Exploring the Presence of Technical Debt in Industrial GUI-based Testware: A Case Study

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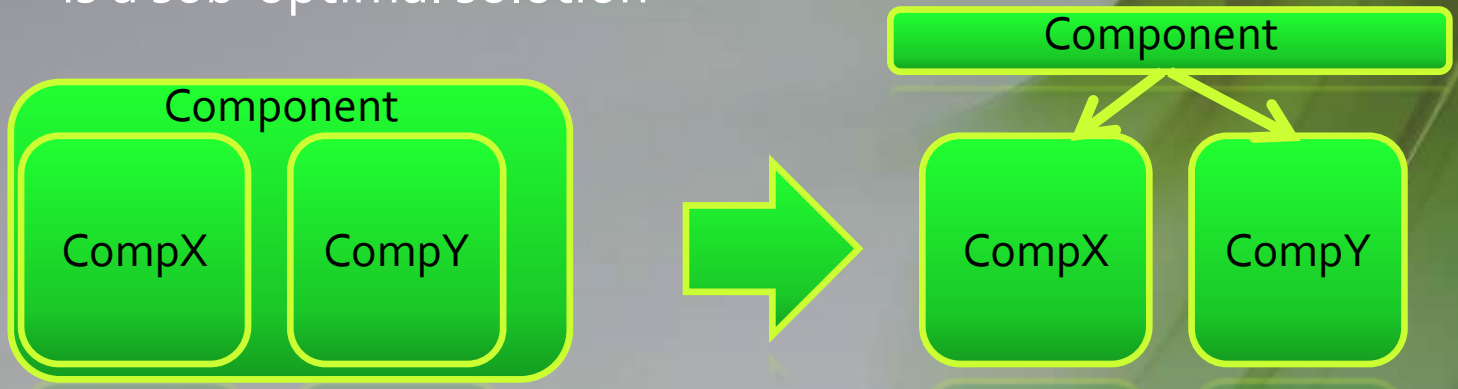
What is Technical Debt?

- Technical debt (TD) is a concept that describes the increased cost of development and maintenance of a system given that it is a sub-optimal solution



- TD implies that software can be developed in an optimal way, e.g. optimized for:
  - Maintainability
  - Reusability
  - Etc.

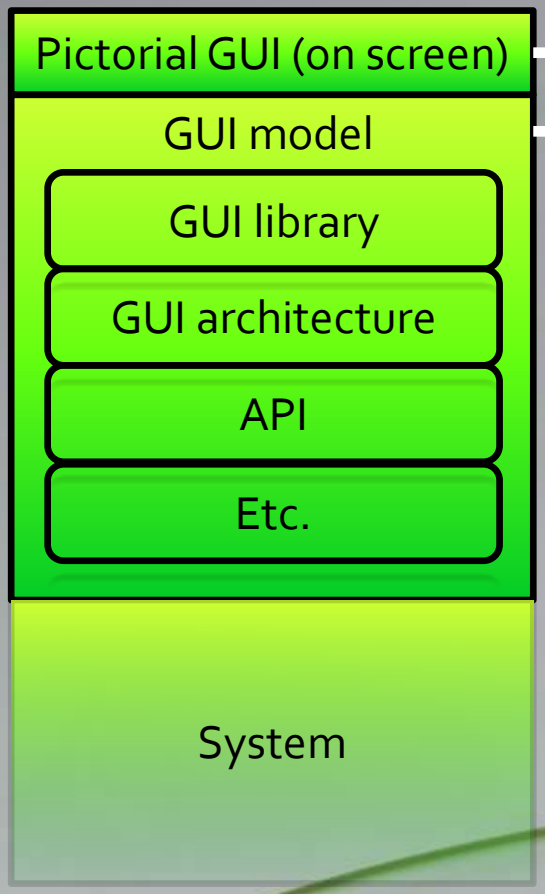
Software vs Testware

- Software is designed and developed using structured development practices
- Testware is regarded as "only scripts"
  - Less structured development practices
  - Less verification of correctness
  - Less followed best practices
- Is this a good, or even viable, practice?

Methodology

- Exploratory case study at CompanyX where one member of the research team worked on location for 6 months.
- The study aimed at answering the research questions:
  - RQ1: What items associated with technical debt of software can be observed in industrial grade GUI-based testware?
  - RQ2: What technical debt items can be observed in practice that are unique to GUI-based testware?

Automated GUI-based testing



Second(2nd) Generation
(Component-, tag-, widget-based)

Tools: Selenium, QTP, RTteser, etc.

Verification:
Verifies that the system conforms to its requirements but not that the pictorial GUI conforms to the GUI model.

Third (3rd) Generation
Visual GUI Testing

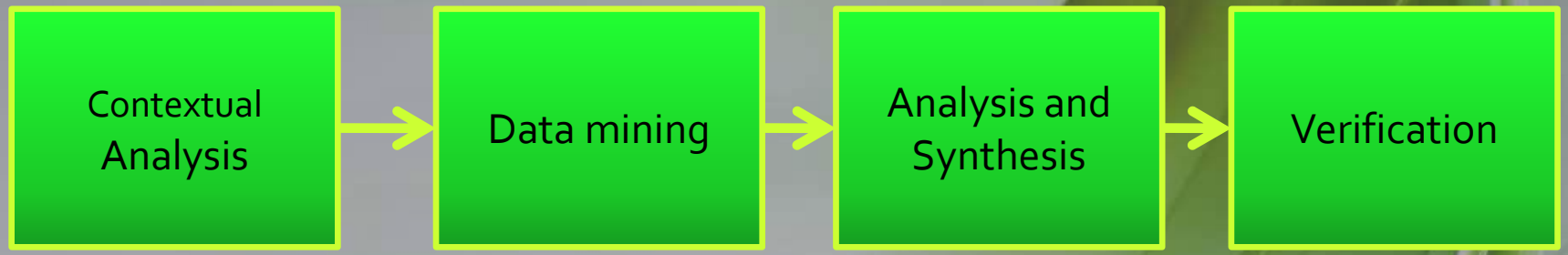
Tools: Sikuli, JAutomate, EggPlant, UFT, etc.

Verification:
Verifies that the system conforms to its requirements through input and assertions made to the GUI as shown on the screen.

Context

- Company with 3000 employees
  - 300 at studied location
- Safety critical software
  - Developed with agile development practices
  - Self-organizing teams
  - Each system in the range of 100k LOC
- Rigorous verification and validation
  - **Low level:** Thousands of Unit tests
  - **Mid level:** Hundreds of integration tests
  - **High level:** Hundreds of GUI tests with Unified functional testing (UFT) and manual testing

Case study



Document analysis, Informal and semi-structured interviews

Semi-automated data mining of forums, issue-tracker and repositories

Thematic analysis with coding

Semi-structured interviews

Data mining

- Projects A-D: Interviews and document analysis
- Forum: Qualitative information acquired through structured search strings
  - Test maintenance: 8467 entries
  - "Test maintenance": 28 entries
- Issue tracker: Lacked structured search
  - Scripts extracted information to spreadsheets
  - Qualitative data analyzed formally
- Analysis:
  - Coding (Thematic analysis)
  - Cyclomatic complexity
  - Statement complexity
  - Single responsibility violations

RQ1: What items associated with technical debt of software can be observed in industrial grade GUI-based testware?

- Function Complexity: Functions that are unnecessarily complex, lower readability, etc. (Cyclomatic complexity)
- DRY (Don't repeat yourself) violations: DRY violations in each repository, in each project, between projects.
- God functions: Methods that test different aspects of the system under test in the same test script.
- Complex statements: Long statements prohibit readability.
- High arity: A high number of input parameters and method calls caused by excessive modularization

RQ2: What technical debt items can be observed in practice that are unique to GUI-based testware?

- Use of wrong UI testing technology:
  - Different benefits with different technologies
  - Often caused by developer preference
  - Lack of guidelines for structured/best suitable use
- Use of monolithic object repositories
  - Binary repositories of GUI representations
  - Stifles concurrent work since the repositories cannot be merged

Implications

- TD can be found in testware!
  - Testware requires equally stringent practices as software
- TD can be automatically identified in testware!
  - For instance using Cyclomatic complexity
  - However, the metric needs to be updated (Find suitable threshold)
- There is best practice for developing testware!
  - Testware requires equally stringent practices to software
- The study only Identified a small set of TD items!
  - More TD items common to software
  - More TD items unique to testware
- Trade-off between testware modularization and readability
  - High modularization: low readability, high reusability
  - Low modularization: High readability, low reusability

Conclusions

What is Technical Debt?

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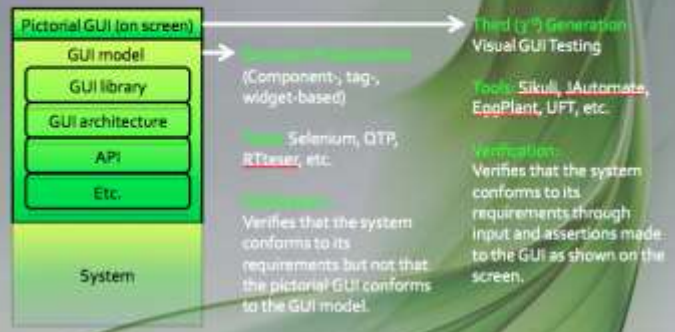

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Questions?
Thank you for listening!

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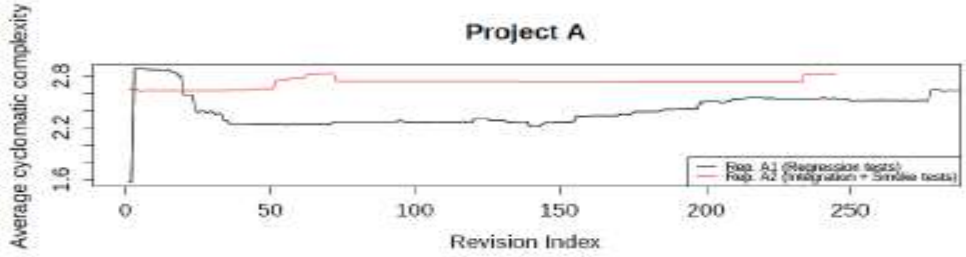
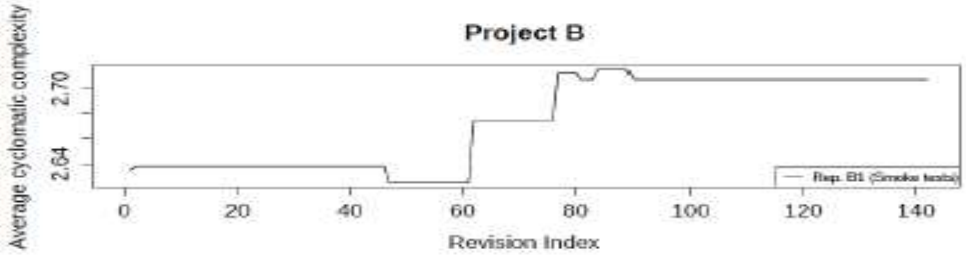
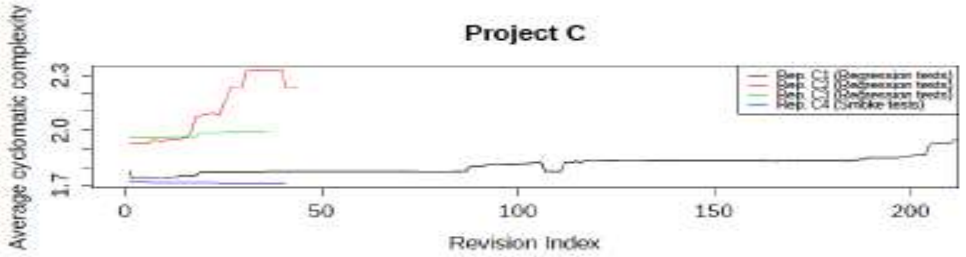
Results



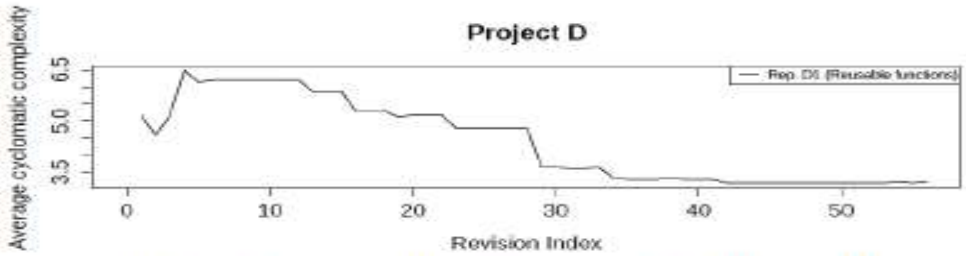
(a) The measured cyclomatic complexity in Project A



(b) The measured cyclomatic complexity in Project B



(c) The measured cyclomatic complexity in Project C



(d) The measured cyclomatic complexity in Project D

Legacy system

Redevelopment of Legacy system

Flight crew management

Common, reusable, repository