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

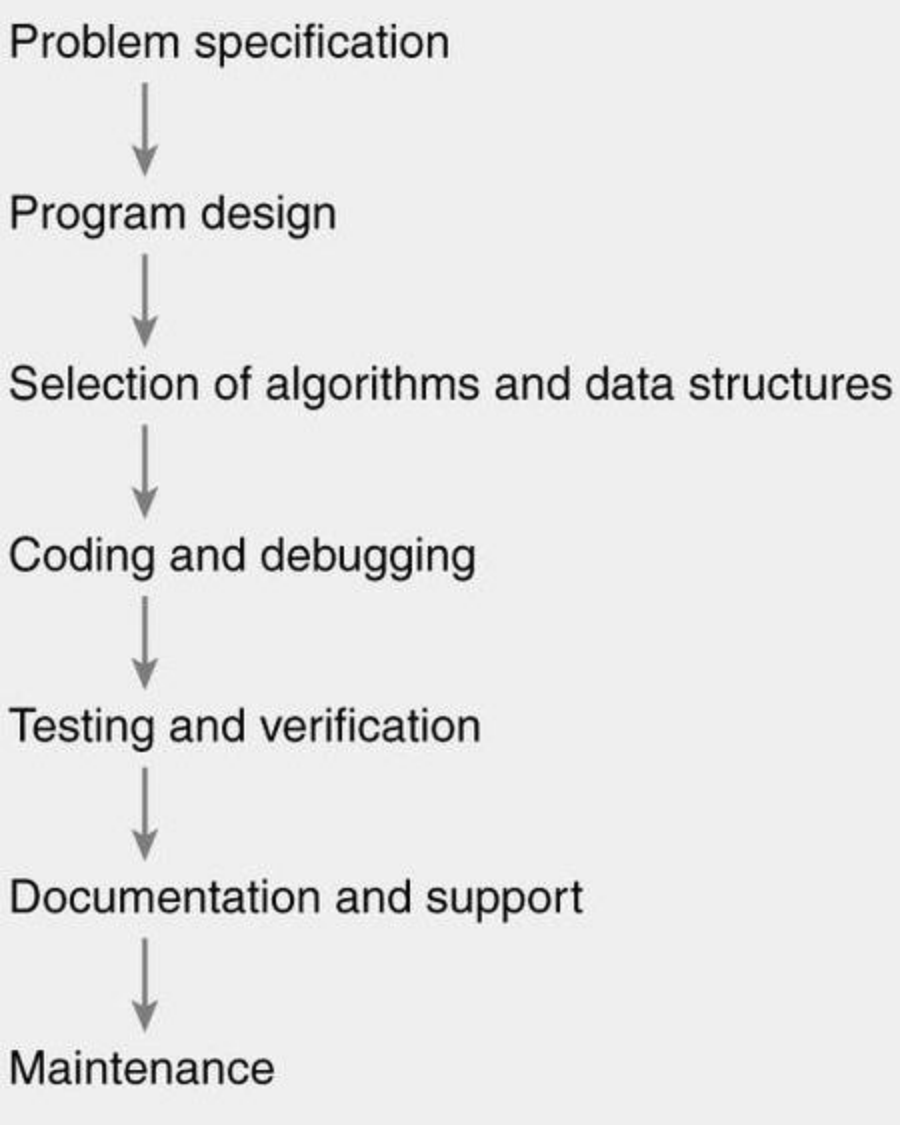
Software Process Models

- **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**

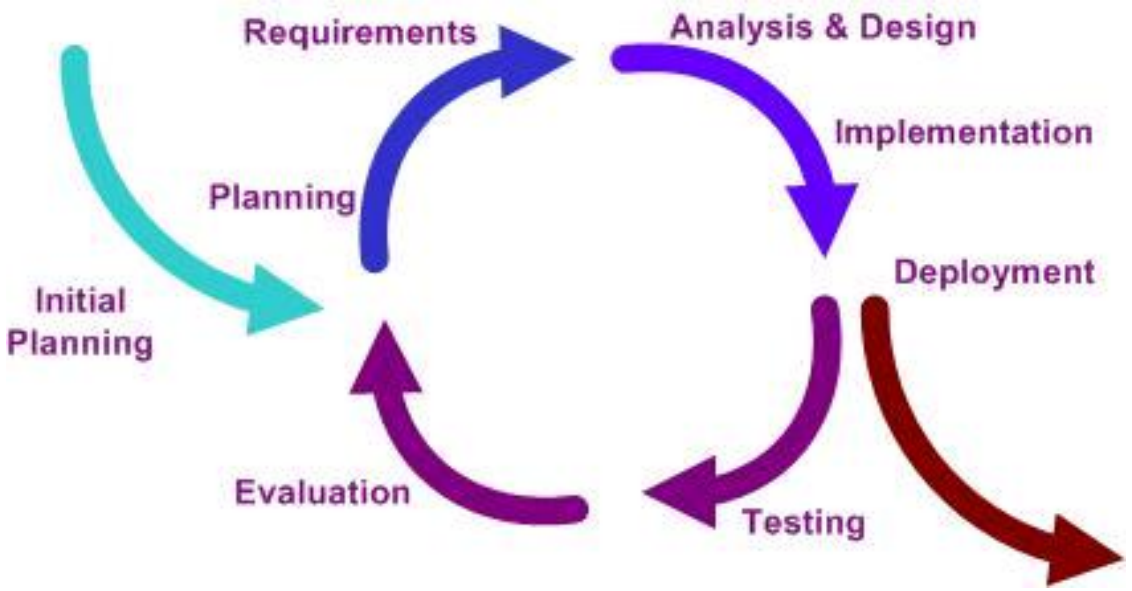


Waterfall Model

- **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**



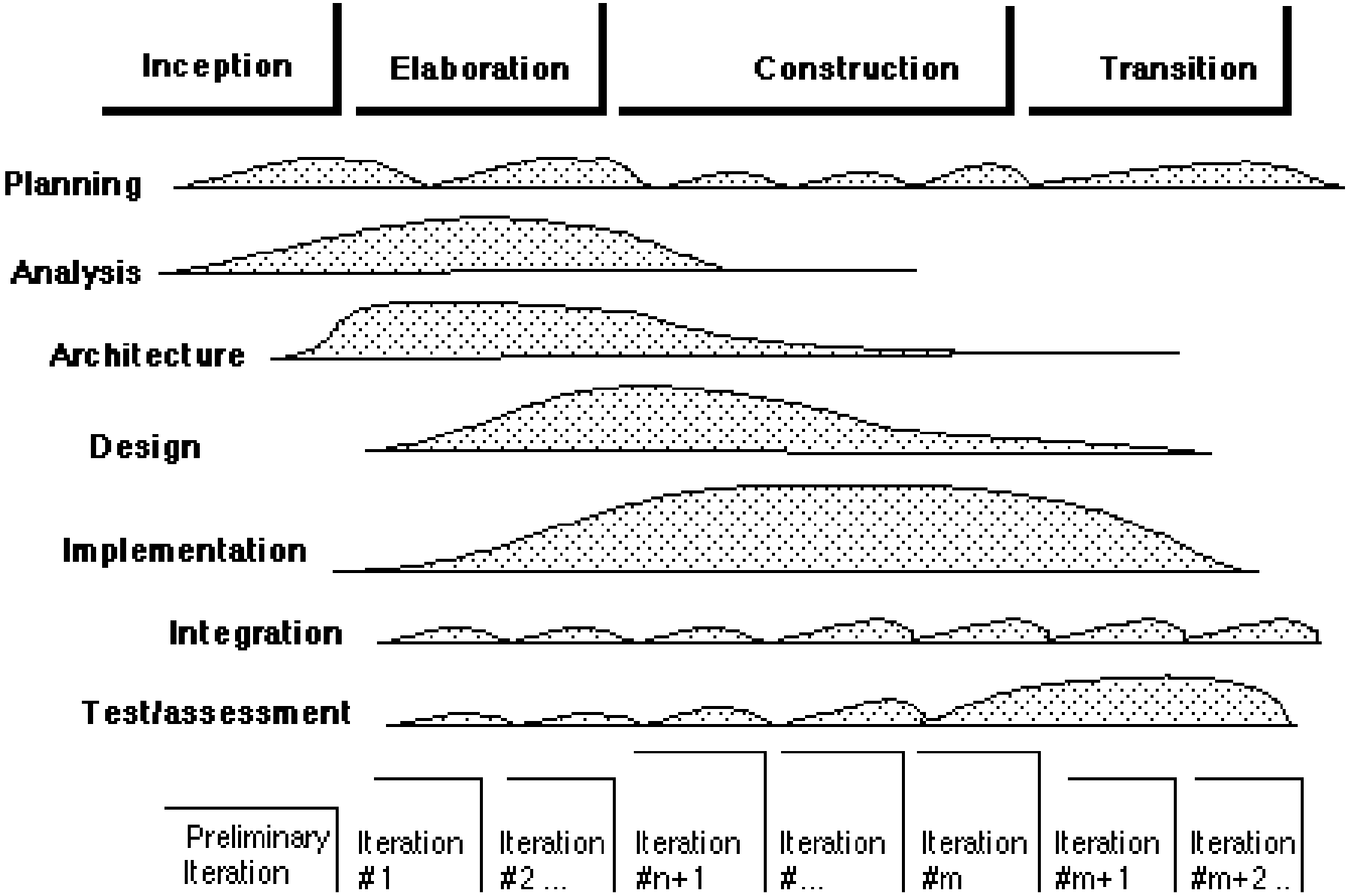
Iterative Software Development

- **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