ÉCOLE DE TECHNOLOGIE SUPÉRIEURE – MONTRÉAL - CANADA

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

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Agenda

- **Introduction**
  - ✓ Process Improvement and Possible Models
- **Support Processes in the CMMI**
  - ✓ Which Processes?
    - ✓ The List
    - ✓ Single or Double Role?
- **CAR: state-of-the-art**
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  - ✓ 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:

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

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:
  - ✓ Q_1: 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?
  - ✓ Q_2: 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?
  - ✓ Q_3: 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

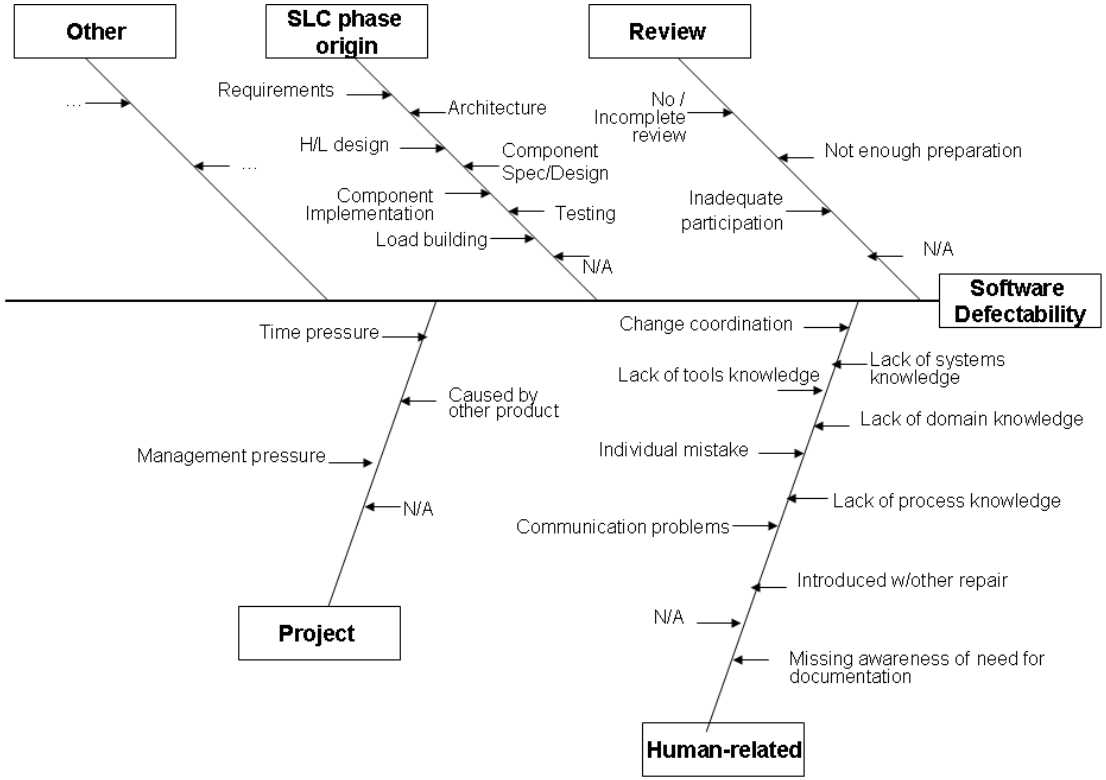
- **CAR** is a ML5 process, with two Specific Goals (SG) and five Specific Practices (SP):

SG1.	**Determine cause of defects**
	SP1.1 - Select Defect Data for Analysis
	SP1.2 – Analyze Causes
SG2.	**Address cause of defects**
	SP2.1 – Implement the Action proposals
	SP2.2 – Evaluate the Effect of Changes
	SP2.3 - Record Data

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



Elaboration from: Leszak M., Perry D.E. & Stoll D., *A Case Study in Root Cause Defect Analysis*, Proceedings of the 22nd International Conference on Software Engineering (ICSE 2000), Limerick (Ireland), June 4-11 2000, ISBN 1581132069, pp.428-437

CAR – Causal Analysis & Resolution

Related Works

✓**Q_1**: 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

✓**A_1**: Use CAR at lower MLs, and applying it in a quantitative manner

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Quantitative CAR

From RCA to ODC - Related Work

✓Q_2: 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

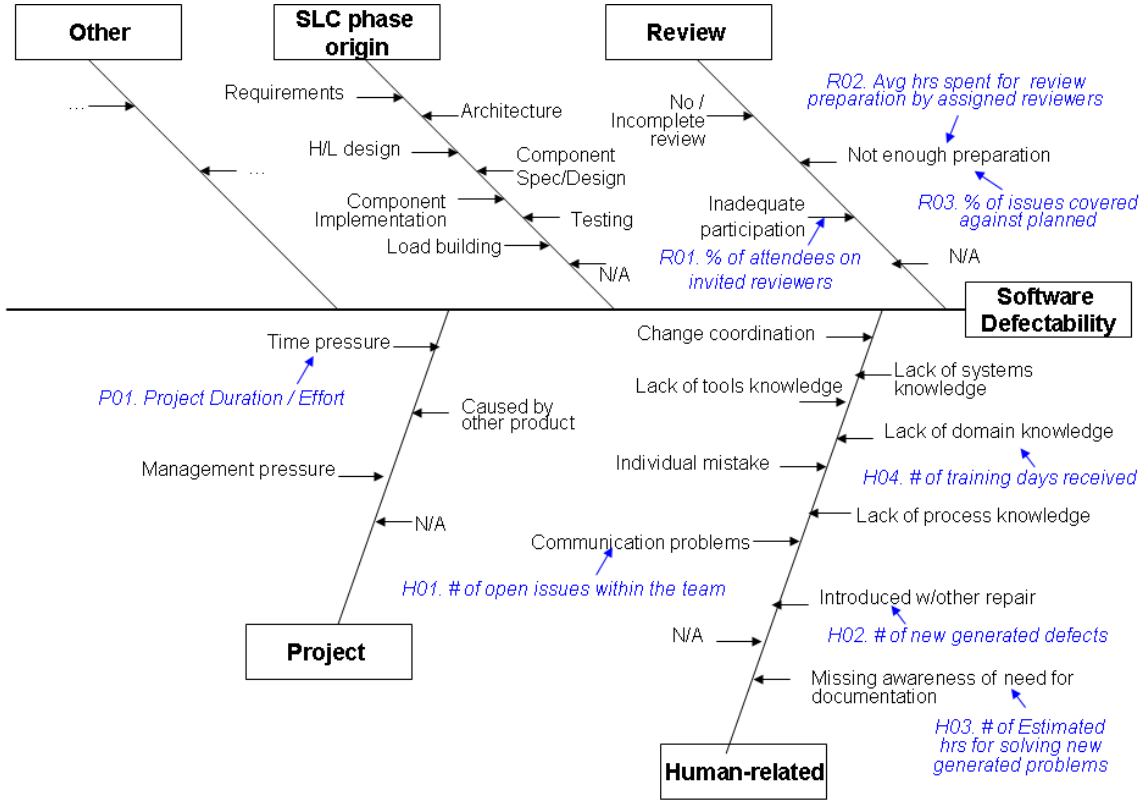
- **Strengths**:
  - ✓ Evolution of RCA from a qualitative to a quantitative approach
  - ✓ Standard taxonomy (types; triggers) adopted → it allows comparability during time and across companies
  - ✓ It helps in gathering defect data during time for statistical analysis and - more in general – to reduce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



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

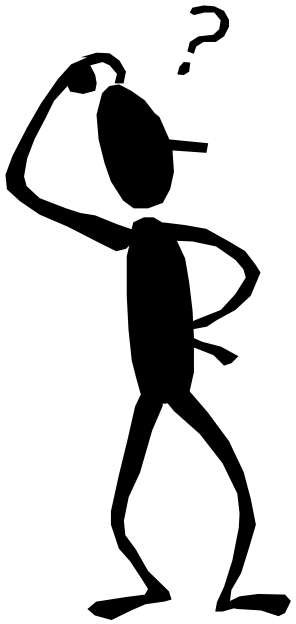
Suggestions and Possible Advantages for CMMI architecture

✓ **Q_3**: 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

✓**A_3**: 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

Q & A



Thank you!

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