - The customer will provide feedback
  - The SW team will integrate feedback into the design for next iteration
    - Develop software
    - Integration and test

The SE maintains integrity of the architecture and requirements
# RACI Matrix for Agile SE Framework

Self-organizing teams have the flexibility to manage their artifacts and activities

## RACI Matrix Legend

<table>
<thead>
<tr>
<th>Role Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsible (one)</td>
<td>Leads the task completion with tangible deliverables</td>
</tr>
<tr>
<td>Accountable (one)</td>
<td>Deligated the responsibility for task, approves completion</td>
</tr>
<tr>
<td>Consulted (many)</td>
<td>Multiple contributors provide special knowledge or expertise</td>
</tr>
<tr>
<td>Informed (many)</td>
<td>Members that will be informed of the task status and deliverables</td>
</tr>
</tbody>
</table>

## IMPLEMENTATION TEAM

<table>
<thead>
<tr>
<th>TASKS</th>
<th>ROLES</th>
<th>Product Owner</th>
<th>Scrum Master</th>
<th>Team Member</th>
<th>Customer/Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop/ Maintain Software Design (Detailed Design)</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Software Implementation</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Integration - unit test, SW integration as possible</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Verification</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Maintain/ Verify System Capabilities as possible</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Maintain Interface Definitions of SW/ Component</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Perform Trade Studies</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Develop/ Maintain Test Procedures</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Meeting Facilitator/ Impediment Remover</td>
<td>A</td>
<td>R</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

What is —

- Agile software development methodologies
  - offer a fast, lean, and flexible approach for developing software
- Agile methodologies have challenged the traditional approach to SE activities

What could be —

- Cross-functional teams maintain the integrity of the requirements and architecture.
- Flexibility to absorb changes in mission requirements
- Frequent deliveries of releasable products

The Agile SE Framework defines a method for SE and SWE to work together in delivering customer satisfaction
Questions

Paper Authors — INCOSE Agile Systems Engineering Working Group
“System Engineering for Software Intensive Projects Using Agile Methods”

Larri Rosser
Raytheon
Garland, TX
larri.rosser@incose.org

Phyllis Marbach
The Boeing Company
Huntington Beach, CA
phyllis.marbach@incose.org

Gundars Osvalds, CSEP
Praxis Engineering
Annapolis Junction, MD
gundars.osvalds@incose.org

David Lempia
Rockwell Collins
Cedar Rapids, IA
david.lempia@incose.org

Can you align your process?