COSMIC AND QUALITY OF REQUIREMENTS

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Agenda

- Quality of requirements
- The COSMIC method overview
- Defect detection experiments
- Requirement defects vs. Functional size
- Discussion
QUALITY OF REQUIREMENTS

Why and how it influences software project performance indicators
Frequent project performance indicators

Schedule

Budget

Unit cost or productivity

Scope

Quality

Functional size of the scope can be measured!
Typical requirements defects

- Incomplete
- Ambiguous
- Inconsistent
- Inadequate
- Wrong
- Irrelevant
- Misplaced
- Etc.
Why the requirements’ quality is important → effect of defects

- Requirements usage:
  - Estimating → underestimation
  - Scoping → partial or wrong software product
  - Reporting → wrong accomplishment data
  - Agreement with the client → dissatisfaction
Identifying requirements defects

- Peer reviews, including inspections
- Formal requirements reviews
- Simulations
- Proof of concept
- Modelling
- Etc.
Example of an inspection method

- Adapted by CRIM from Gilb & Graham (1993)

1. Plan the inspection
   [Document ready for inspection]

2. Open the inspection
   [Commitment obtained from participants]

3. Inspect the product
   [Defects found]

4. Explain issues (logging meeting)
   [Defects understood by author]

5. Update the inspected product
   [Defects corrected]

6. Re-check with issues
   [No new defect introduced]

7. Close the inspection
   [Defects corrected and inspection data collected]
The COSMIC Method Overview

Why and how it measures the software functional size
Why do we measure the software size of projects?

Four typical needs:
1. Process productivity
2. Estimation
3. Benchmarking
4. Governance

- Need for objectivity, repeatability, and reproducibility
- How to measure software size independently from technology?

Solution:
Measure functional size with the ISO 19761 standard
Productivity of software projects

- Strong correlation between:

- Unit cost = Effort / Size $\rightarrow$ hours/size-unit
- Productivity = Size / Effort $\rightarrow$ size-unit/person-month
- Delivery rate = Size / Time $\rightarrow$ size-unit/month
ISO/IEC standards related to functional size measurement

**Functional size measurement standard framework**
- 14143-1: Definition of concepts
- 14143-2: Conformity evaluation to 14143-1
- 14143-3: Verification of methods
- 14143-4: Reference model
- 14143-5: Determination of functional domains
- 14143-6: Guide for use of 14143

**Measurement process**
- 15939: Software engineering measurement process

**Functional size measurement methods**
- COSMIC
- IFPUG 4.1
- NESMA
- Mark II
- FiSMA

**Legend:**
- 1st generation
- 2nd generation

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COSMIC Overview

Functional users

Input/Output hardware

Entry (E)

Software to measure

Functional process 1

Functional process 2

Functional process n

Storage hardware

Read (R)

Write (W)

Data

‘Front end’

‘Back end’

Users or

or

Entry (E)

eXit (X)

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Comparative study to assess the efficiency and effectiveness of peer reviews and COSMIC as a means to identify defects in software requirements.
Research goal

- Contribute to improve the quality of functional software requirements by assessing efficiency and effectiveness of the COSMIC method as a means to identify defects and then compare the results with a peer review approach.
Peer reviews derived measures

- Effectiveness (unit cost) = \( \frac{\text{Effort}}{\text{# defects found}} \) (minutes/defect)

- Efficiency (%) = \( \frac{\# \text{ defects found}}{\text{Total # of defects}} \)

- Only consider Critical, Major and Minor defects
  - Drop spelling & syntax errors and other issues (improvement suggestions & questions)

Source: (Weigers 2002)
Experiment protocol overview

1. Prepare experiments

2. Train participants on inspection approach (peer review)

3. Apply peer review

4. Measure functional size

5. Compile data

6. Review data with participants or inspection leader

7. Analyse data

Participants

Inspectors

Measurers

- Defects & other issues
- Effort

- Functional size
- Defects & other issues
- Effort

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Prepare experiments: select material and methods

uObserve SRS

Inspection method from CRIM (adapted from Gilb & Graham)

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   [Document ready for inspection]
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The COSMIC Method

User and uSpy client workstation

Camera with microphone

Audio/video

Event log

User

uSpy server

Data Storage

FPs

E

R

F.U.

W

X

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The uObserve SRS

1. Peer reviewed
2. Defects fixed
3. Software developed successfully
4. SRS reviewed by industry expert
5. Defects fixed

- 2200 words
- 10 use cases
- Event-based system
- 2 software boundaries
- Compliant w/ UML 2.0
- Compliant w/ IEEE Std
1st phase of experiments

Research objectives

1) Determine **effectiveness** (unit cost), when allotted **limited effort** as applied in the industry

2) Determine **efficiency**

3) Determine whether it is advantageous to include a measurer role in a peer review team

Phase 1: Compare efficiency and effectiveness (unit cost) of COSMIC and an inspection approach

- Expert practitioners experiment
- Practitioners with limited experience experiments

17 Inspectors
18 Measurers
35 participants!

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Defects & other issues: Raw Data

- 426 Defects
- 153 Duplicates
- 30 Rejected
- 58 Non Functional defects
- 31 Spelling or syntax defects

154 Unique functional defects, major & minor

= 100% To compute efficiency
Defect analysis

- Inspectors and measurers find defects of different nature
- Measurers find more defects of a higher severity than inspectors
- Defects affecting functional size:
  - Ambiguous functional descriptions
  - Missing functional processes
  - Missing error handling
  - Ambiguous data groups
  - Ambiguities due to multiple occurrences
What if …
a measurer replaces an inspector

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average efficiency with 2 to 4 inspectors = 19.2%</td>
<td>Average effectiveness with 2 to 4 inspectors = 49.6 min/defect</td>
</tr>
<tr>
<td>Adding an inspector = 23.6%</td>
<td>Adding an inspector = 32.4 min/defect</td>
</tr>
<tr>
<td>Adding a measurer = 22.4% (↓1.2%)</td>
<td>Adding a measurer = 28.0 min/defect</td>
</tr>
</tbody>
</table>

→ But: measurers find higher severity defects!

→ Plus: you get the size measured!
Exploring the consequences experimentally
2nd phase of experiments

Research objective

4) Determine the influence of defects on functional size

Defects from previous experimental sessions

uObserve SRS v1.0 (10 UCs)

Prepare next phase experimental material

Update uObserve SRS from v1.0 to v2.0

uObserve SRS v2.0 (15 UCs)

Phase 2: Determine the influence of defects on functional size

Expert measurers experimental session

Measurers with limited experience experimental session

5 expert measurers

5 measurers with limited experience

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Functional size: comparing results

Size increase of 36.6%

All differences explained with measurement assumptions

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**Data analysis summary**

**Objective:** Determine the influence of defects on functional size

- Defects in requirements influence the functional size: Up to 39%
- Important decrease of new defects identified: -86%
  - However, some measurers said they would have found more defects if they had more time
- All differences among individual results were explained through 20 written measurement:
  - Level of decomposition
  - Identified boundaries
  - Identified functional users
  - Identified functional processes
  - Absence of a data model
Discussion

And future work
Discussion

- Exploration of the value-added of having a measurer as part of an inspection team
- Relation between requirements defects and functional size
- Practical new usage of the COSMIC method
- Shifting of the measurement cost from management cost (indirect) to software engineering cost (direct)
Future work

- Process residual defects into uObserve SRS v3.0
  - Include a verified measurement case study