CMSC 132:
Object-Oriented Programming II

Software Process Models

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Overview

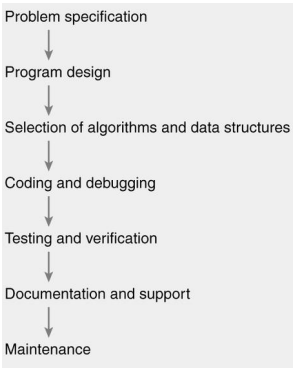
- Software process models
  - Waterfall
  - Iterative
- Choosing a software process model
  - Level of understanding
  - Cost of change

Software Process Models

- Software methodology
  - Codified set of practices
  - Repeatable process for producing quality software
- Software process model
  - Methodology for organizing software life cycle
  - Major approaches
    - Waterfall model
    - Iterative development
    - Formal methods

Waterfall Model

- Approach
  - Perform steps in order
  - Begin new step only when previous step is complete
  - Result of each step flow into next step

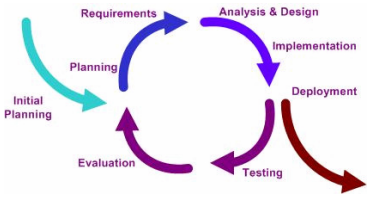


Waterfall Model

- Advantages
  - Simple
  - Predictable results
    - Software follows specifications
  - Reasonable for small projects
- Problems
  - In real life
    - May need to return to previous step
    - Steps may be more integrated
    - Steps may occur at same time
  - Unworkable for large projects

Iterative Software Development

- Approach
  - Iteratively add incremental improvements
  - Take advantage of what was learned from earlier versions of the system
  - Use working prototypes to refine specifications



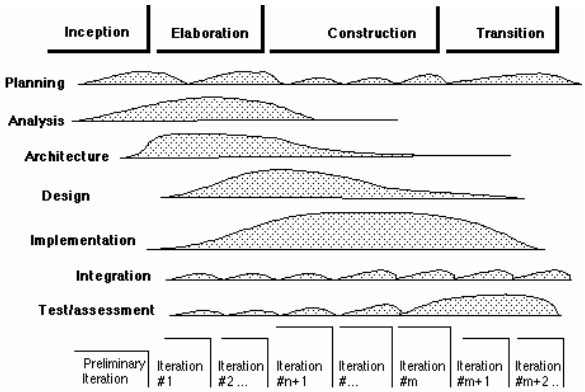
Iterative Software Development

- Goals
  - Emphasize adaptability instead of predictability
  - Respond to changes in customer requirements
- Examples
  - Unified model
  - Agile software development
  - Extreme programming (XP)

Unified Model

- Development divided into phases (iterations)
  1. Inception
  2. Elaboration
  3. Construction
  4. Transition
- During each phase
  - Multiple iterations of software development
  - Development treated as mini-waterfalls
  - Emphasis gradually shifts from specification to testing

Unified Software Life Cycle Model



Agile Software Development

- Agile approach
  - Based on iterative development
    - Short iterations (timeboxes) lasting 1- 4 weeks
  - Working software as principal measure of progress
    - Produced at end of each iteration
  - Adds a more people-centric viewpoint
    - Face-to-face communication preferred
    - Co-locate programmers, testers, "customers"
  - Relies on adapting to feedback rather than planning as the primary control mechanism
    - Less specification & documentation

Extreme Programming (XP)

- Prominent example of Agile methodology
  - Iterative, adaptive software development
- Describes set of day-to-day practices
  - Followed by managers & programmers
  - Intended to encourage a set of values
- Appropriate for environments with
  - Small teams
  - Rapidly-changing requirements

Extreme Programming Values

- Communication
  - Rapidly building & disseminating institutional knowledge among programming team
- Simplicity
  - Implement simplest code needed by customer without emphasis on future versions
- Feedback
  - From testing, team members, customers
- Courage
  - Willingness to rewrite / refactor software to add or change features

Extreme Programming Practices

- Pair programming
  - Pairs of programmers combine software development efforts at one computer
  - Especially useful for novice programmers
- Test-driven development
  - Tests are designed first, before writing software
- Continuous integration
  - Tests performed throughout development process
- On-site customer
  - Customer available at all times to answer questions

Formal Methods

- Mathematically-based techniques for
  - Specification, development, and verification
  - Software and hardware systems
- Intended for high-integrity systems
  - Safety
  - Security
- Levels

  0 – Informal implementation of formal specifications

  1 – Formal code development & verification

  2 – Theorem prover to ensure correctness

Choosing A Software Model

- Which software life cycle model is appropriate?
- For class programming projects
  - Code and test probably suffices
  - But software in real world not like class projects
- Some big questions
  - Do you understand what you are trying to build?
  - What is the cost of change?
  - How many people have to interact with the design?
  - How easy is it to get the entire thing in your head?

Do You Understand The Problem?

- In many cases, the things we want software to do are not well understood
  - Examples
    - Provide a web interface for student applications
    - Allow users to view and manipulate photographs
    - Build a better search engine
- Hard to understand constraints / interactions
- May have to build prototype
  - To understand how users can effectively use it

What Is The Cost Of Change?

- Possible situation
  - Most coding already complete
  - Realize need to change something
    - In the design
    - Or even the requirements
- How expensive is that?
  - If hugely expensive
  - Better get requirements & design right
    - Before completing too much code

Has The Cost Of Change Changed?

- Some people believe
  - Recent software development techniques have substantially reduced cost of change
- Possible reasons
  - Safer programming languages
    - E.g., not C/C++/assembly language
  - Object-oriented design & programming
  - Test-driven development

Sometimes, Change Is Still Expensive

- Expensive to change software that
  - Is key nexus in a large system
    - Affects many lines of code
  - Interacts with co-designed hardware
    - May need to change hardware design
  - Interacts with software being developed externally
    - Can't easily change API once published

How Many People Interact With Its Design?

- People interacting with software design
  - Part of the cost of change
    - Need to alert / consult people on design change
  - Design changes that interact with a lot of people
    - Expensive and need to be minimized
    - Try to get design choices right early and documented

How Easy Is Software To Understand?

- When building and developing software, you need to understand it (at least, parts of it)
  - For 100 lines of code, just read the code
  - Doesn't work for 100,000 lines of code
- Need to have ways of documenting the requirements & design at a higher level