SOFTWARE PROCESS MODELS
Software Process Models

• Process model (Life-cycle model) - steps through which the product progresses
  • Requirements phase
  • Specification phase
  • Design phase
  • Implementation phase
  • Integration phase
  • Maintenance phase
  • Retirement
Overview

- Different process models
  - Build-and-fix model
  - Waterfall model
  - Incremental model
  - Evolutionary process models
    - Rapid prototyping model
    - Spiral model
  - Agile process models
    - Extreme programming
  - Synchronize-and-stabilize model
  - Object-oriented life-cycle models
    - Fountain Model
    - Unified Process
Build-and-Fix Model

- Problems
  - No specifications
  - No design
- Totally unsatisfactory
  - High cost
  - Difficult maintenance
Waterfall Model

• Only model widely used until early 1980s

• Characterized by
  • Feedback loops
  • Documentation-driven
Waterfall Model (contd)

• Advantages
  • Enforces disciplined approach
    o Documentation for each phase
    o Products of each phase checked by SQA group
  • Maintenance is easier
    o Every change reflected in the relevant documentation

• Disadvantages
  • Working version of the software will not be available until late in the project time-span
  • Specifications are long, detailed, written in a style unfamiliar to the client
  • “Blocking states” – some project team members must wait for other team members to complete dependent tasks
Incremental Model

- Divide project into builds – modules interacting to provide a specific functionality

- Typical product - 5 to 25 builds
Incremental Model (contd)

- Waterfall and rapid prototyping models
  - Deliver complete product at the end
- Incremental model
  - Deliver portion of the product at each stage
- Advantages
  - Less traumatic
  - Smaller capital outlay, rapid return on investment
  - Open architecture—maintenance implications
- Disadvantages
  - Easily can degenerate into build-and-fix model
  - Contradiction in terms
Incremental Model (contd)

- Concurrent incremental model
  - more risky version — pieces may not fit
Rapid Prototyping Model

- First step - construct the prototype as rapidly as possible
  - Only those aspects of the software that will be visible to the customer/user

- Linear model – no feedback loops
Rapid Prototyping Model (contd)

• Rapid prototype
  • Used in the requirements phase
  • Evaluated by the customer/user
  • Then, it is discarded - do not turn into product

• Rapid prototyping model is not proven and has its own problems
  • Possible solution
    o Rapid prototyping for defining requirements
    o Waterfall model for rest of life cycle
Spiral Model

- Minimize risk via the use of prototype and other means
  - Simplified form - Waterfall model plus risk analysis
- Precede each phase by
  - Alternatives
  - Risk analysis
- Follow each phase by
  - Evaluation
  - Planning of next phase
Simplified Spiral Model

- If risks cannot be resolved, project may be terminated immediately
Full Spiral Model (contd)

- Radial dimension
  - cumulative cost to date
- Angular dimension
  - progress through the spiral
Analysis of Spiral Model

• **Strengths**
  - Answers the question “How much to test?” in terms of risk
  - No distinction between development and maintenance (another cycle of the model)

• **Weaknesses**
  - Internal (in-house) development only
    - For contract software, all risk analysis must be performed before the contract is signed, not in the spiral model
  - Large-scale software only
    - For small software performing risk analysis would significantly affect the profit potential
Agile Process Models

- Agile software engineering combines a philosophy and a set of development guidelines
- Philosophy
  - Encourages customer satisfaction and early incremental delivery of the software
  - Small highly motivated project teams
  - Informal methods
  - Minimal software engineering work products
  - Overall development simplicity
- Development guidelines
  - Stress delivery over analysis and design
  - Active and continuous communication between developers and customers
Agile Process Models (contd)

- There are many agile process models
  - **Extreme Programming (XP)**
  - Adaptive Software Development (ASD)
  - Dynamic System Development Method (DSDM)
  - Scrum
  - Crystal
  - Feature Driven Development (FDD)
  - Agile Modeling (AM)

**Reading:** Choose “Agile Methods” from

[http://www.computer.org/portal/site/seportal/index.jsp](http://www.computer.org/portal/site/seportal/index.jsp)
Extreme Programming (XP)

- Somewhat controversial new approach; variation of the incremental model
- First step
  - Determine features that client wants (stories)
  - Estimate duration and cost of each feature
- Client selects stories for each successive build
- Each build is divided into tasks
- Test cases for a task are drawn up
- Pair programming – working with a partner on one screen
- Continuous integration of tasks
Extreme Programming (contd)

http://www.extremeprogramming.org/
Features of XP

- Computers are put in center of large room lined with cubicles
- Client representative works with the XP team at all the times
- Individual cannot work overtime for 2 successive weeks
- There is no specialization
  - all members of the XP team work on specification, design, code, and testing
- There is no overall design phase before various builds are constructed – refactoring
Features of XP

• Advantages
  • Useful when requirements are vague or changing
  • Emphasis on teamwork and communication
  • Programmer estimates before committing to a schedule
  • Continuous measurement; frequent, extensive testing

• Disadvantages
  • Limited to small products and small teams - can be disastrous when programs are larger than a few thousand lines of code or when the work involves more than a few people.
  • Lack of design documentation
  • Lack of a structured review process
Synchronize-and-Stabilize Model

- **Microsoft’s life-cycle model** – version of incremental model
- Requirements analysis — interview potential customers; list of features with priorities
- Draw up specifications
- Divide project into 3 or 4 builds
- Each build is carried out by small teams working in parallel
Synchronize-and-Stabilize Model (contd)

• At the end of the day — synchronize (put together partially completed components; test and debug)

• At the end of the build — stabilize (fix the remaining faults; freeze build)

• Advantages
  • Components always work together
  • Early insights into operation of product
  • Model can be used even the initial specification is incomplete
Object-Oriented Life-Cycle Models

• Need for iteration within and between phases
  • Fountain model
  • Unified software development process

• All incorporate some form of
  • Iteration
  • Parallelism
  • Incremental development
Fountain Model

- Overlap (parallelism)
- Arrows (iteration)
- Smaller maintenance circle
Unified Process

• Unified process is a framework for OO software engineering using UML (Unified Modeling Language)
  • Book by Ivar Jacobson, Grady Booch, and James Rumbaugh (1999)

• Unified process (UP) is an attempt to draw on the best features and characteristics of conventional software process models, but characterize them in a way that implements many of the best principles of agile software development
Unified Process: Phases

• **Inception phase**
  - Encompasses the customer communication and planning activities
  - Rough architecture, plan, preliminary use-cases

• **Elaboration phase**
  - Encompasses the customer communication and modeling activities
  - Refines and expands preliminary use-cases
  - Expands architectural representation to include: use-case model, analysis model, design model, implementation model, and deployment model
  - The plan is carefully reviewed and modified if needed

• **Construction phase**
  - Analysis and design models are completed to reflect the final version of the software increment
  - Using the architectural model as an input develop or acquire the software components, unit tests are designed and executed, integration activities are conducted
  - Use-cases are used to derive acceptance tests
Unified Process: Phases

• Transition phase
  • Software is given to end-users for beta testing
  • User report both defects and necessary changes
  • Support information is created (e.g., user manuals, installation procedures)
  • Software increment becomes usable software release

• Production phase
  • Software use is monitored
  • Defect reports and requests for changes are submitted and evaluated
Unified Process: Major work products

**Inception phase**
- Vision document
- Initial use-case model
- Initial project glossary
- Initial business case
- Initial risk assessment
- Project plan
  - phases and iterations
- Business model if necessary
- One or more prototypes

**Elaboration phase**
- Use-case model
- Supplementary requirements, including non-functional
- Analysis model
- Software architecture description
- Executable architectural prototype
- Preliminary design model
- Revised risk list
- Project plan including
  - iteration plan
  - adapted workflows
  - milestones
  - technical work products
- Preliminary user manual
Unified Process: Major work products

**Construction phase**
- Design model
- Software components
- Integrated software increment
- Test plan and procedure
- Test cases
- Support documentation
  - User manuals
  - Installation manuals
  - Description of current increment

**Transition phase**
- Delivered software increment
- Beta test reports
- General user feedback
Conclusions

• Different process models, each with its own strengths and weaknesses

• Criteria for deciding on a model include
  • Organization
  • Its management style
  • Skills of the employees
  • Product nature