Software Architecture

When to use Alternative Formats for Communicating Ideas from Stakeholders to Software Developers

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ABSTRACT

Documenting software in a way that avoids verbosity, ambiguity, and confusion is a goal that all software architects should aspire to. The authors will identify and compare several formats that may be used to document software. The authors will list some of the pros and cons of each format, helping the readers to make an informed choice of the format to use for their own software projects.

Keywords

Software, Architecture, Documentation

1. INTRODUCTION

2. BACKGROUND

Software architects are responsible for communicating ideas from stakeholders to software coders with the goal that the software coders accurately and completely implement those ideas into a working software product.
With an estimated software project failure rate of over 40%, we need to investigate possible reasons for such a high percentage of failures. One such reason may be a failure to communicate effectively. Communication is required between stakeholders and requirements engineers, between requirements engineers and software architects, and finally between software architects and software coders and testers [4]. The authors will focus their investigation on communication failures between software architects and software coders and testers. This approach will assume that documents created prior to this communication phase are both complete and correct.
Software architects have several formats to chose from when it comes to creating documentation for software. We will assume that most software projects are too complex to support an all oral format using natural language to communicate the ideas, so we will assume that at least a written format using natural language is required. Other formats that are more formal and structured in nature include UML diagrams and mathematical models.

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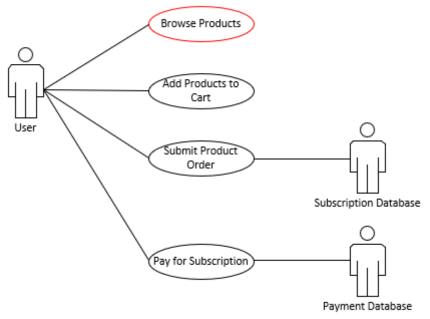
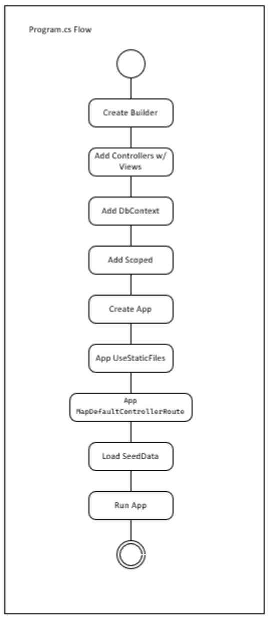
3. RELATED WORK

Miles and Hamilton describe why and how to use UML (Universal Modeling Language) for documenting software. They state that because informal languages do not have exact rules they will always suffer from the problem of verbosity, confusion, ambiguity and unnecessary details, which is an extremely dangerous way to model a system. Their solution is to use a formal modeling language, such as UML [2].
They list the following situations for using UML [2].

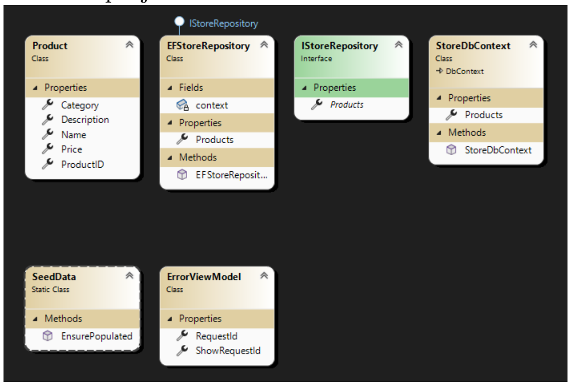
1. Requirements using Use Case Diagrams
   Use cases are the system's functional requirements and should be the first output from your modeling. "How can you begin to design a system if you don't know what it will be required to do?" [2] Use cases specify what the system will deliver to users.
   The figure below shows a sample use case diagram from our class project.



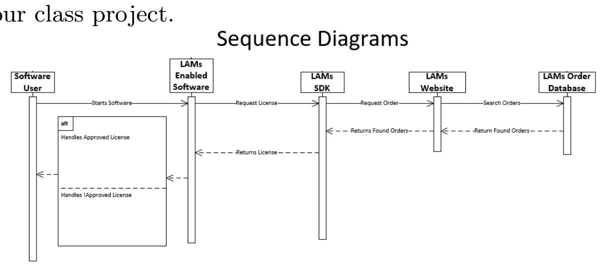
2. System Workflows using Activity Diagrams
   Activity diagrams show how the system will accomplish the requirements set out in the user case diagrams. High-level actions are linked together to represent a process that needs to occur in the system [2].
   The figure below shows a sample activity diagram from our class project.



3. A Systems Logical Structure using Class Diagrams
   Class diagrams show classes and their relationships [2]. The figure below shows a sample class diagram from our class project.



4. Ordered Interactions using Sequence Diagrams
   Sequence diagrams are an important member of a group known as interaction diagrams. They help accurately model how the parts that make up the system interact. They capture the order of interactions between parts of the system, describe which interactions will be triggered and in what order those interactions will occur. The figure below shows a sample class diagram from our class project.



5. Interaction Links using Communication Diagrams
6. Interaction Timing using Timing Diagrams
7. Interaction Picture using Interaction Overview Diagrams
8. Internal Class Structure using Composite Structures
9. System Parts using Component Diagrams
10. Organize Your Model using Packages
11. Object State using State Machine Diagrams
12. The Deployed System using Deployment Diagrams

Wiegers and Beatty discuss the importance of using both textual and visual formats to capture the full intentions of the intended system. Their book describes the following visual requirements models [5].

1. Data flow diagrams (DFDs)
2. Process flow diagrams
3. State-transition diagrams and state tables
4. Dialog maps
5. Decision tables and decision trees
6. Event-response tables
7. Feature trees (Ch 5)
8. Use case diagrams (Ch 8)
9. Activity diagrams (Ch 8)
10. Entity-relationship diagrams (Ch 13)

Wiegers and Beatty also briefly discuss the use of visual models in agile driven projects [5].

The American Institute of Architects discuss the need for standard content and graphics to be used by Construction Architects to document their projects (Appendix E). [3]. Although software architecture and construction architecture are technically different fields, they share many common goals of turning stakeholder ideas into a real products.
The US CAD Standard (NCS) is a compilation of related documents published by several organizations for the purposes of creating a national standard for construction related CAD documents. [3].
A national design document standard provides the following advantages

1. Allows information to be transfered throughout the project cycle from one professional to another.
2. Results in better coordination between architects and engineers
3. Saves production time
4. Improves the overall design of the project

The Uniform Drawing System consist of 8 modules that help standardize the documents needed to convey information from the architect to the builder [3].

1. Module 1 - Drawing Set Organization
2. Module 2 - Sheet Organization
3. Module 3 - Schedules
4. Module 4 - Drafting Conventions
5. Module 5 - Terms and Abbreviations
6. Module 6 - Symbols
7. Module 7 - Notations
8. Module 8 - Code Conventions

Ingeno discusses methods for documenting and reviewing software architectures [1] In particular, he discusses

1. Uses of software architecture documentation
2. Creating architecture descriptions (ADs), including architecture views
3. Using UML to document software architecture
4. Reviewing software architecture documents

4. PROPOSED APPROACH

The authors will review some of the literature written by leading experts on the topic of requirements documentation content and format. A table will be generated listing the different formats proposed and the pros and cons of each format.

5. EXPERIMENTAL RESULTS

6. DISCUSSION

7. THREATS TO VALIDITY

8. CONCLUSIONS AND FUTURE WORK

Our conclusion is ...

9. ACKNOWLEDGMENTS

We would like to thank Dr. Kristen Walcott, Dr. Armin Moin and the Computer Science and Software Engineering Department at UCCS for helping us gain a deeper understanding of the challenges and opportunities in software architecture.

10. NOTES AND BRAINSTORMING - DELETE BEFORE SUBMITTING FINAL PAPER

1. Understanding Research Problems
   (a) Topic: We are evaluating the usefulness of presenting ideas in different formats
   (b) Question: because we want to find out if certain formats are more useful than others in communicating ideas from stakeholders to software developers
   (c) Significance: so that we can help others choose a document format that will result in successful communication of ideas from stakeholders to software developers.
2. Levels of Idea Formats from Abstract to Concrete
   (a) Mental
   (b) Natural Language
      i. Oral
      ii. Written
   (c) Formal Languages
      i. Mathematical
      ii. Models (UML)
   (d) Source Code

11. REFERENCES

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[2] R. Miles and K. Hamilton. *Learning UML 2.0.* O'Reilly, 2006.
[3] A. I. of Architects. *Architectural Graphic Standards, 11th Edition.* John Wiley and Sons, Inc., 2007.
[4] A. van Lamsweerde. *Requirements Engineering.* Wiley, 2010.
[5] K. Wiegers and J. Beatty. *Software Requirements.* Microsoft Press, 2013.