Lecture 27: Life Cycles and OO Design Methods

Kenneth M. Anderson

Object-Oriented Analysis and Design

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Goals for this Lecture

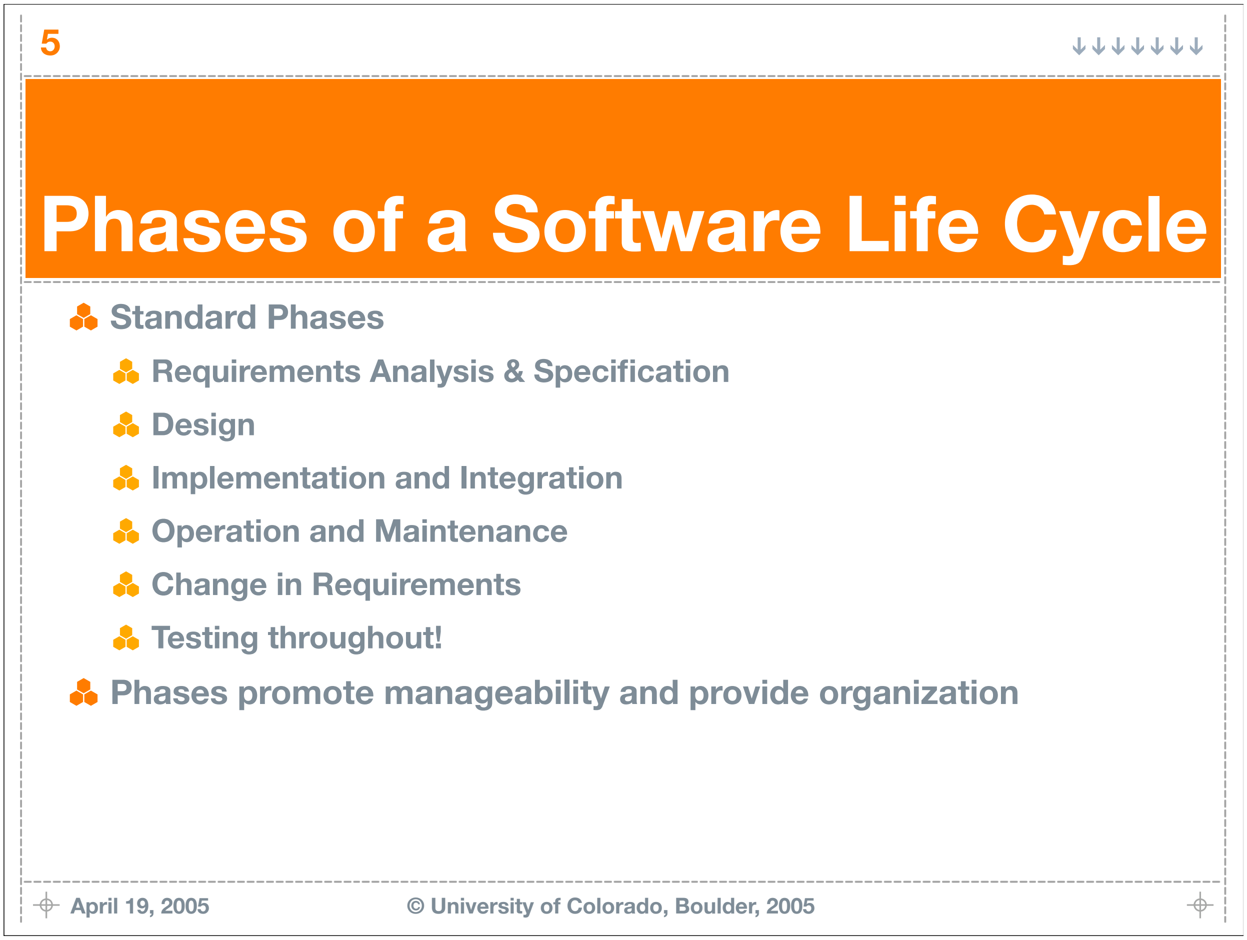
- Review the concepts of software engineering life cycles
- Introduce the notion of an object-oriented design method
  - Hint: its another name for “life cycle”
- Present an introduction of Agile design methods
  - Hint: yet another name for “life cycle”

Background

- In Software Engineering:
  - “Process is King”
  - We want our activities to be coordinated and planned, e.g. “engineered”
  - The reason?
    - A high quality process should increase our ability to create a high quality product

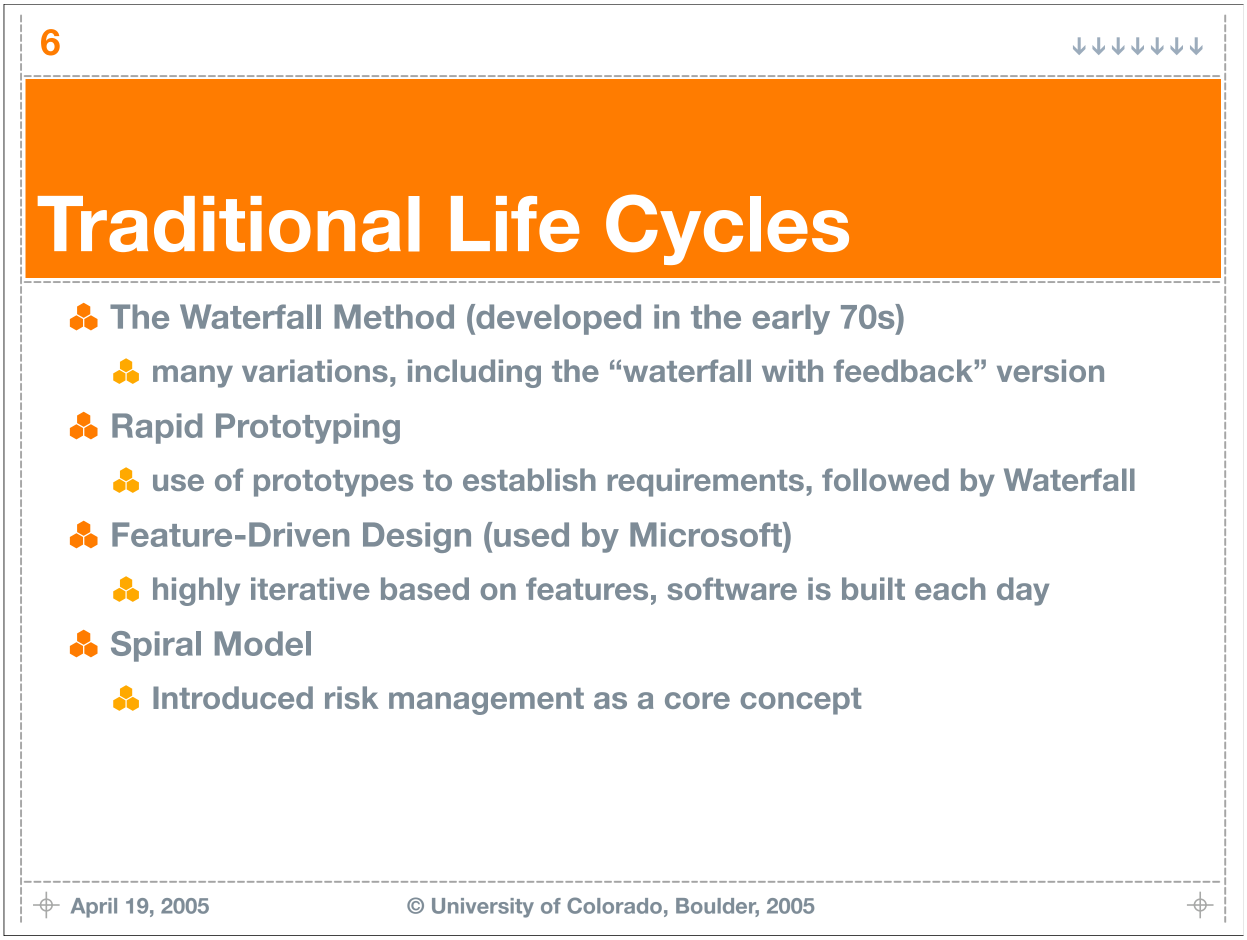
Software Life Cycle

- A series of steps that organizes the development of a software product
- Duration can be from days to years
- Consists of
  - people (!)
  - overall process
  - intermediate products
  - stages of the process



Phases of a Software Life Cycle

- Standard Phases
  - Requirements Analysis & Specification
  - Design
  - Implementation and Integration
  - Operation and Maintenance
  - Change in Requirements
  - Testing throughout!
- Phases promote manageability and provide organization



Traditional Life Cycles

- The Waterfall Method (developed in the early 70s)
  - many variations, including the “waterfall with feedback” version
- Rapid Prototyping
  - use of prototypes to establish requirements, followed by Waterfall
- Feature-Driven Design (used by Microsoft)
  - highly iterative based on features, software is built each day
- Spiral Model
  - Introduced risk management as a core concept

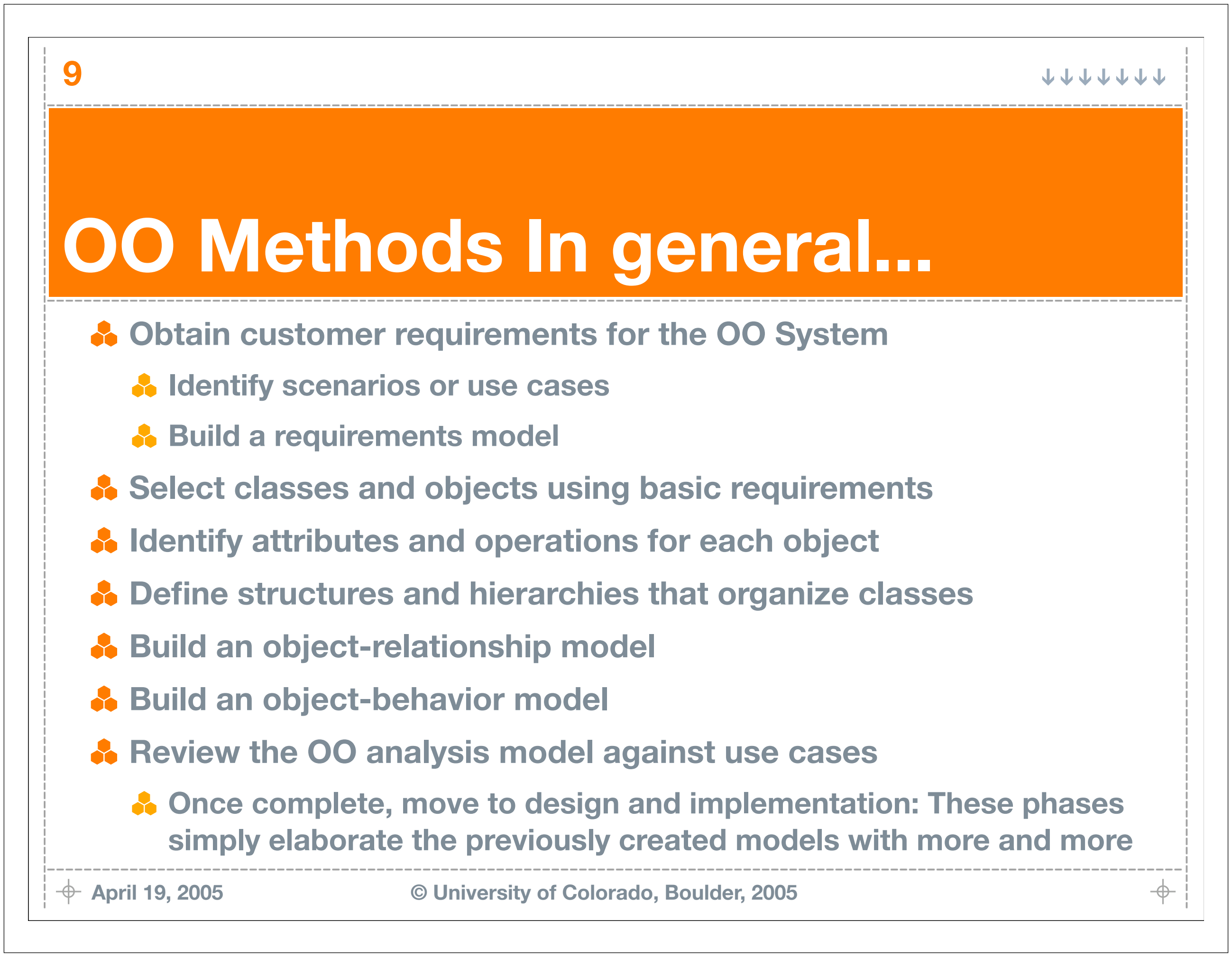
Summary

- Life cycles make software development
  - predictable
  - repeatable
  - measurable
  - efficient
- High-quality processes should lead to high-quality products
  - at least it improves the odds of producing good software

Survey of OOA&D Methods

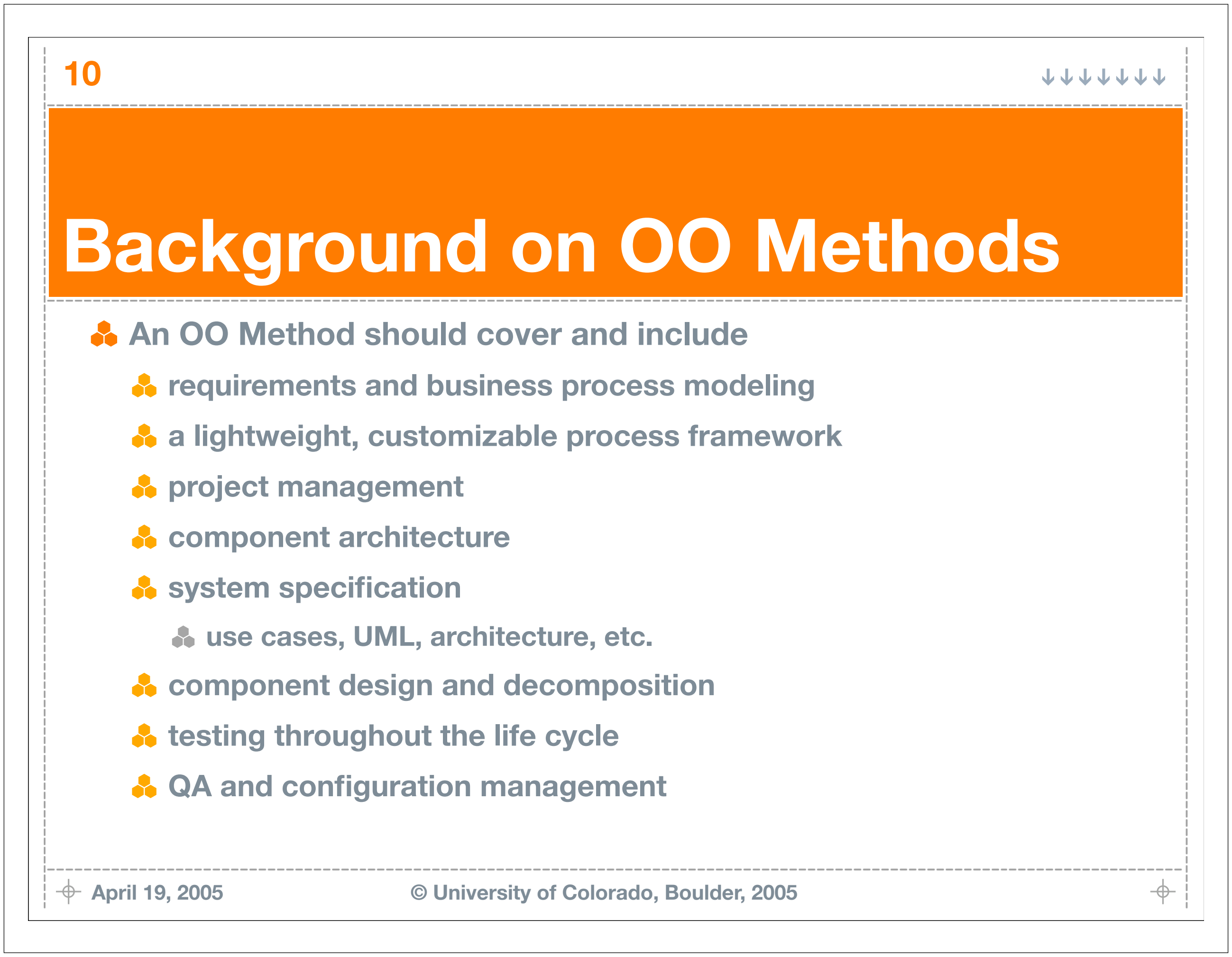
- Generalization
  - Taken from “SE: A Practitioner’s approach, 4th ed.” by Roger S. Pressman, McGraw-Hill, 1997
- The Booch Method
- The Jacobson Method
- The Rambaugh Method
- The Unified Software Process

- Information on the four methods taken from
  - Graham, I. Object-Oriented Methods, Addison-Wesley, 3rd Ed., 2001



OO Methods In general...

- Obtain customer requirements for the OO System
  - Identify scenarios or use cases
  - Build a requirements model
- Select classes and objects using basic requirements
- Identify attributes and operations for each object
- Define structures and hierarchies that organize classes
- Build an object-relationship model
- Build an object-behavior model
- Review the OO analysis model against use cases
  - Once complete, move to design and implementation: These phases simply elaborate the previously created models with more and more



Background on OO Methods

- An OO Method should cover and include
  - requirements and business process modeling
  - a lightweight, customizable process framework
  - project management
  - component architecture
  - system specification
    - use cases, UML, architecture, etc.
  - component design and decomposition
  - testing throughout the life cycle
  - QA and configuration management

The Booch Method

- Identify classes and objects
  - Propose candidate objects
  - Conduct behavior analysis
  - Identify relevant scenarios
  - Define attributes and operations for each class
- Identify the semantics of classes and objects
  - Select scenarios and analyze
  - Assign responsibility to achieve desired behavior
  - Partition responsibilities to balance behavior
  - Select an object and enumerate its roles and responsibilities
  - Define operations to satisfy the responsibilities

Booch, continued

- Identify relationships among classes and objects
  - Define dependencies that exist between objects
  - Describe the role of each participating object
  - Validate by walking through scenarios
- Conduct a series of refinements
  - Produce appropriate diagrams for the work conducted above
  - Define class hierarchies as appropriate
  - Perform clustering based on class commonality
- Implement classes and objects
  - In analysis and design, this means specify everything!

The Jacobson Method

- Object-Oriented Software Engineering
  - Primarily distinguished by the use-case
  - Simplified model of Objectory
    - Objectory evolved into the Rational Unified Software Development Process
  - For more information on this Objectory precursor, see
    - Jacobson, I., Object-Oriented Software Engineering, Addison-Wesley, 1992.

Jacobson, continued

- Identify the users of the system and their overall responsibilities
- Build a requirements model
  - Define the actors and their responsibilities
  - Identify use cases for each actor
  - Prepare initial view of system objects and relationships
  - Review model using use cases as scenarios to determine validity
- Continued on next slide

Jacobson, continued

- Build analysis model
  - Identify interface objects using actor-interaction information
  - Create structural views of interface objects
  - Represent object behavior
  - Isolate subsystems and models for each
  - Review the model using use cases as scenarios to determine validity

The Rumbaugh Method

- Object Modeling Technique (OMT)
  - Rumbaugh, J. et al., Object-Oriented Modeling and Design, Prentice-Hall, 1991
- Analysis activity creates three models
  - Object model
    - Objects, classes, hierarchies, and relationships
  - Dynamic model
    - object and system behavior
  - Functional model
    - High-level Data-Flow Diagram

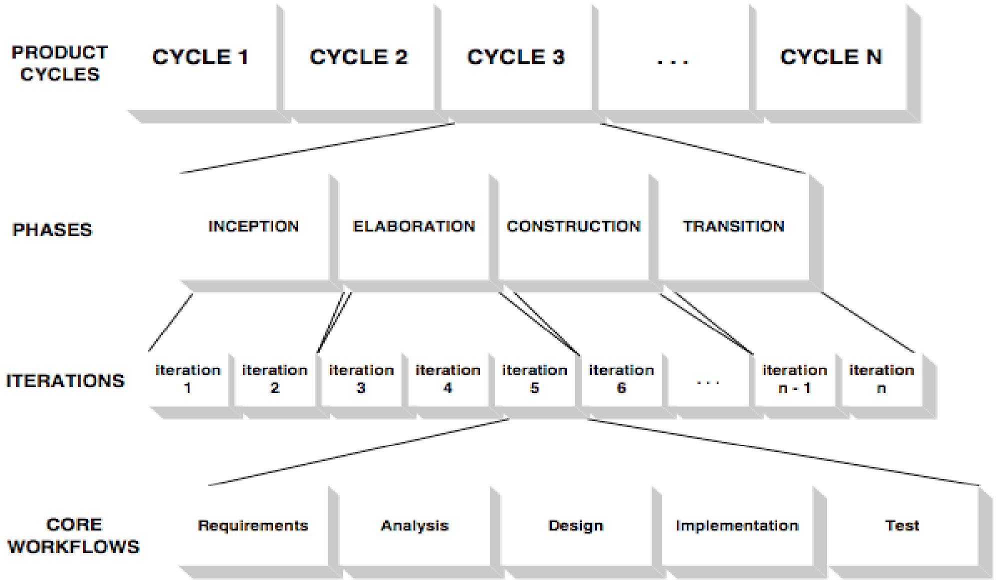
Rumbaugh, continued

- Develop a statement of scope for the problem
- Build an object model
  - Identify classes that are relevant for the problem
  - Define attributes and associations
  - Define object links
  - Organize object classes using inheritance
- Develop a dynamic model
  - Prepare scenarios
  - Define events and develop an event trace for each scenario
  - Construct an event flow diagram and a state diagram
  - Review behavior for consistency and completeness

Rumbaugh, continued

- Construct a functional model for the system
  - Identify inputs and outputs
  - Use data flow diagrams to represent flow transformations
  - Develop a processing specification for each process in the DFD
  - Specify constraints and optimization criteria
- Iterate!

Rational Unified Process: Overview



PRODUCT CYCLES

CYCLE 1 | CYCLE 2 | CYCLE 3 | . . . | CYCLE N

PHASES

INCEPTION | ELABORATION | CONSTRUCTION | TRANSITION

ITERATIONS

iteration 1 | iteration 2 | iteration 3 | iteration 4 | iteration 5 | iteration 6 | . . . | iteration n - 1 | iteration n

CORE WORKFLOWS

Requirements | Analysis | Design | Implementation | Test

Inception

- High-level planning for the project
- Determine the project’s scope
- If necessary
  - Determine business case for the project
    - Estimate cost and projected revenue

Elaboration

- Develop requirements and initial design
- Develop Plan for Construction phase
- Risk-driven approach
  - Requirements Risks
  - Technological Risks
  - Skills Risks
  - Political Risks

Requirements Risks

- Is the project technically feasible?
- Is the budget sufficient?
- Is the timeline sufficient?
- Has the user really specified the desired system?
- Do the developers understand the domain well enough?

Dealing with Reqs. Risks

- Construct models to record Domain and/or Design knowledge
  - Domain model (vocabulary)
  - Use Cases
  - Design model
    - Class diagrams
    - Activity diagrams
- Prototype construction

Dealing with Reqs. Risks

- Begin by learning about the domain
  - Record and define jargon
  - Talk with domain experts
    - Oftentimes end-users!
- Next construct Use cases
  - What are the required external functions of the system?
  - Iterative process; Use Cases can be added as they are discovered

Dealing with Reqs. Risks

- Finally, construct Design model
  - Class diagrams identify key domain concepts and their high-level relationships
  - Activity diagrams highlight the domain’s work practices
    - A major task here is identifying parallelism that can be exploited later
- Be sure to consolidate iterations into a final consistent model

Dealing with Reqs. Risks

- Build prototypes
  - Used only to help understand requirements
  - Throw them all out!
    - Do not be tied to an implementation too early
    - Make use of rapid prototyping tools
      - 4th Generation Programming Languages
      - Scripting and/or Interpreted environments
      - UI Builders
- Be prepared to educate the client as to the purpose of the prototype

Technology Risks

- Are you tied to a particular technology?
- Do you “own” that technology?
- Do you understand how different technologies interact?
- Techniques
  - Prototypes!
  - Class diagrams, package diagrams
  - “Scouting” — evaluate technology early

Skill Risks

- Do the members of the project team have the necessary skills and background to tackle the project?
- If not, try
  - Training
  - Consulting
  - Mentoring
  - Hiring people with the required skills

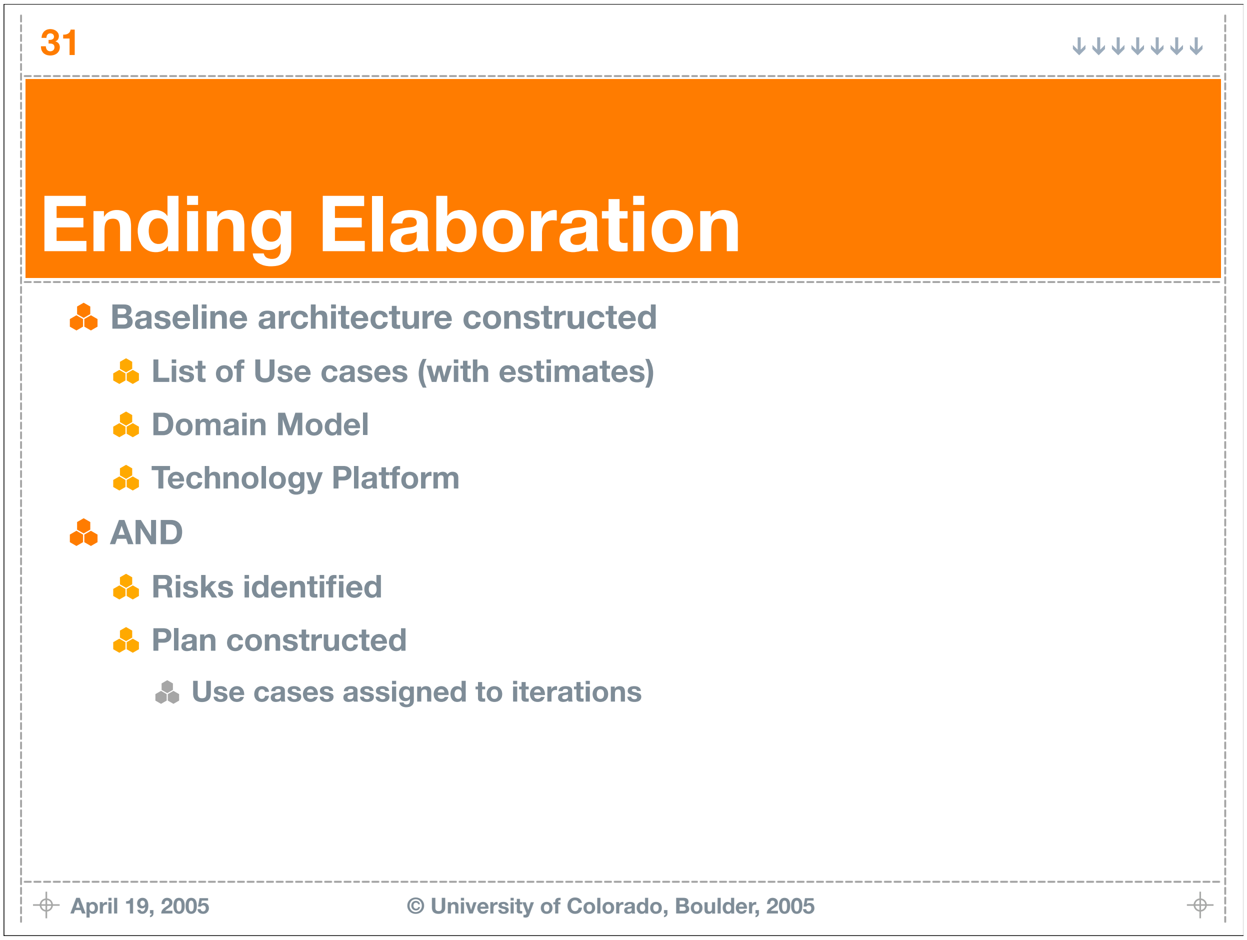
Political Risks

- How well does the proposed project mesh with corporate culture?
  - Consider the attempt to use Lotus Notes at Arthur Anderson
    - Lotus Notes attempts to promote collaboration
    - Arthur Anderson consultants compete with each other!
  - Consider e-mail: any employee can ignore the org chart and mail the CEO!
- Will the project directly compete with another business unit?
- Will it be at odds with some higher level manager’s business plan?

- Any of these can kill a project…

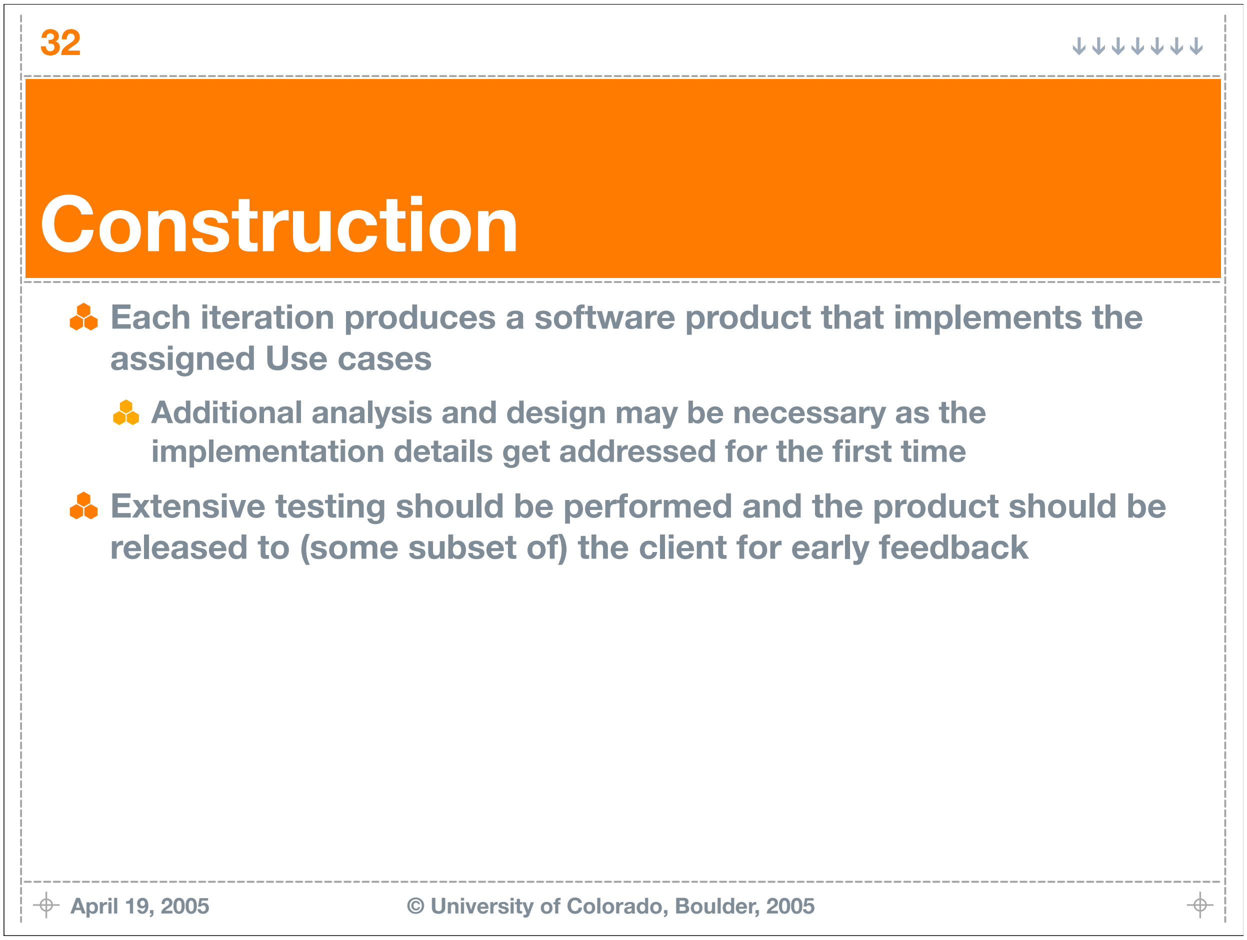
Reference

- Lotus Notes vs. Arthur Anderson
  - Orlikowski, W. J. (1992). "Learning from Notes: Organizational Issues in Groupware Implementation". Proceedings of ACM CSCW'92 Conference on Computer-Supported Cooperative Work: 362-369.



Ending Elaboration

- Baseline architecture constructed
  - List of Use cases (with estimates)
  - Domain Model
  - Technology Platform
- AND
  - Risks identified
  - Plan constructed
    - Use cases assigned to iterations



Construction

- Each iteration produces a software product that implements the assigned Use cases
  - Additional analysis and design may be necessary as the implementation details get addressed for the first time
- Extensive testing should be performed and the product should be released to (some subset of) the client for early feedback

Transition

- Final phase before release 1.0
- Optimizations can now be performed
  - Optimizing too early may result in the wrong part of the system being optimized
  - Largest boosts in performance come from replacing non-scalable algorithms or mitigating bottlenecks