CISC 327 - Software Quality Assurance

Lecture 3

Software Process Models

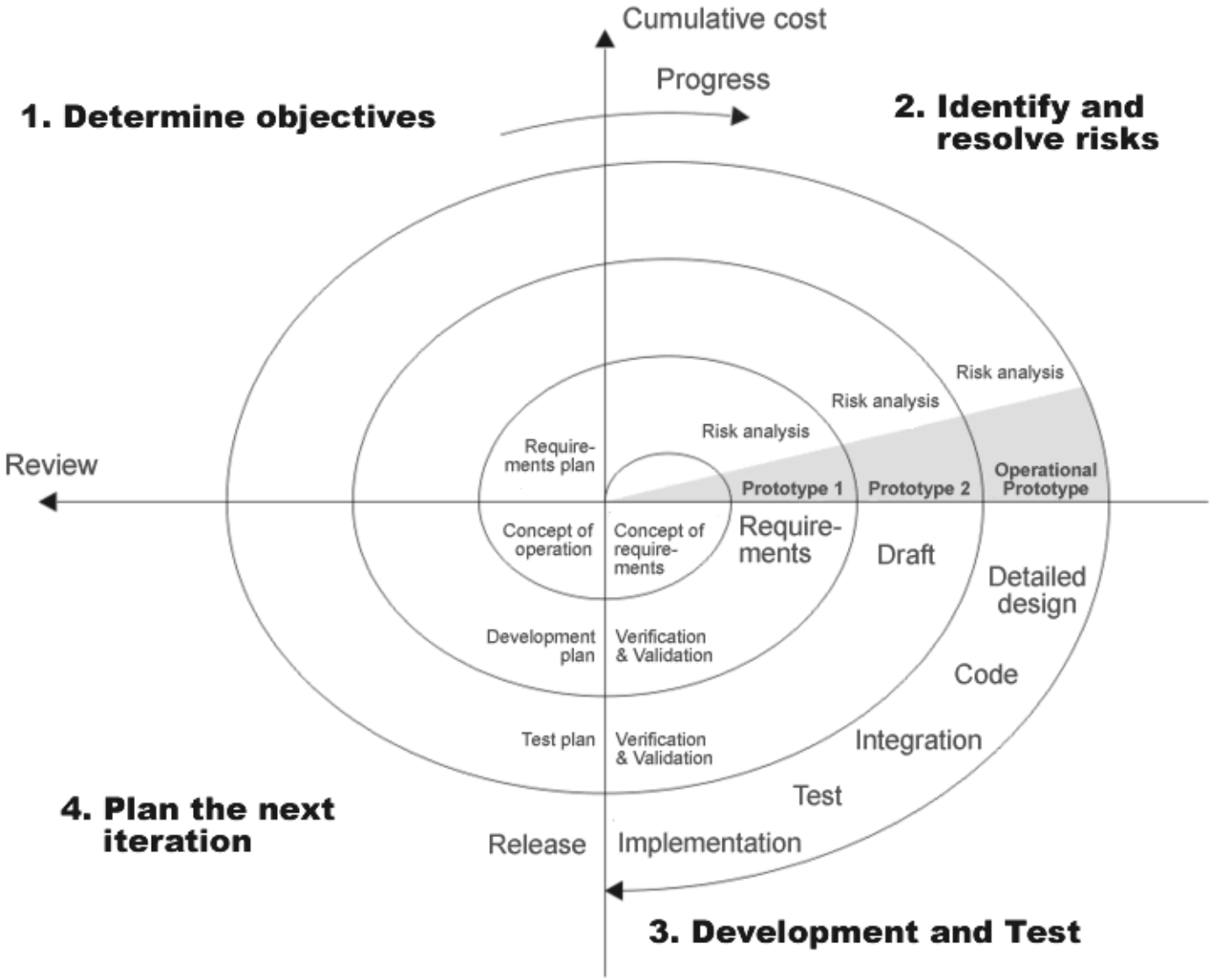
Software Process Models

- More Process Models
  - We continue today with more models of software process
  - Recall that our objective is to understand how quality control fits into software processes

The Spiral Model

- Boehm's Spiral Model
  - The Spiral Model is a refinement of the waterfall model designed around continuous documentation and evaluation of risk
  - Based on experience applying the waterfall model to large (U.S.) government software projects
  - Now a standard used by many government agencies and software providers

The Spiral Model



http://en.wikipedia.org/wiki/File:Spiral_model_%28Boehm,_1988%29.png

The Spiral Model

- Spiral Layers
  - Roughly, each layer of the spiral corresponds to one phase of the waterfall (although there are no fixed phases)
  - For example, the first layer could be the requirements phase, second layer the design phase, etc.

The Spiral Model

- Four Step Cycle
  - In each layer, the same four step cycle is used, consisting of:
    - Determine Objectives: determine objectives, constraints, risks for next phase
    - Assess and Reduce Risks: analyze and reduce identified risks
    - Develop and Validate: choose development model, develop and test
    - Review and Plan: review status, plan next layer

The Spiral Model

For each layer (phase) of the project:

- 1) Determine Objectives
  - Specific objectives (aims) for the phase of the project are defined
  - Constraints on the process and product are identified
  - Alternatives for achieving the objectives are identified
  - Potential risks associated with each alternative are identified

The Spiral Model

- 2) Assess and Reduce Risks
  - For each potential risk, a detailed analysis is carried out
  - Steps are taken to reduce risk (e.g., create prototype to check)
  - Alternatives are chosen to minimize risk

The Spiral Model

- 3) Develop and Validate
  - Based on risk analysis, choose or modify development model
  - For example, to implement and validate,
    - if user interface risks dominate, use evolutionary prototyping
    - if safety risks are the major issue, use formal methods
    - if integration problems are the big risk, use waterfall model

The Spiral Model

- 4) Review and Plan
  - Review and evaluate results of this phase (layer)
  - Decide whether another layer of the spiral is needed
  - If so, draw up plans for next phase

Drawbacks of the Spiral Model

- Heavyweight Process
  - The spiral model requires a large amount of overhead
    - Every layer requires a lot of documentation and many meetings, progress can therefore be slow
- Not really a development model
  - The spiral model is really more of a "meta-model" since it describes the way to carry out stages, not what the stages are
  - But focuses on identifying potential problems early at every stage, so very good at producing high quality results

Drawbacks of the Spiral Model

- Depends on Risk Analysis
  - Needs a very experienced team to recognize and analyze risks accurately
  - High dependency on quality of people (itself a risk!)
- Not for Novices
  - Layers of process are flexible and not explicitly laid out
  - Each layer's goals and plan must be decided by team itself, requires experienced people!

The Iterative Development Model

- Subset Development
  - The Iterative Development Process (IDP) is based on subsets
  - Begin with a subset of the requirements and develop a subset of the software product
  - The subset should:
    - satisfy immediate needs of users
    - serve as a vehicle of training for customers, and learning for developers

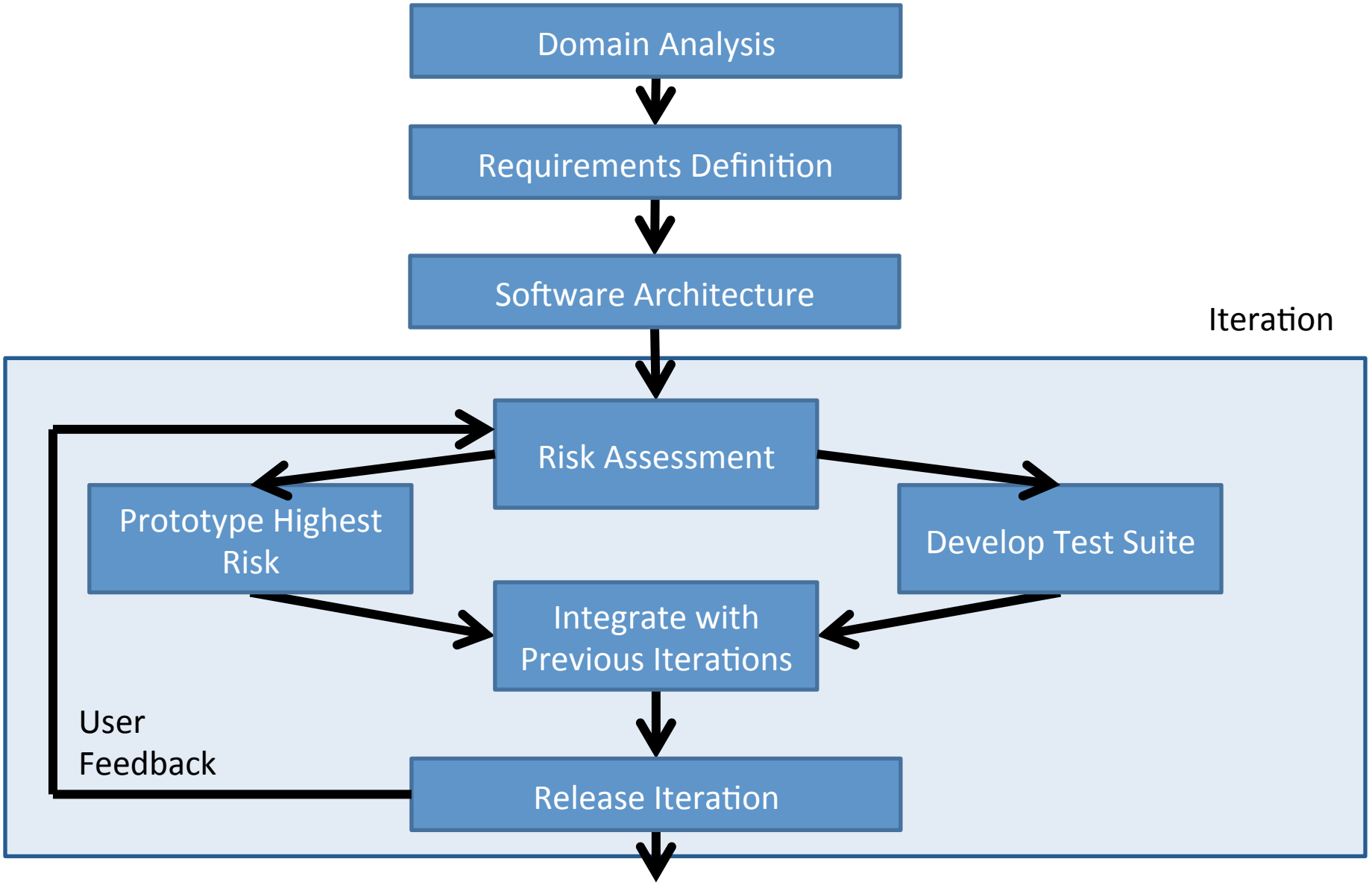
The Iterative Development Model

- Sequence of Intermediate Products
  - Analysis of the subset product leads to modifications to the design and requirements, from which we build a new (hopefully larger) subset product
  - Design and requirements refined over a series of iterations to provide a system that meets evolving customer needs with improved design based on feedback and learning

The Iterative Development Process

- Iterative Development Process
  - Analysis of the problem domain and definition of requirements begins process as usual
  - Need initial architecture design to begin
  - Add most critical remaining features each cycle
  - Quality control, development of test suite for new features on each iteration

The Iterative Development Process



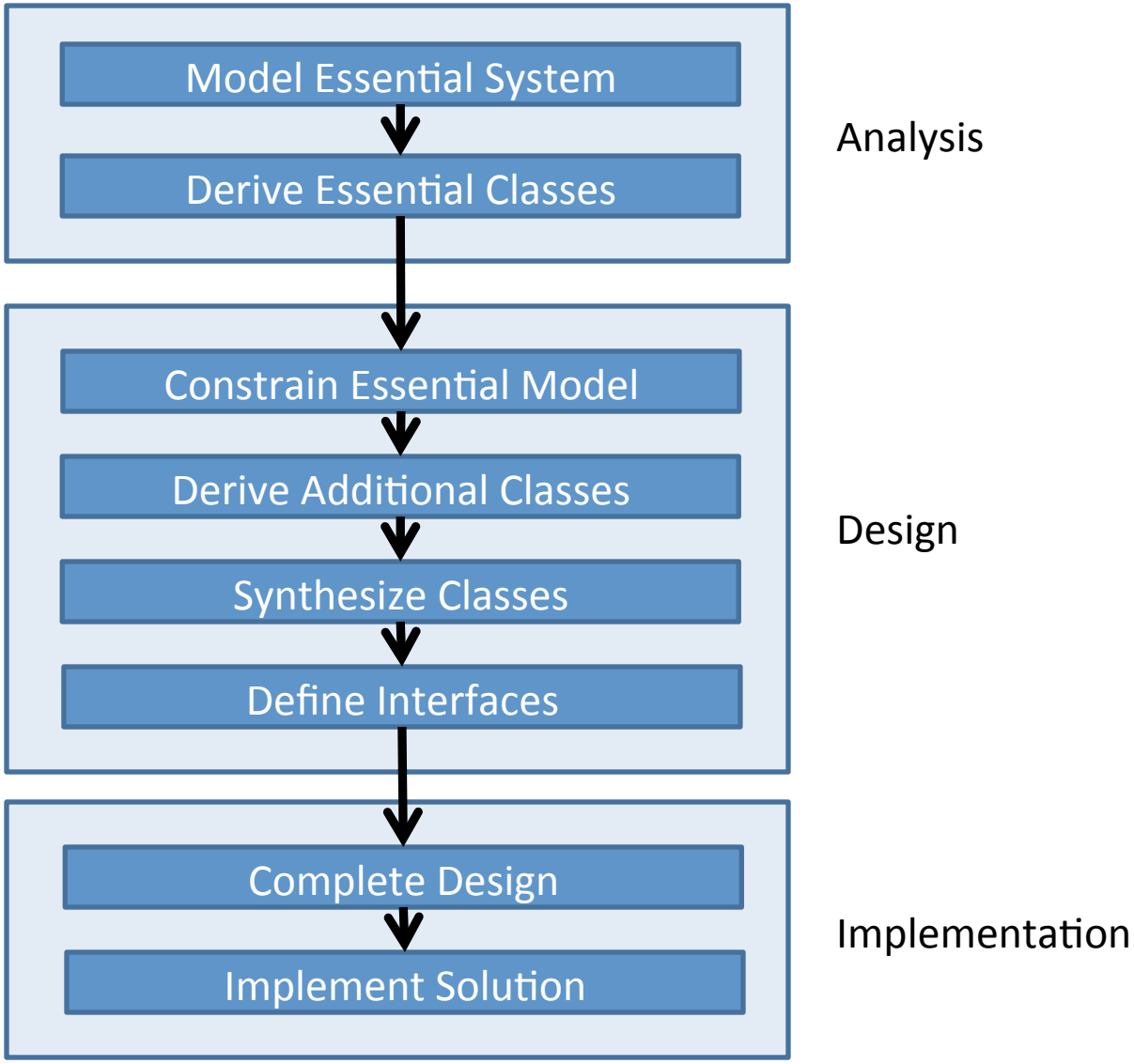
Drawbacks of the Iterative Process

- Needs Small Team
  - Process does not allow for large scale parallel development, depends on focussing on one remaining risk at a time
  - Works best with relatively small teams
- Needs Early Architecture
  - Requires early design of overall architecture, difficult to change later
  - But when architecture can be settled early, has been very successful at producing significant, very high quality products, e.g., IBM's OS/2 system

Object-Oriented Development

- OO Process Models
  - Many OO process models are proposed, based on OOAD ("Object-Oriented Analysis and Design")
  - All have three major phases:
    - Analysis: model the "essential system" to represent user requirements, and design implementation-independent "essential classes"
    - Design: constrain and refine essential classes to be implemented on particular implementation environment, derive additional classes
    - Implementation: define class interfaces and implementation methods, then code and unit test all classes

Object-Oriented Development



OO Development Process - Analysis

- 1) Model the Essential System
  - Create a "user view" of the system
  - Model essential activities, essential solution data, and how they are related
  - Quality control: requirements reviews (inspection)

OO Development Process - Analysis

- 2) Derive Essential Classes
  - "Carve" out candidate essential classes from the essential model using data-flow diagrams, process, and data specifications
  - Quality control: design reviews (inspection)

OO Development Process - Design

- 3) Constrain the Essential Model
  - Modify essential model to fit within constraints of target implementation environment
  - Map essential activities and data to implementation processors (hardware/software) and containers (memory/files)

OO Development Process - Design

- 4) Derive Additional Classes
  - Additional classes and methods specific to implementation environment added to support additional activities added while constraining the essential model

OO Development Process - Design

- 5) Synthesize Classes
  - Essential classes and additional classes refined and organized into a class hierarchy
  - Final classes chosen to maximize reuse
  - Quality control: design review (inspection)
- 6) Define Interfaces
  - Class definitions written for final classes

OO Development - Implementation

- 7) Complete Design
  - Design of "implementation module" completed
  - Implementation module specifies methods such that each provides a single cohesive function
  - Quality control: design review
- 8) Implement Solution
  - Implementation of classes and methods is coded and validated
  - Quality control: unit testing (class-wise)

Drawbacks of the OO Process

- Delayed Testing
  - Development process missing intermediate results
  - Most testing delayed to final implementation stage
- Architectural Inflexibility
  - Process assumes that overall architecture can be designed in the requirements phase
  - Allows little architectural flexibility in design and implementation steps
  - Can lead to spaghetti results

Summary

- Software Process
  - Spiral Model organizes and generalizes the waterfall model
  - Iterative Development Process is based on product subsets
  - Object Oriented Development is a currently popular model with drawbacks

Summary

- Today's References
  - Sommerville, Software Engineering, ch. 2
  - Kan, Metrics and Models in Software Quality Engineering, ch. 2
- Next Time
  - Quality standards and assessment of software processes
- Then...
  - The eXtreme Programming software process