Chapter 2 Objectives

- What we mean by a “process”
- Software development products, processes, and resources
- Several models of the software development process
- Tools and techniques for process modeling

2.1 The Meaning of Process

- A process: a series of steps involving activities, constraints, and resources that produce an intended output of some kind

- A process involves a set of tools and techniques
2.1 The Meaning of Process

Process Characteristics

- Prescribes all major process activities
- Input:
  - Uses resources (e.g., customer input, specifications),
  - subject to set of constraints (such as schedule, platform reqts)
- Output: Produces intermediate and final products (e.g., models)
- Structure:
  - May be composed of subprocesses
  - with hierarchy or links
- Properties:
  - Each process activity has entry and exit criteria
  - Activities are organized in sequence, so timing is clear
  - Each process guiding principles, including goals of each activity
  - Constraints may apply to an activity, resource or product

The Importance of Processes

- Impose consistency and structure on a set of activities
- Guide us to understand, control, examine, and improve the activities
- Enable us to capture our experiences and pass them along
2.2 Software Process Models

Reasons for Modeling a Process

- To form a common understanding
- To find inconsistencies, redundancies, omissions
- To find and evaluate appropriate activities for reaching process goals
- To tailor a general process for a particular situation in which it will be used

Software Life Cycle

- When a process involves building a software, the process may be referred to as software life cycle
  - Requirements analysis and definition
  - System (architecture) design
  - Program (detailed/procedural) design
  - Writing programs (coding/implementation)
  - Testing: unit, integration, system
  - System delivery (deployment)
  - Maintenance
2.2 Software Process Models

Software Development Process Models

• Waterfall model
• V model
• Prototyping model
• Operational specification
• Transformational model
• Phased development: increments and iteration
• Spiral model
• Agile methods

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2.2 Software Process Models

Waterfall Model

• One of the first process development models proposed
• Works for well understood problems with minimal or no changes in the requirements
• Simple and easy to explain to customers
• It presents
  – a very high-level view of the development process
  – sequence of process activities
• Each major phase is marked by milestones and deliverables (artifacts)
2.2 Software Process Models
Waterfall Model (continued)

• There is no iteration in waterfall model
• Most software developments apply a great many iterations
2.2 Software Process Models

Sidebar 2.1 Drawbacks of The Waterfall Model

- Provides no guidance how to handle changes to products and activities during development (assumes requirements can be frozen)
- Views software development as manufacturing process rather than as creative process
- There is no iterative activities that lead to creating a final product
- Long wait before a final product

Waterfall Model with Prototype

- Different types of prototype:
  - Requirements: User interface shell to illustrate observable behavior (i.e., used to elicit reqts info)
  - Design: A prototype can be a partially developed product (black box design details and/or components)
- Prototyping helps
  - users understand what the system will be like (user interface prototype)
  - developers assess alternative design strategies (design prototype)
- Prototyping is useful for verification and validation
2.2 Software Process Models
Waterfall Model with Prototype (continued)

- Waterfall model with prototyping

2.2 Software Process Models
V Model (continued)
2.2 Software Process Models

**V Model**

- A variation of the waterfall model
- Uses unit testing to verify procedural design
- Uses integration testing to verify architectural (system) design
- Uses acceptance testing to validate the requirements
- If problems are found during verification and validation, the left side of the V can be re-executed before testing on the right side is re-enacted

**Prototyping Model**

- Allows repeated investigation of the requirements or design
- Reduces risk and uncertainty in the development
2.2 Software Process Models

Operational Specification Model

- Requirements are executed (examined) and their implication evaluated early in the development process
- Functionality and the design are allowed to be merged

Transformational Model

- Fewer major development steps
- Applies a series of transformations
  - Change data representation
  - Select algorithms
  - Optimize
  - Compile
- Relies on formalism
- Requires formal specification (to allow transformations)
2.2 Software Process Models
Phased Development: Increments and Iterations

• Shorter cycle time
• System delivered in pieces
  – enables customers to have some functionality while rest is being developed
• Allows two systems functioning in parallel
  – the production system (release n): currently being used
  – the development system (release n+1): the next version
2.2 Software Process Models
Phased Development: Increments and Iterations
(continued)

- **Incremental development**: starts with small functional subsystem and adds functionality with each new release
- **Iterative development**: starts with full system, then changes functionality of each subsystem with each new release

Phased development is desirable for several reasons
- Training can begin early, even though some functions are missing
- Markets can be created early for functionality that has never before been offered
- Frequent releases allow developers to fix unanticipated problems globally and quickly
- The development team can focus on different areas of expertise with different releases
2.2 Software Process Models

Spiral Model

- Suggested by Barry Boehm (1988)
- Combines development activities with risk management to minimize and control risks
- The model is presented as a spiral in which each iteration is represented by a circuit around four major activities
  - Plan
  - Determine goals, alternatives and constraints
  - Evaluate alternatives and risks
  - Develop and test

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![Spiral Model Diagram](image-url)
2.2 Software Process Models
Agile Methods

- Emphasis on flexibility in producing software quickly and capably

- Agile manifesto
  - Value individuals and interactions over process and tools
  - Prefer to invest time in producing working software rather than in producing comprehensive documentation
  - Focus on customer collaboration rather than contract negotiation
  - Concentrate on responding to change rather than on creating a plan and then following it

2.2 Software Process Models
Agile Methods: Examples of Agile Process

- Extreme programming (XP)
- Crystal: a collection of approaches based on the notion that every project needs a unique set of policies and conventions
- Scrum: 30-day iterations; multiple self-organizing teams; daily “scrum” coordination
- Adaptive software development (ASD)
2.2 Software Process Models
Agile Methods: Extreme Programming

- Emphasis on four characteristics of agility
  - Communication: continual interchange between customers and developers
  - Simplicity: select the simplest design or implementation
  - Courage: commitment to delivering functionality early and often
  - Feedback: loops built into the various activities during the development process

2.2 Software Process Models
Agile Methods: Twelve Facets of XP

- The planning game (customer defines value)
- Small release
- Metaphor (common vision, common names)
- Simple design
- Writing tests first
- Refactoring
- Pair programming
- Collective ownership
- Continuous integration (small increments)
- Sustainable pace (40 hours/week)
- On–site customer
- Coding standard
2.2 Software Process Models
Sidebar 2.2 When Extreme is Too Extreme?

• Extreme programming's practices are interdependent
  – A vulnerability if one of them is modified
• Requirements expressed as a set of test cases must be passed by the software
  – System passes the tests but is not what the customer is paying for
• Refactoring issue
  – Difficult to rework a system without degrading its architecture

2.7 What this Chapter Means for You

• Process development involves activities, resources, and product
• Process model includes organizational, functional, behavioral and other perspectives
• A process model is useful for guiding team behavior, coordination and collaboration
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