NDIA 11th Annual Systems Engineering Conference

“Daily Challenges of Requirements Engineering”

October 22, 2008

Frank Salvatore
High Performance Technologies, inc.
3159 Schrader Road
Dover NJ, 07801
(973) 442-6436 ext 249
fsalvatore@hpti.com
Outline

- Requirements Elicitation
- Requirements Capture and Management
- Requirements Traceability
- Requirements Control
- Reaching Consensus
- Eliciting Verifications
- Communicating Requirements
- Metrics
Requirements Elicitation

How do you gather the requirements?

- Interviews
- QFD Workshops
- Web Based Surveys
- Vignettes and Scenarios
- Questionnaires
- Brainstorming and Mind Mapping
- Analysis/Derivation
  - Hazard
  - Fault Tree
  - Sensitivity
  - Trade Studies
- Existing Documentation and or Policies
- Quality Assurance Provisions

It involves a lot of research and is evolutionary!

Don’t forget to Document Rational. It will save you time latter when you will need to defend the requirements.
Interview Based Elicitation

Using and Enterprise Architecture approach one can first probe into Business Goals and Architecture Principles by asking questions to understand:

- Mission and Values of your organization
- Understand importance (PM Level)
- Understand organization structure
- Understand Products
- Understand Customers and Stakeholders
- Understand Daily Activities

Mostly used for Business Systems
Interview Based Elicitation

Project and Product Data can be understood by asking these leading questions:

- What are the Projects/Products that the organization manages?
- Who do you interact with?
- What data types do you manage?
- How do you organize your data?
- What data do you view as being most important?
- Who are the Customers for each product?
- Who are the stakeholders for each product?
- What are the day-to-day activities that go on for the projects you choose?

Diagram:

- Current Architecture
  - Business Goals / Drivers
  - Stakeholders / Concerns
  - IT Architecture Principles
  - Business Architecture
  - Data Architecture
  - Applications Architecture
  - Technology Architecture

- Target Architecture
  - Technical Standards / COE / Security / Tools
  - Migration Planning / Implementation
  - Program Management / Architecture Refreshment
QFD Based Elicitation

Also helps to Build Consensus and Understanding of complex relationships as well as importance.

<table>
<thead>
<tr>
<th>USER NEEDS</th>
<th>Engineering Metrics</th>
<th>USER RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engineering Metric 1</td>
<td>Absolute Score</td>
</tr>
<tr>
<td>Customer Need 1.0</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Customer Need 2.0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Customer Need 3.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Customer Need 4.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Customer Need 5.0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USER RATING</th>
<th>Absolute Score</th>
<th>Relative Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept A</td>
<td>3</td>
<td>0.79</td>
</tr>
<tr>
<td>Concept B</td>
<td>0.47</td>
<td>3</td>
</tr>
<tr>
<td>Concept C</td>
<td>0.47</td>
<td>3</td>
</tr>
<tr>
<td>Concept D</td>
<td>0.47</td>
<td>3</td>
</tr>
<tr>
<td>Concept E</td>
<td>0.47</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organizational Difficulty</th>
<th>Absolute</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>93</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>131</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>97</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>93</td>
<td>15%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concept</th>
<th>Raw Score</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept A</td>
<td>135, 135</td>
<td>1920</td>
</tr>
<tr>
<td>Concept B</td>
<td>135, 135</td>
<td>1964</td>
</tr>
<tr>
<td>Concept C</td>
<td>135, 135</td>
<td>1732</td>
</tr>
<tr>
<td>Concept D</td>
<td>135, 135</td>
<td>1920</td>
</tr>
<tr>
<td>Concept E</td>
<td>135, 135</td>
<td>1920</td>
</tr>
</tbody>
</table>

Also helps to Build Consensus and Understanding of complex relationships as well as importance.
Requirements are Discovered Thru
The SW Safety Process
Eliciting Verification Methods

Similar to Requirements. Stakeholders are different. Methods are typically thru Analysis, Test, Inspection, Measurement.

- Use Interview
- Use Questionnaires
- Include Stakeholders Early and Often.
- Have Stakeholders Peer Review Requirements
- Use a JCCB
How and where do you store the requirements?

Word Documents are standard. Tools are useful and can Help. But try to get everyone to use them consistently!!!!!

- Access
- Excel
- DOORS
- RTM
- Requisite Pro
- RM Calibre
- etc.

*Use Document Templates Based On Standards. Also IM is Important for Efficiency.*
Establish Hierarchy and Naming Convention, Follow IEEE Standard
**Document Outline is Standard Throughout Project.**

- Using Mil-STD-490/961C standard template
- Standardized Documentation format makes it easier to find what you are looking for

<table>
<thead>
<tr>
<th>ID</th>
<th>MRAAS System Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYR37</td>
<td>1 SCOPE</td>
</tr>
<tr>
<td>SYR38</td>
<td>2 APPLICABLE DOCUMENTS</td>
</tr>
<tr>
<td>SYR39</td>
<td>2.1 Government Documents</td>
</tr>
<tr>
<td>SYR40</td>
<td>2.2 Non-Government Document</td>
</tr>
<tr>
<td>SYR41</td>
<td>3 REQUIREMENTS</td>
</tr>
<tr>
<td>SYR42</td>
<td>3.1 MRAAS System Definition</td>
</tr>
<tr>
<td>SYR43</td>
<td>3.2 Characteristics</td>
</tr>
<tr>
<td>SYR46</td>
<td>3.3 Design and Construction</td>
</tr>
<tr>
<td>SYR44</td>
<td>3.4 Documentation</td>
</tr>
<tr>
<td>SYR48</td>
<td>3.6 Logistics</td>
</tr>
<tr>
<td>SYR55</td>
<td>3.6 Personnel and Training</td>
</tr>
<tr>
<td>SYR71</td>
<td>3.7 Major Component Characteristics</td>
</tr>
<tr>
<td>SYR72</td>
<td>3.8 Precedence</td>
</tr>
<tr>
<td>SYR73</td>
<td>4 QUALITY ASSURANCE</td>
</tr>
<tr>
<td>SYR78</td>
<td>5 PREPARATION FOR DELIVERY N/A</td>
</tr>
<tr>
<td>SYR79</td>
<td>6 NOTES</td>
</tr>
<tr>
<td>SYR80</td>
<td>7 SCHEDULE</td>
</tr>
<tr>
<td>SYR81</td>
<td>8 TECHNOLOGIES TO INVESTIGATE</td>
</tr>
<tr>
<td>SYR82</td>
<td>9 This section intentionally left blank</td>
</tr>
<tr>
<td>SYR83</td>
<td>10 APPENDIX</td>
</tr>
</tbody>
</table>

Username: fsalvatore  Exclusive edit mode
Level 1 User Requirements

- This is where the User Requirements would be stored.
- Everyone on the project can read only few can change.
Level 2 System Requirements

- System Requirements and Verification Methods.
Level 3 Product Requirements

- Product Requirements and Verification Methods.
- IPT’s Manage and communicate changes to SEIT.
Level 4-6 Subassembly to Component Requirements

- IPT’s Own and work to requirements
- Designers communicate Changes and assess impact.
- Everyone works together to achieve a common goal.
Requirements Traceability

How do you understand how the requirements are being satisfied, are complete, are accurate, etc……

- Trace Matrices are Typical and require constant care and feeding to maintain.
- Use a tool to manage your requirements and capture traceability so you can search and query when doing impact analysis.
  - More accurate
  - More efficient
  - More complete

If a requirement isn’t traceable to anything it doesn’t belong!!!

No tool will automatically generate but they will preserve it once you do it the first time.

This is Important when performing Impact Analysis, doing FCA and PCA, etc….!!
Requirements Change Control

If a Requirement is changed, how do we determine effects on other Requirements, Verifications or Schedule Events?

- Use Inter-IPT Coordination
- Use Impact Analysis & Visualization Tools
- Use Formal Change Control Procedures
- Attributes

*With a tool you have better and more efficient ways of controlling the requirements.*
Follow a Change Proposal Process

**Step 1**
Perform Impact Analysis and collaborate with IPT Rep to create CP(s).

**Step 2**
Submit Change Proposal and/or Suggestions. Submit additional CPs for impacted objects.

**Step 3**
Review CPs and Suggestions for Submittal to CCB.

**Step 4 & 6**
Determine which CPs and Suggestions to review and assemble review package/CP list. Distribute actions.

**Step 5**
Conduct CCB Review & Disposition of CP and Suggestions

**Step 7**
Coordinate formal change actions to the requirements database.

START
Requirements Database

FINISH
Apply

Problem Detected

- Project Member
- IPT Rep
- Other IPT Reps
- CM
- CCB
- CM
- Accept
- Reject
- In-Review
- Hold
- START
Starting the Change Process

IPT Member brings an issue to attention of IPT Lead
IPT Lead makes an initial determination:
  PURSUE – Proposed change has merit and is worth further investigation
  DISCARD – Proposed change does not have merit or is not worth further investigation at this time

If you choose to PURSUE the potential change:
  1. Coordinate with other IPT's to discuss
  2. Initiate working group(s) as needed

COMMUNICATE !!!
Starting the Change Process

Still think a change is needed? Perform an “Impact Analysis”

Step 1: Perform Impact Analysis and collaborate with IPT Rep to create CP(s).

Step 2: Submit Change Proposal and/or Suggestions. Submit additional CPs for impacted objects.

Step 3: Review CPs and Suggestions for Submittal to CCB.

Step 4 & 6: Determine which CPs and Suggestions to review and assemble review package/CP List. Distribute actions.

Step 5: Conduct CCB Review & Disposition of CP and Suggestions

Step 7: Coordinate formal change actions to the requirements database.
Impact Analysis Complete… Submit a Change Proposal
Fill out appropriate fields in the ‘Proposed’ half of the Change proposal Form. Remember to address any affected attributes.

Make adjustments to the Reason for change as needed. BE SURE TO NOTATE ANY CONTRACTUAL IMPLICATIONS!!!

Select Very High, High, Medium or Low (refer to CPP Document for details)

When satisfied with form, press Submit to create the new Change proposal
When 5 or more actions need to occur (i.e., Change proposals) in order to fully satisfy a Change Proposal, a Change Suggestion should be created instead of a change proposal.

Fill out fields as needed and press **Submit** to create a new suggestion. The JCCB will approve and apply suggestions via the Change Proposal System.
Review CP’s and Suggestion

Step 1
Perform Impact Analysis and collaborate with IPT Rep to create CP(s).

Step 2
Submit Change Proposal and/or Suggestions. Submit additional CPs for impacted objects.

Step 3
Review CPs and Suggestions for Submittal to CCB. Hold.

Step 4 & 6
Determine which CPs and Suggestions to review and assemble review package/CP List. Distribute actions.

Step 5
Conduct CCB Review & Disposition of CP and Suggestions.

Step 7
Coordinate formal change actions to the requirements database.

START
Requirements Database

FINISH
Apply

Problem Detected

Other IPT Reps

IPT Rep

CM

CCB

Accept

Reject

Hold

In-Review

Review Package
Views can be built in an RM Tool to help in the review process.
Forms are another way of stepping thru changes and suggestions made by the IPT.
ID CP’s and Suggestions and Schedule JCCB

Step 1: Perform Impact Analysis and collaborate with IPT Rep to create CP(s).

Step 2: Submit Change Proposal and or Suggestions. Submit additional CPs for impacted objects.

Step 3: Review CPs and Suggestions for Submittal to CCB.

Step 4 & 6: Determine which CPs and Suggestions to review and assemble review package/CP list. Distribute actions.

Step 5: Conduct CCB Review & Disposition of CP and Suggestions.

Step 7: Coordinate formal change actions to the requirements database.

START

Requirements Database

FINISH

Apply

Accept

Problem Detected

Reject
Perform JCCB and Update dB with Results.

Approved (ready for implementation)
On-Hold (further investigation needed)
Rejected (requested change discarded)
Reaching Consensus

Use IPT forum to Elicit Requirements.

- Include Stakeholders Early and Often.
- Have Stakeholders Peer Review Requirements
- Document Rational. It will save you time latter when you will need to defend the requirements.
- Use a JCCB
- Try using QFD Method to Build Consensus
Use of DOORS has helped BUT!!

- Culture shock is hard to overcome.
- Revert back to WORD and EXCEL documents.
  - Not so efficient and may introduce errors.
- May need to hold hands
- Provide Training and Tailor it to the project.
- Need to pay close attention to Permission and database administration details.
- JCCB has forced communication to happen and has made it mandatory.
- Will need good IT support to reach remote locations when using a tool.
Requirements Metrics

Select metrics you will use. Don’t try to many or they won’t be managed. You can build them into an RM tool.

Some Examples Include:
- Volatility
- # Requirements
- # TBD
- # Verified

Using a tool will produce metrics naturally.
# Requirements Attributes

Attributes are additional defined characteristics of a requirement and they provide essential information in addition to requirement text.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Who specified this requirement?</td>
</tr>
<tr>
<td>Priority</td>
<td>What is the priority of this requirement?</td>
</tr>
<tr>
<td>Verifiability</td>
<td>Is the requirement verifiable?</td>
</tr>
<tr>
<td>Accepted</td>
<td>Has this requirement been accepted by the developers?</td>
</tr>
<tr>
<td>Review</td>
<td>Review status of this requirement</td>
</tr>
<tr>
<td>Safety</td>
<td>Is this a safety-critical requirement?</td>
</tr>
<tr>
<td>Comments</td>
<td>Any comments on the requirement to clarify its meaning</td>
</tr>
<tr>
<td>Questions</td>
<td>Any questions that must be clarified with the source</td>
</tr>
</tbody>
</table>

You can define attributes that will support your process and make your database more productive for you.
The use of an RM tool is an enabling technology to achieve greater accuracy and efficiency when engineering requirements.

There are definite skills and disciplines required to do requirements engineering.

Not only will One need to understand how to:
- Elicit Requirements
- Capture and Control Them
- Establish and maintain Traceability
- Reach Consensus
- Elicit Verification Methods
- Communicate Requirements
- Defined some Metrics and Attributes

They will also need to be proficient in using and tailoring an RM Tool.
Questions?