ODC and CMMI: 
Introducing the Root-Cause Analysis and Orthogonal Defect Classification at Lower Maturity Levels

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MENSURA 2006
1st Int. Conference on Software Process and Product Improvement
6-8 November 2006, Cadiz (Spain)
Agenda

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  - Process Improvement and Possible Models

- **Support Processes in the CMMI**
  - Which Processes?
    - The List
    - Single or Double Role?

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  - The Process
  - The Tools
  - Related Work

- **Quantitative CAR as a foundation for higher MLs**
  - From RCA to ODC – Related Work
  - ODC: Strengths & Limitations
  - Generalizing and Customizing ODC

- **Conclusions & Prospects**
  - Suggestions and Possible Advantages
Introduction

Process Improvement and possible models

• Process Improvement can be “measured” against several schemas, there is no a model absolutely better than others. Two of the most used ones are:
  ✓ ISO 9001:2000 (applicable to every domain, general requirements)
  ✓ CMMI (typical for Software & Systems Engineering domain)

• Approx. the ML equivalence CMMI-ISO 9001:2000 companies is between CMMI Levels 2 and 3
  ✓ 1994 Mark Paulk’s paper
  ✓ Mutafeljia & Stromberg mapping with coverage evaluations

• A greater attention is usually paid to “Engineering” and “Project” Processes, not to “Support” ones
  ✓ Goal: achieving and consolidating faster ML2 and building foundation for higher MLs
  ✓ Question: how to do it?
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Support Processes in the CMMI

Processes: the list

- CMMI classifies 5 processes in the “Support” group:

<table>
<thead>
<tr>
<th>ML</th>
<th>PA</th>
<th>Title</th>
<th>PA Purpose</th>
<th>Related GP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML2</td>
<td>CM</td>
<td>Configuration Mgmt</td>
<td>establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits</td>
<td>GP2.6</td>
</tr>
<tr>
<td>ML2</td>
<td>PPQA</td>
<td>Process &amp; Product Quality Assurance</td>
<td>provide staff and management with objective insight into processes and associated work products</td>
<td>GP2.9</td>
</tr>
<tr>
<td>ML2</td>
<td>MA</td>
<td>Measurement &amp; Analysis</td>
<td>develop and sustain a measurement capability that is used to support management information needs</td>
<td>GP2.8</td>
</tr>
<tr>
<td>ML3</td>
<td>DAR</td>
<td>Decision Analysis &amp; Resolution</td>
<td>analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria</td>
<td>N.A.</td>
</tr>
<tr>
<td>ML5</td>
<td>CAR</td>
<td>Causal Analysis &amp; Resolution</td>
<td>identify causes of defects and other problems and take action to prevent them from occurring in the future</td>
<td>GP5.2</td>
</tr>
</tbody>
</table>
Support Processes in the CMMI

Single or Dual Role? (1/2)

• ML2 Support processes play in CMMI a “dual role”:
  ✓ as process area (PA) and as general practice (GP), as in the previous table

• This “dual role” helps organizations in building foundations for better improvements and making faster the achievement of higher MLs
  ✓ I.e. a good Measurement & Analysis (MA) implementation has positive impacts both on PAs (PMC, PPQA) and GPs (3.2-Collect Improvement Information and 4.2-Stabilize Subprocess Performance) ratings
Support Processes in the CMMI

Single or Dual Role (2/2)

• Because ISO 9001:2000 requires Root-Cause Analysis (RCA) for achieving the certification and it should be equivalent to CMMI ML2-3, an anticipated attention should be paid to Root-Cause Analysis (RCA), and its related CMMI process area (CAR - Causal Analysis & Relationship).

• Some questions to answer:
  ✓ Q₁: Why CAR was placed at ML5 in the Staged Representation and not before? Is it really put in place mainly by high-level maturity companies?

  ✓ Q₂: RCA and Measurement: is it possible to use RCA in a more quantitative manner? RCA is typically a TQM qualitative tool and ODC (Orthogonal Defect Classification), even if opens to a quantitative RCA, has some drawbacks. Which effects on Measurement abilities, outcomes and outputs?

  ✓ Q₃: Are there some possible suggestions also for improving CMMI architecture about this issue? Which effects if CAR would be referred not only to GP5.2 but also as a GP2.x?
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CAR - Causal Analysis & Resolution

State-of-the-art: the process

- **CAR** is a ML5 process, with two Specific Goals (SG) and five Specific Practices (SP):

<table>
<thead>
<tr>
<th>SG1.</th>
<th>Determine cause of defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1.1</td>
<td>Select Defect Data for Analysis</td>
</tr>
<tr>
<td>SP1.2</td>
<td>Analyze Causes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SG2.</th>
<th>Address cause of defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP2.1</td>
<td>Implement the Action proposals</td>
</tr>
<tr>
<td>SP2.2</td>
<td>Evaluate the Effect of Changes</td>
</tr>
<tr>
<td>SP2.3</td>
<td>Record Data</td>
</tr>
</tbody>
</table>
CAR - Causal Analysis & Resolution
State-of-the-art: the tools

- **SP1.2 #2** (Analyze selected defects and other problems to determine their root causes)
  - Cause-and-effect (fishbone) diagrams

CAR - Causal Analysis & Resolution

Related Works

✓Q₁: Why CAR was placed at ML5 in the Staged Representation and not before? Is it really put in place mainly by high-level maturity companies?

• It has been a “strong” assumption, evolving the “Defect Prevention” KPA from the old Sw-CMM
• Few suggestions in the technical literature were about moving RCA (and CAR) from a qualitative towards a quantitative approach, anticipating its usage to lower MLs
  • Williams (2002) mapped the CAR SGs against the Juran’s 10 points, suggested an intensive usage of qualitative and quantitative TQM tools for each CAR SP
    ➢ Open point: no suggestions about the “how to” on each tool listed in point #4 (Identify root causes)
  • Norausky (2003) proposed a “distributed usage” of CAR across the five MLs, using an “hybrid implementation approach” of CAR also for companies adopting the staged representation
    ➢ Open point: no detailed suggestions for each ML, only high-level CAR Measurement suggested usage, in particular about the metrics traceability to business drivers at ML1

✓A₁: Use CAR at lower MLs, and applying it in a quantitative manner
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Quantitative CAR
From RCA to ODC - Related Work

✓ Q₂: RCA and Measurement: is it possible to use RCA in a more quantitative manner? RCA is typically a TQM qualitative tool and ODC, even if opens to a quantitative RCA, has some drawbacks. Which effects on Measurement abilities, outcomes and outputs?

- Orthogonal Defect Classification (ODC) was probably the most known technique derived for the Software Engineering domain from RCA
- ODC is a technique proposed by Chillarege et al. in 1992 introducing a standard taxonomy of causes with quantitative elements, moving RCA from a qualitative to a quantitative view.
- Two main attributes:
  - **defect types** → needed in order to classify the kind of defect detected. There are 8 types initially foreseen to be associated to the related SLC phase: function, interface, checking, assignment, timing/serialization, build/package/merge, documentation, algorithm.
  - **defect triggers** → defined as the condition that allows a defect to surface, helps in the verification process to understand where the defect has been originated
Quantitative CAR
ODC: Strengths & Limitations

• **Strengths:**
  √ Evolution of RCA from a qualitative to a quantitative approach
  √ Standard taxonomy (types; triggers) adopted → it allows comparability during time and across companies
  √ It helps in gathering defect data during time for statistical analysis and - more in general - to reduce resistance for measurement

• **Limitations:**
  √ ODC is only about Software Defect Management, where “Defects” typically refers to code defects
  √ Typically adopted by organizations with a robust measurement system → its introduction can be limited in organizations with low Maturity Levels (ML), because its possible remote payback period
  √ Updating of types and triggers does not allow a backward comparability
Quantitative CAR
Generalizing and Customizing ODC (1/2)

✓ A_2: Keep ODC principles and customize it to each implemented PA

- Derive measures with GQM-GQ(I)M each low-level leaf/bone in a Fishbone diagram using our own causes groups and adopt this tool whatever its ML

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MENSURA 2006 – Cadiz (Spain)
Nov 6-8, 2006

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Quantitative CAR
Generalizing and Customizing ODC (2/2)

• **Practical Guidance:**
  - ✓ Build your own *types & triggers* for each implemented PA to be refined during time (effects to analyze could be the not (fully) achievement of PAs Specific Goals) → this will allow to reach your own standard taxonomy (even if you could start using standard classifications as 4Ms or 4Ps (People, Process, Procedure, Plans)
  - ✓ Link measures detected from RCA to their related processes, as a standard element

• **Possible Outcomes:**
  - ✓ Facilitate the adoption of (new) measures effectively needed for removing defects and related causes → it helps to re-think which are the core measures for the organization and their total cost as a *process* and not as an *activity*
  - ✓ Facilitate the data collection process in the organization, as a foundation for statistical analysis (typically run at ML4)
  - ✓ Reduce the CONQ in the M/L term and increase the CONQ/COQ ratio
  - ✓ Facilitate the proper implementation of other PAs (i.e. PMC, PPQA) and GPs (GP2.8; GP3.2; GP4.2) by more skilled resources
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Conclusions & Prospects

Main issues discussed

• Root-Cause Analysis (RCA) is a fundamental tool for process improvement
  ✓ Often used in a qualitative manner, it represents the basic for taking corrective and/or preventive actions

• ODC (Orthogonal Defect Classification) is a quantitative interpretation of RCA, but limited in scope to Defect Management with a standard taxonomy of defect *types* and *triggers*
  ✓ It allows an external comparability (benchmarking), but not helps organizations at lower MLs in starting a data defect collection (note: defect to be meant not as a “code” defect)

• Extending and generalizing the ODC message
  ✓ It allows to overcome intrinsic ODC limitations
  ✓ Build specific *types & triggers for each PA*
  ✓ Link measures to the organization and project plans, spreading quantitative RCA to all ML levels and across the organization
Conclusions & Prospects
Suggestions and Possible Advantages for CMMI architecture

✓ Q₃: Are there some possible suggestions also for improving CMMI architecture about this issue? Which effects if CAR would be referred not only to GP5.2 but also as a GP2.x?

• Suggestions:
  ✓ Introduce CAR process area at ML2, as a Basic (rather than Advanced) Support Processes
  ✓ Add a direct reference to CAR also in GP2.9, jointly with PPQA

• Possible Advantages:
  ✓ Help people in advancing faster in their DAR ability, as mandatory in ISO 9001:2000 (§8.4)
  ✓ RCA would be recognized more and more as a basic Process Improvement principle, yet introduced from lower ML as a foundation for achieving higher ML
  ✓ Corroborate the proper implementation of other PAs (i.e. PMC, PPQA) and GP (GP2.8; GP3.2; GP4.2) by more skilled resources

✓ A₃: Have a comprehensive approach to improvement and build your path having in mind all mappings among the PI models of interest at the same time
Thank you!

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