"Using Requirements Compliance Metrics to Identify Gaps Between the Technical Solution and Requirements"

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Outline

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- State of Practice
- Improving the State of Practice
- Benefits
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- Report on Progress and show data
- Summary
Background

Engineering projects that are completed on time and within budget most likely implement established “frozen” designs, e.g. roads, bridges, where there is limited opportunity to change requirements.

When building new and complex systems:

- Requirement changes are expected
- Requirement changes are common activities early in the lifecycle
- Material developers and stakeholders often “refine” the intended end-use of the system
**Background**

Metrics on cost, schedule, and performance do not account for discontinuities between the defined requirements (the intent) and the delivered technical solution.

The US Army Armament Research Development Engineering Center (ARDEC) has devised a measurement and reporting method based on Requirements Engineering best practices to identify these discontinuities and facilitate fact-based management decisions.
State of Practice
Metrics

Program / Project Managers (PMs) rely on various sets of metrics to:

- Get an objective assessment of the project / program (Cost, Schedule, Performance)
- Formulate corrective actions
- Adjust budgets, schedules, and resources

Program / Project sponsors, however, often measure program / project success or failure by met or missed:

- Schedule
- Budget, and
- Requirements
Best-practice Requirements Management (RM) requires measurement and collection of requirements metrics

- Process Metrics (i.e. Change Frequency)
- Requirements Metrics (i.e. # of Requirements allocated, approved, etc…)

Requirements Management Reports

- Traceability
- Priority
- Verification
- Compliance
### SYSTEM XYZ Requirements Compliance Matrix

<table>
<thead>
<tr>
<th>Section</th>
<th>Requirement #</th>
<th>Requirement Text</th>
<th>Compliance</th>
<th>Rationale, comments of how the requirement was met</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2.4 Mobility</td>
<td>3.2.4.6. Braking</td>
<td>The propulsion subsystem shall enable the system to decelerate from maximum speed to full stop at a rate of 5 m/s² with side drift not to exceed 2 m in 15 m on a dry, level, hard surface road.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2.4.7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2.4.8.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2.4.14.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2.4.19.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- Y - Yes, meets requirement
- N - No, does not meet requirement
- D - Deviation required
- W - Waiver required

These matrices generally report the gaps between *intent* and *end-state*. Additionally, there is no standard terminology or meaning.
Improving the State of Practice

In our approach we take Requirements Compliance a step further by tracking progress in meeting the intent.

• This approach provides a common language between management and developers.
Benefits

PM visibility into implementation status

- A matrix will be maintained for each (sub)system, which will allow for metrics and reports to be generated against the system requirements. This will serve as a tool the PM can use to assess the current compliance of each (sub)system.

Facilitate communication between stakeholders

- The use of this approach will improve visibility into progress toward meeting program goals.
- Discrepancies can be discussed, clarified, resolved, documented and archived.

Help with Requirements Prioritization

- Can track incremental development with improved accuracy and identify issues with development progress sooner.
Implementation

Requirements Compliance Model defined
- The model is based on the DoD’s Systems Engineering “V” approach to Systems / material development.
- The model will serve as the language that converts engineering phases to a compliance percentage.

Requirements Compliance Tool developed
- A matrix has been constructed within DOORS which allows the following:
  - Direct linking to system/component specifications.
  - Ability to run reports to collect metrics on compliance.
  - Can export to Excel or other formats with ease.

Scripts constructed to run against DOORS Module
- This helps automate the process of measuring compliance.
Requirements Compliance Tool

Assess Compliance

Script Automatically Generates Metrics

Automatic Reporting

Assess Compliance

Capture Metrics

Report Results
**Compliance Concept**

Requirements Progress/Compliance
- Acceptance of Requirements (Dispositioned)
- Requirement Progression (Life Cycle)

Metrics can be used to compare progress & compliance to planned activities and can be sorted by increment, build, priority, capability etc.
Disposition Progress

100 Requirements

- 80 Accepted
  OR
  Accepted with Change

- 5 Review Results (Accepted):
  - Waiver
  - Not Applicable
  - Reallocation

  100%

- 5 Pending Review:
  - Waiver
  - Not Applicable
  - Change
  - Reallocation

  0%

- 5 Review results (Denied):
  - Waiver
  - Not Applicable
  - Change
  - Reallocation

  0%

- 5 Indiscernible

  0%

Percentage not Assigned to Accepted Requirements
This is deferred to life cycle compliance scoring.

Establishes basis for measuring the progress made towards accepting the requirements.
Shows the project moving towards full acceptance/allocation of the requirements.
Once Requirements have been accepted we track their progress thru the development life cycle.

Credit is given when a requirement has finished each phase of the Life Cycle.
100 Requirements

- 80 Accepted
  - OR
  - Accepted with Change

  5 Review Results (Accepted):
  - Waiver
  - Not Applicable
  - Reallocation

  5 Pending Review:
  - Waiver
  - Not Applicable
  - Change
  - Reallocation

  5 Review results (Denied):
  - Waiver
  - Not Applicable
  - Change
  - Reallocation

  5 Indiscernible

- 10 Fielded 100%
- 25% Verified & Validated
- 65% Integrated
- 50% Implemented
- 15% Req. Analysis Complete
- 5% Planned

Current Progress/Compliance: 18.5%
Requirements Compliance Score: 100%

Life Cycle Progress
(Example Over Time)

Shows the project moving towards full fielding of the accepted requirements.
### Acceptance of Requirements

#### (Sample output)

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted</td>
<td>140</td>
</tr>
<tr>
<td>Accepted with Change</td>
<td>128</td>
</tr>
<tr>
<td>Pending N/A Review</td>
<td>1</td>
</tr>
<tr>
<td>Pending Change Review</td>
<td>31</td>
</tr>
<tr>
<td>Not Applicable</td>
<td>6</td>
</tr>
<tr>
<td>Not Allocated</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total Requirements (inc 1-3)</strong></td>
<td><strong>313</strong></td>
</tr>
</tbody>
</table>

- Discovered a program that claimed almost full acceptance, but was actually changing over 50% of the requirements
- Discovered 32 requirements whose disposition had not yet been fully reviewed
- Discovered 7 High Level Requirements that were not allocated
- Documented 43 requirements that still had not been dispositioned although they were allocated
- Discovered 16 problem requirements that developers were having trouble understanding
- Discovered 5 High Level Requirements that were not allocated
Acceptance of Requirements

System 1 - 14% of Hi Level Requirements are not “Accepted”

System 2 - 20% of Hi Level Requirements are not “Accepted”
Summary

Benefits observed are positive proof that there needs to be a well understood approach to reporting requirements.

Gaps already found and reported to Customer.

Just starting to roll out Life Cycle progression.