

CMSC 132: Object-Oriented Programming II



Software Process Models

Department of Computer Science
University of Maryland, College Park

Overview

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

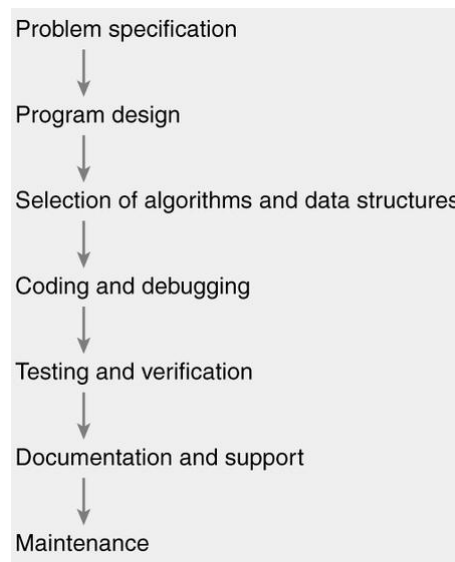
Software Process Models

- **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

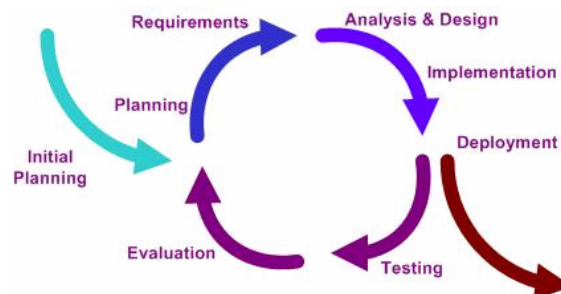
■ Problems

- 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

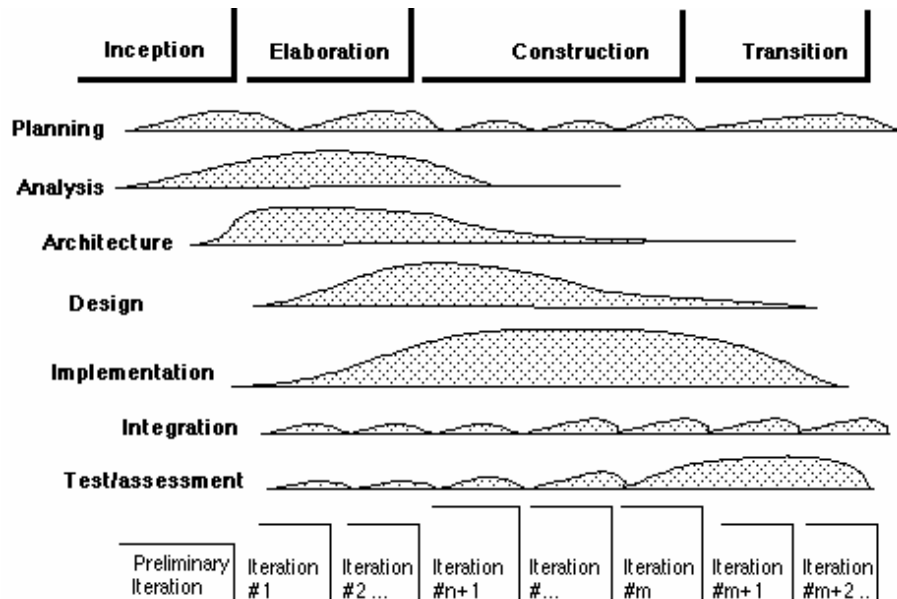
■ Development divided into phases (iterations)

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**