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 recourse estimates
    – We deliver on schedule and within budget
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

- Organized by distinct software development concerns*
- Development viewed as sequence of activities
- Each produces complete work products for the next

Based on first clearly defined process model (Winn Royce)
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

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
A “Waterfall” Model

As a guide: does not address common development risks
• What happens if requirements are wrong?
• If scheduling or budget is wrong?

Greater temporal distance between and error and when it is corrected increases cost (long feedback loop)
Common Process Models

Waterfall
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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

determine goals
Risk evaluation and Mitigation
plan next phase
development

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

How do we Choose a Development Process?

E.g., for your projects
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?