Making Use of a Decade of Widely Varying Historical Data

SARP project
“Full Life-cycle Defect Management”

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Problem we are addressing

- We are in the second year of our initiative and studying
  - Parameters that affect the results of inspection
  - The relation between V&V effectiveness in early lifecycle (e.g., inspection) and late (testing)

- We are using this information to provide feedback and decision support to NASA projects, on questions such as:
  - Can I get guidance on how to plan my inspections based on results from projects like my own?
  - Based on my inspection results, what are the implications for the effort required to be spent on other non-optional activities, like system testing?
Our approach

Literature Recommendations
Historical Baseline Models
Current Model Formulation

Inputs from:
- GSFC
- GRC
- J PL
- J SC
- MSFC

More to come...

Outputs:
- Automated feedback
- What if Analysis
- Experience Bases
- Trends
- …

Users:
- Projects
- SEPG
- Inspection Planners
- Researchers
First year results

- **Collected** more than 2,529 inspection records in our database
  - Evaluated old classification schema
  - Developed *new classification* based on existing standards and the collected data
  - Mapped data into new classification schema

- **Developed** prototype tool to support planning and reporting
  - Incorporated latest *analyses and models* based on the data
  - Designed capabilities for accepting data from various forms (e.g., JPL forms) as well as various databases
  - Gained *feedback* on usability and possible enhancements

- **Created** central inspection experience base
  - Provides materials necessary for applying inspections in various contexts: e.g., defect type definitions, mapping to various taxonomies, checklists, forms, …
Unifying different defect classifications

- **Motivation:** Valuable defect data has been collected over the years across many Centers and projects

- **Issue:** Different defect classifications used in historic and contemporary data sets, as well as across and within Centers

- **Action:** Define a unified defect classification schema along with a mapping to existing data sets

- **Benefits:**
  - Leverages data required by NPR 7150.2 for analysis and feedback to teams
  - Enables monitoring and validation of existing guidelines
  - Unified classification schema is applicable to inspections and testing
## Mapping the different data sets

<table>
<thead>
<tr>
<th>historic data sets</th>
<th>actions</th>
<th>contemporary data</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B Y Z</td>
<td>Select candidate defect categorization scheme (e.g., ODC)</td>
<td>ODC A7</td>
</tr>
<tr>
<td>A' B' W Y' Z</td>
<td>Analyze historical categories; (e.g., keep A &amp; Z; combine Y&amp;Y'; exclude C; partition all others)</td>
<td></td>
</tr>
<tr>
<td>A C W Y Z</td>
<td>Define initial new categorization schema (i.e., mix of historic and common categorization schema)</td>
<td>initial ODC-based new schema</td>
</tr>
<tr>
<td>A B Y Z</td>
<td>Map historical data to new categorization, for categories that exist in both.</td>
<td>initial ODC-based new schema</td>
</tr>
<tr>
<td>A B' W Y' Z</td>
<td>Partition remaining historical data set categories; refine new schema if needed</td>
<td>ODC-based new schema</td>
</tr>
</tbody>
</table>

Review new categorization and mapping
Mapping algorithm

begin
Select new categorization schema S (e.g., ODC)

end
Remove X from historical datasets

Any historical datasets left?

Choose historical dataset X

Any defect categories left in X?

Add C_X to S, along with all its defects.

Use the assignment algorithm to distribute defects in C_X

Assign all historical defects in C_X into this category

Assign all historical defects in C_X into this category

Can all defects in C_X be included under multiple (existing) categories in S?

Can all defects in C_X be included under any single existing category in S?

Is C_X already in S? (under another name)?

Remove category C_X

Choose defect category C_X

Is CX already in S? (under another name)?

yes

yes

yes

no

no

no

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Updating existing inspection guidelines

**Motivation:** NASA guidelines for effective inspections (e.g., 3 points of control) were formulated in early 1990’s

**Issue:** Development procedures (e.g., standards, languages, etc.) have changed over time; → New factors must be considered

**Action:**
- Validate guidelines based on a wider set of recent data;
- Refine the guidelines if needed (e.g., by adding more variables, tailoring to different domains, etc.)
- Integrate them into an inspection support tool and training courses

**Benefits:** Refined guidelines will increase **effectiveness** of inspections and provide better user guidance
User guidance based on heuristics

- Optimum
- Problematic
- Border line
- Acceptable

Defines

Problematic
Border line
Acceptable
Border line
Problematic
Example: Comparison of team size

Target team size: optimal is 4 to 6; borderline is 3 or 7
Comparing test and inspection data

- **Motivation**: Better knowledge of inspection’s strengths & weaknesses could be used to better allocate resources among V&V activities.
- **Issue**: Defects that slip through inspections aren’t found until much later; different defect type descriptors mean they often are hard to compare.
- **Action**: Compare test and inspection defect profiles (on the same projects or within the same domain)
- **Benefits**: Past knowledge about recurring defect types can be used to select the right overall strategy for optimal V&V planning

**Research Questions:**
- What defects types are typically removed by inspections vs. testing?
- What project characteristics (size, language, software domain, new development/enhancements) influence the types of defects found?
- What percent of logic errors can be expected to be removed by inspections?
- Can test results be used for post-mortem analysis of inspection performance?
Overview: Inspections vs. testing

Percent of Defects

Logic
Internal interface
Assignment/Initialization
External interface
Data value or structure
Algorithm/method

Proj A  Proj B  Proj C  Proj D  Proj E  Proj F  Proj G  Proj H

INSPECT  TEST  INSPECT  TEST  INSPECT  TEST  INSPECT  TEST  INSPECT  TEST  INSPECT  TEST  INSPECT  TEST  INSPECT  TEST
Initial results: Across projects

**Research Question:** What defect types are typically removed by inspections vs. testing? In this domain:

- Overall the defect removal profile seems similar, but
- Inspections found on average 64% of the total system defects
Initial results: Within a project

**Research Question:** What defect types are typically removed by inspections vs. testing? Specifically, for a maintenance project:

→ Many more internal interface defects were found by inspections
Improving tool support

- **Motivation:** Data and resources from across NASA, that use different taxonomies, cannot easily be leveraged without centralized tool support.

- **Issue:** Need to do mappings and analysis without requiring extra steps from the user, and to seamlessly integrate the results.

- **Action:**
  - Centralize existing materials and resources → Experience Base;
  - Integrate Experience Base and results data into a combined dashboard

- **Benefits:** Integrating real-time feedback into normal engineering activities, for:
  - The planning of inspections,
  - Collection of data,
  - Analysis and building of up-to-date baselines,
  - Feedback and improvement.
Providing an inspection experience base

http://fc-md.umd.edu/EB/

<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
<th>Category</th>
<th>Subcategory</th>
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<tr>
<td>Open Design-based Reading</td>
<td>Perspective-based scenarios tailored for a team at GSFC in 1994 by Dr. Vic Bassi et al.</td>
<td>Checklists</td>
<td>Requirements</td>
<td>9/27/2007 PDF</td>
<td>PDF</td>
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<tr>
<td>R1 - Software Requirements Checklist</td>
<td>Software requirements, developed and used by JPL.</td>
<td>Checklists</td>
<td>Requirements</td>
<td>9/27/2007 PDF</td>
<td>PDF</td>
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<td>Requirements defects</td>
<td>A defect classification for requirements documents</td>
<td>Defect classifications</td>
<td>Requirements</td>
<td>9/25/2007 PDF</td>
<td>PDF</td>
</tr>
<tr>
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<td>Subsystem-level, developed and used by JPL.</td>
<td>Checklists</td>
<td>Requirements</td>
<td>9/27/2007 PDF</td>
<td>PDF</td>
</tr>
<tr>
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<td>Checklists</td>
<td>Requirements</td>
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<td>Test-Based Reading Technique</td>
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Improving tool support for inspections

- file import capability
- built-in experience base access
- reporting and evaluation capabilities

Dashboard Tool 0.9.0

Characteristics

- Data Source
  - Optional

Checklists

- Used

Results

- Meeting Date: 6/15/2008
- Completion Date: 6/20/2008
- Participants: 7
- Document Size: 5763

Save
Future work

- Refine the test and inspection data comparison
  - Obtain additional data sets for testing and refining our preliminary conclusions
  - Integrate test results into inspection tool

- Initial deployment of tool
  - Obtain additional feedback on usability and future deployment
  - Pursue expansion of the Experience Base with testing-related materials
    - a centralized site for V&V resources

- Integrating with other existing inspection data forms and tool support
  - Especially eRoom-based tool available through Kevin Carmichael / GRC
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