
CIS 422/522

Software Life cycles and Process Models



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View of SE in this Course

- The purpose of software engineering is to *gain and maintain* intellectual and managerial control over the *products* and *processes* of software development.
- Intellectual control implies
 - We understand the developmental goals
 - Can distinguish good choices from bad
 - We can effectively build to meet our goals
 - Behavioral requirements (functionality)
 - Software Qualities (reliability, security, maintainability, etc.)
- Managerial control implies
 - We make accurate resource estimates
 - We deliver on schedule and within budget

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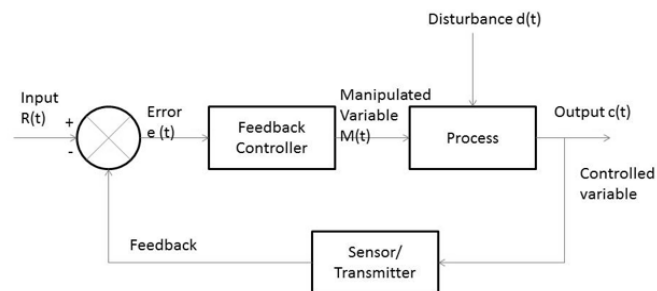
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Course Approach

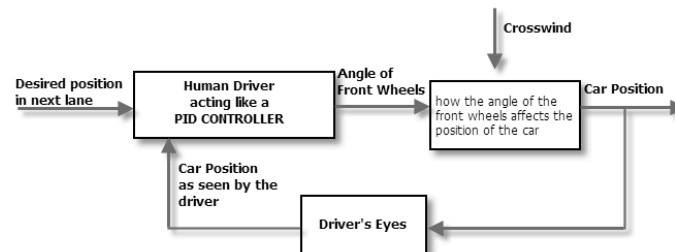
- Will learn practical methods for acquiring and maintaining control of software projects
- Intellectual control
 - Methods for software requirements, architecture, design, test
 - Modeling methods and notations
 - What to produce, how to make decisions, how to check correctness
- Managerial control
 - Planning and controlling development
 - Process models addressing development
 - People management and team organization
- Caveat: we can only simulate the problems of large developments

Control Realities

- Reality Check:
 - Cannot fully predict consequences of our choices
 - Control is never absolute
- Implication: maintaining control is an active process (view as a feedback-control loop)



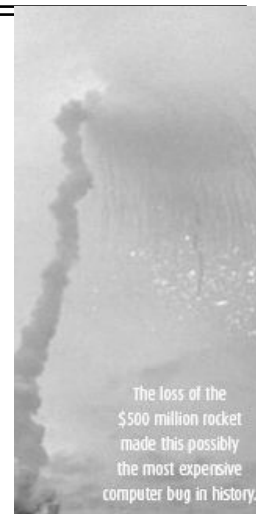
Active Control



- Control in a software development means
 - Understand where we want to be (ideal)
 - Evaluate current delta
 - Make adjustments

Control and Risk

- Risk: a *risk* is defined as a condition that can lead to a loss of control
 - Incorrect, misunderstood, or missing requirements
 - Poor design choices
 - Differing assumptions by developers
 - Inadequate testing, validation, etc.
- Can lead to delivering wrong product, late, over cost..
- Assessing and mitigating risk is a critical SE activity
- Assertion: well defined processes help organize work and control risks



Need to Organize the Work

- Nature of a software project
 - Software development produces a set of interlocking, interdependent work products
 - E.g. Requirements -> Design -> Code -> Test
 - Implies dependencies between tasks
 - Implies dependencies between people
- Must organize the work such that:
 - Every task gets done
 - Tasks get done in the right order
 - Tasks are done by the right people
 - The required qualities are built in
 - Steps are done on schedule to meet delivery

Addressed by Software Processes

- Developed as a conceptual tool for organizing complex software developments
- Answers the “who”, “what”, “when”, etc. questions
 - What product should we work on next?
 - What kind of person should do the work?
 - What information is needed to do the work?
 - When is the work finished?
- Intended use (idealized)
 1. *Model* of development (what does or should occur)
 2. *Guide* to developers in what to produce and when to produce it

Definitions

- *Software Life Cycle*: evolution of a software development effort from concept to retirement
- *Software Process Model*: Abstract representation of a software life cycle as a set of
 - *Activities*: tasks to be performed (how)
 - *Artifacts*: work products produced (what)
 - *Roles*: skills needed (who)
 - and the relationships between them
- *Software Process*: institutionalized version of a software model defining specific roles, activities, and artifacts

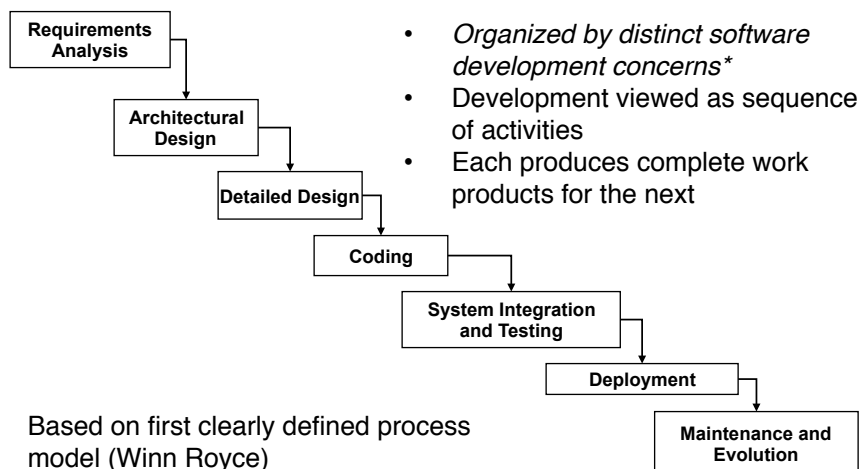
Examples of Use

- Software life-cycle: in choosing whether to build or buy, companies should consider the entire life-cycle cost of software
- Software process model: many companies are currently adapting some form of agile model of development
- Software process: organizations often standardize their software process across developments

Common Process Models

Waterfall
Prototyping
Iterative
Spiral
Agile

A “Waterfall” Model



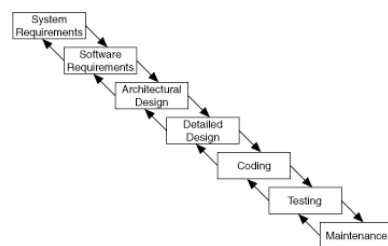
Activities, Artifacts & Roles

- **Requirements Analysis**
 - Activities: understand and define what the software must do and any properties it must have
 - Artifacts: Software Requirements Specification (SRS)
 - Roles: Requirements Analyst
- **Architectural Design**
 - Activities: decompose the problem into components that together satisfy the requirements
 - Artifacts: architectural design specification, interface specs.
 - Roles: Software Architect
- **Detail Design**
 - Activities: internal design of components (e.g., objects) defining algorithms and data structures supporting the interfaces
 - Artifacts: design documentation, code documentation
 - Roles: Coder

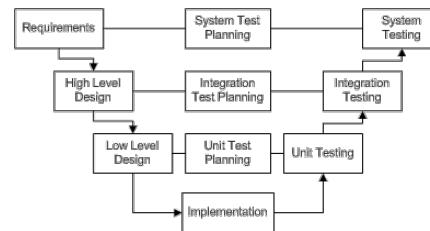
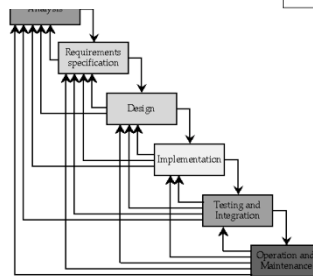
Activities, Artifacts & Roles

- **Implementation**
 - Activities: realization of the design in executable form
 - Artifacts: code, makefiles, etc.
 - Roles: Coder
- **Integration and Testing**
 - Activities: validation and verification of the implementation against requirements and design
 - Artifacts: test plan, test cases
 - Roles: tester, user (customer)
- **Maintenance (really multiple distinct activities)**
 - Activities: repair errors or update deployed system
 - Artifacts: bug fixes, patches, new versions
 - Roles: Architect, Coder, Tester

Waterfall Model Variations



There have been many variations



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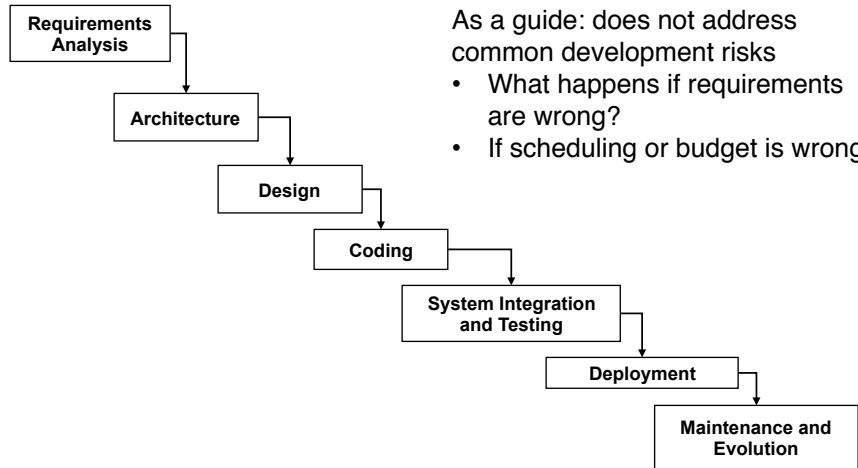
Issues with the Waterfall Model

- Variations created to address perceived shortcomings
- Model implies that you should complete each stage before moving on to the next
 - Implies that you can get the requirements right up front: does not account for inevitable changes
 - Implies testing and validation occur only when development is finished
 - Customers does not see the product until the end
 - Implies that once the product is finished, everything else is maintenance

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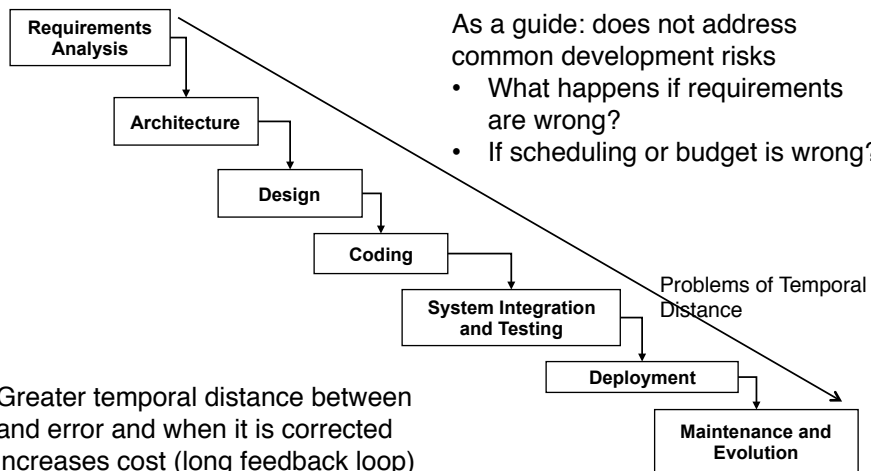
A "Waterfall" Model



As a guide: does not address common development risks

- What happens if requirements are wrong?
- If scheduling or budget is wrong?

A "Waterfall" Model*



As a guide: does not address common development risks

- What happens if requirements are wrong?
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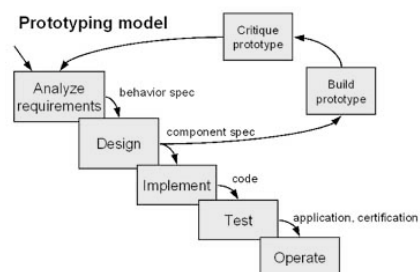
Greater temporal distance between and error and when it is corrected increases cost (long feedback loop)

Common Process Models

Waterfall
 Prototyping
 Iterative
 Spiral
 Agile

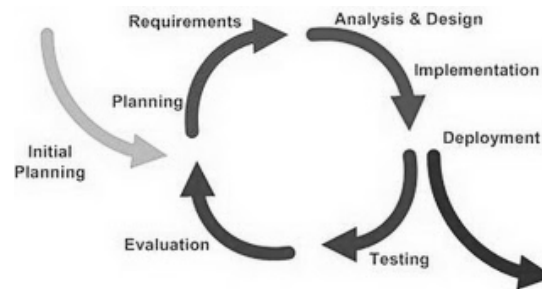
Characteristic Model: Prototyping

- Waterfall variation
- First system versions are prototypes, either:
 - Interface
 - Functional
- Which waterfall risks does this try to address?



Characteristic Processes: The Iterative Model

- Process is viewed as a sequence of iterations
 - Essentially, a *series of waterfalls*
 - Each iteration builds on the previous one (e.g., adds requirements, design components, code features, tests)
 - Each iteration produces complete set of work products deliverable software
 - Customers provide feedback on each release
 - There is no “maintenance” phase – each version includes problem fixes as well as new features



Iterative Model

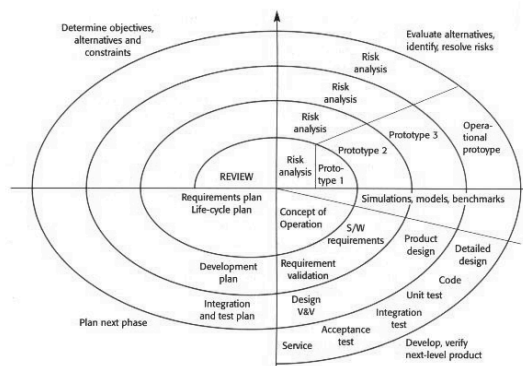
- Also called “incremental development”
- Addresses some common waterfall risks
 - Risk that software cannot be completed – build incremental subsets
 - Risk of building the wrong system – stakeholder have opportunities to see the software each increment
 - Each iteration provides checkpoint for feasibility, schedule, budget and others issues

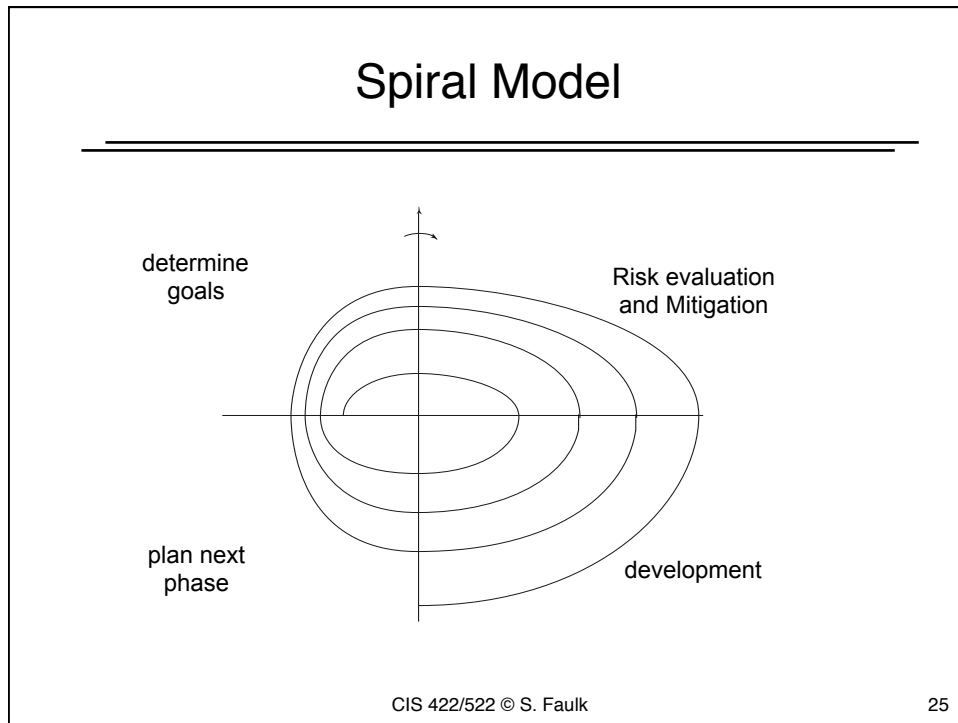
Advantages of Incremental Development

- Customers get usable functionality earlier than with waterfall
- Early feedback improves likelihood of producing a product that satisfies customers
 - Reduces market risk: if customers hate the product, find out before investing too much effort and money
- The quality of the final product is better
 - The core functionality is developed early and tested multiple times
 - Only a relatively small subset of functionality added in each release: easier to get it right and test it thoroughly
 - Detect design problems early and get a chance to redesign

Characteristic Processes: The Spiral Model

- Process viewed as repeating cycles of increasing scale
- Identify risks and determine (next set of) requirements
- Each cycle builds next version by extension, increasing scale each time



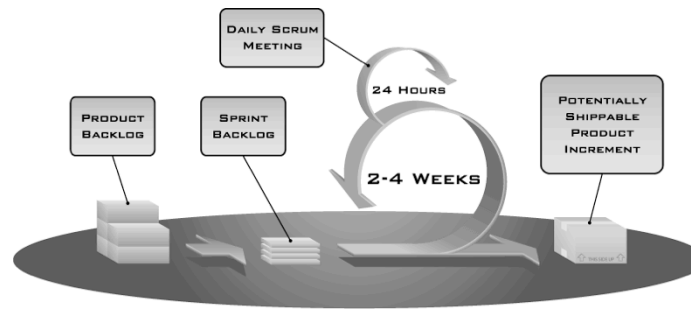


Spiral Model Characteristics

- Response lack of explicit risk analysis and risk mitigation in “waterfall” process
- Includes risk analysis and mitigation activities at each phase (e.g., prototyping)
- Explicit Go/No-Go decision points in process
- Heavy-weight process: substantial overhead not contributing directly to end products

Characteristic Processes: Agile (e.g. scrum)

- Process viewed as nested sequence of builds (sprints)
 - Each build adds very small feature set (one or two)
 - Nightly build/test, frequent customer validation
 - Focus on delivering code, little or no time spent on documentation



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How do we Choose a Development Process?

E.g., for your projects

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Objectives

- Goal: proceed as rationally and systematically as possible (i.e., in a controlled manner) from a statement of goals to a design that demonstrably meets those goals within design and management constraints
 - Understand that any process description is an abstraction
 - Always must compensate for deviation from the ideal (e.g., by iteration)
 - Still important to have a well-defined process to follow and measure against

A Software Engineering Perspective

- Question of control vs. cost: processes introduce *overhead*
- Choose process to provide an appropriate level of control for the given product and context
 - Sufficient control to mitigate risks, achieve results
 - No more than necessary to contain cost and effort
- Provides a basis for choosing or evaluating processes, methods, etc.
 - Does it achieve our objectives at reasonable cost?
 - Does it address the most important developmental risks?
- Need to agree on kind of control you need and how you will accomplish it

Take-away

- A process definition defines a model for organizing development work
- A process model should define
 - Activities (Tasks)
 - Artifacts (Products)
 - Roles (Skill sets)
- Delay (temporal distance) between when an error occurs and when it is fixed raises costs

Project Preparation

Worksite
Teams

Assignment

- **First Meeting**
 - Discuss relevant experiences and skills
 - Look at examples of the deliverables (pointers on Schedule page)
 - Choose people for roles (primary and backup)
 - Choose a team name, logo and put on Assembla page
- **Assembla workspace**
 - Understand how to use Wiki
 - Copy document templates (I'll supply)
 - Create first parts of project plan
 - Create first meeting notes, developer logs

Questions?