Software Engineering

Session 2 – Main Theme
Software Development Lifecycles (SDLCs)
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Presentation material partially based on textbook slides
Software Engineering: A Practitioner’s Approach (7/e)
by Roger S. Pressman
Agenda – Session Overview

1. Session Overview
2. Software Engineering LifeCycles (SDLCs)
3. Summary and Conclusion
What is the class about?

- Course description and syllabus:
  - http://www.nyu.edu/classes/jcf/g22.2440-001/
  - http://www.cs.nyu.edu/courses/spring14/G22.2440-001/

- Textbooks:
  - *Software Engineering: A Practitioner’s Approach*
    Roger S. Pressman
    McGraw-Hill Higher International
    - http://highered.mcgraw-hill.com/sites/0073375977/information_center_view0/
Agenda

- Software Engineering Detailed
- Process Models
- Agile Development
- Software Engineering Knowledge
- Roles and Types of Standards
  - ISO 12207: Life Cycle Standard
  - IEEE Standards for Software Engineering Processes and Specifications
- Summary and Conclusion
  - Readings
  - Assignment #1
  - Course Project
Agenda

1. Session Overview
2. Software Engineering LifeCycles (SDLCs)
3. Summary and Conclusion
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System Development Life Cycle:
- It is about developing a software-driven solution to a business problem
- It concerns a process which takes from two months to two years
- This is called a System Development Life Cycle but it should really be called a (Business) Solution Development Life Cycle
Some realities

- A concerted effort should be made to understand the problem before a software solution is developed
- Design becomes a pivotal activity
- Software should exhibit high quality
- Software should be maintainable

The seminal definition

- Software engineering is the establishment and use of sound engineering principles in order to obtain economically software that is reliable and works efficiently on real machines
The IEEE definition

Software Engineering:

(1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software

(2) The study of approaches as in (1)
A Layered Technology

Software Engineering

process model

methods

tools

a “quality” focus
A Process Framework

Process framework
Framework activities
- work tasks
- work products
- milestones & deliverables
- QA checkpoints

Umbrella Activities
Framework Activities

- Communication
- Planning
- Modeling
  - Analysis of requirements
  - Design
- Construction
  - Code generation
  - Testing
- Deployment
Umbrella Activities

- Software project management
- Formal technical reviews
- Software quality assurance
- Software configuration management
- Work product preparation and production
- Reusability management
- Measurement
- Risk management
Adapting a Process Model

- The overall flow of activities, actions, and tasks and the interdependencies among them
- The degree to which actions and tasks are defined within each framework activity
- The degree to which work products are identified and required
- The manner which quality assurance activities are applied
- The manner in which project tracking and control activities are applied
- The overall degree of detail and rigor with which the process is described
- The degree to which the customer and other stakeholders are involved with the project
- The level of autonomy given to the software team
- The degree to which team organization and roles are prescribed
Polya* suggests:

1. Understand the problem (communication and analysis)
2. Plan a solution (modeling and software design)
3. Carry out the plan (code generation)
4. Examine the result for accuracy (testing and quality assurance)

* [http://www.stevemcconnell.com/rl-top10.htm](http://www.stevemcconnell.com/rl-top10.htm)
Understand the Problem

- **Who has a stake in the solution to the problem?** That is, who are the stakeholders?
- **What are the unknowns?** What data, functions, and features are required to properly solve the problem?
- **Can the problem be compartmentalized?** Is it possible to represent smaller problems that may be easier to understand?
- **Can the problem be represented graphically?** Can an analysis model be created?
Plan the Solution

- **Have you seen similar problems before?** Are there patterns that are recognizable in a potential solution? Is there existing software that implements the data, functions, and features that are required?

- **Has a similar problem been solved?** If so, are elements of the solution reusable?

- **Can subproblems be defined?** If so, are solutions readily apparent for the subproblems?

- **Can you represent a solution in a manner that leads to effective implementation?** Can a design model be created?
Does the solution conform to the plan? Is source code traceable to the design model?

Is each component part of the solution provably correct? Has the design and code been reviewed, or better, have correctness proofs been applied to algorithm?
Examine the Result

- **Is it possible to test each component part of the solution?** Has a reasonable testing strategy been implemented?

- **Does the solution produce results that conform to the data, functions, and features that are required?** Has the software been validated against all stakeholder requirements?
David Hooker’s General Principles*

- 1: The Reason It All Exists
- 2: KISS (Keep It Simple, Stupid!)
- 3: Maintain the Vision
- 4: What You Produce, Others Will Consume
- 5: Be Open to the Future
- 6: Plan Ahead for Reuse
- 7: Think!

Software Myths

- Affect managers, customers (and other non-technical stakeholders) and practitioners
- Are believable because they often have elements of truth,

*but* …

- Invariably lead to bad decisions,

*therefore* …

- Insist on reality as you navigate your way through software engineering
Every software project is precipitated by some business need

- The need to correct a defect in an existing application;
- The need to adapt a ‘legacy system’ to a changing business environment;
- The need to extend the functions and features of an existing application, or
- The need to create a new product, service, or system.
Whatever form it takes, it is always followed by a maintenance cycle:

- Maintenance is the most expensive part
- If all the steps are done carefully maintenance is reduced
- For maintenance to be effective, documentation must exist
A software-driven solution consists of two parts:

- **Model**
  - Prototypes
  - Diagrams and supporting Documents

- **System**
  - Hardware
  - Software
Some Definitions (1/3)

- **Prototype**
  - An initial software-driven solution usually done with a rapid development tool
  - Usually has limited functionality
  - Users can see results very quickly

- **Planning**
  - The process of gathering what is needed to solve a business problem
  - Includes a feasibility study
  - Includes project steps
Some Definitions (2/3)

- **Analysis**
  - The process of determining detail requirements in the form of a model

- **Design**
  - The process of drawing blueprints for a new system at a high-level first then at a detailed level

- **Construction**
  - The actual coding of the model into a software package
  - Uses one or more programming languages
    - Java
    - C#
    - C++
    - etc.
Some Definitions (3/3)

- **Implementation**
  - Doing whatever is necessary to startup a system
  - Includes:
    - Database
    - Networks
    - Hardware configuration

- **Maintenance**
  - Doing whatever is necessary to keep a system running
  - Includes:
    - Repairs to correct errors
    - Enhancements to accommodate changes in requirements
Deliverables consist mainly of diagrams and their supporting documentation.

For example:

- Models that emphasize dynamics
- Models that emphasize structure
- Models can be used for specifying the outcome of analysis
- Models can be used for specifying the outcome of design
Planning:

- **System Functions**
  - A simple list of each requirement a system must do
  - For example:
    - record video rental
    - calculate fine

- **System Attributes**
  - A simple property describing each requirement of a system
  - For example:
    - record video rental under 15 seconds
    - calculate fine and return response in 5 seconds
Sample Deliverables – Planning (2/3)

- Planning:

**Environmental Diagram**

Rent Video → Video Store

Information System → Clerk

Pay Employees → Employees
Planning:

Prototype

- Recall it is a first system usually done with a rapid development tool
- Since users can see results very quickly they will pay attention
- Final product is seldom created in same tool as the prototype
Analysis:

- Use case
  - Shows the dynamics between the users (actors) of the system and the system itself
  - This is a narrative representation
- Conceptual Diagram
  - Shows the structure of the objects and their relationships
  - This is a graphical representation
- System Sequence Diagram
  - Shows the dynamics between the users (actors) of the system and the system itself
  - This is a graphical representation
- Contracts
  - Shows the state of each object before each action
  - This is a narrative representation
Sample High-Level Architecture Design Logical Blueprint

Legend:
- In scope
- Out of scope

Business Functions
- Users
- Facilitators
- Clients

Connectivity
- University Internal LAN
- University Intranet WAN

e-Business Portal
- Facilitator Interfaces
- XML/Web Enabling Facilities
- Component Manager Application Logic
- Support Services
- Connectors

Legacy Systems
- University Systems
- Client Administration
- Back-Office Systems
- Client Support Systems

In-Memory Database
- Customer Profiles
- Time Critical Information

XML MOM & POP
- XML Core Services
- XML MOA/POP

SML Data
- XML Core Services
- Operational Data

Local Account Data
- Entitlement/Security Data

Legacy Systems
- Educational Research
- Educational News

Desktop File Systems
- Content Mgmt Repository
- Global Application Data Repository
- Business Information Repository

Educational Research
- Global Educational

Support Systems
- University Intranet LAN
Design:

- Interaction Diagram
  - Shows the interaction between objects
  - This is a graphic representation
  - It is a dynamic blueprint

- Class Diagram
  - Shows the structure between objects
  - Shows the structure inside objects
  - This is a graphic representation
  - It is a static blueprint
Agenda – Software Engineering Lifecycles (SDLCs)

2. Software Engineering LifeCycles SDLCs
   - Software Engineering Detailed
   - Process Models
   - Agile Development
   - Software Engineering Knowledge
   - Roles and Types of Standards
A Generic Process Model

Software process

Process framework

Umbrella activities

framework activity # 1
software engineering action #1.1

Task sets
- work tasks
- work products
- quality assurance points
- project milestones

software engineering action #1.k

Task sets
- work tasks
- work products
- quality assurance points
- project milestones

framework activity # n
software engineering action #n.1

Task sets
- work tasks
- work products
- quality assurance points
- project milestones

software engineering action #n.m

Task sets
- work tasks
- work products
- quality assurance points
- project milestones
Process Flow

(a) linear process flow

(b) iterative process flow

(c) evolutionary process flow

(d) parallel process flow
A task set defines the actual work to be done to accomplish the objectives of a software engineering action

- A list of the tasks to be accomplished
- A list of the work products to be produced
- A list of the quality assurance filters to be applied
A *process pattern* describes a process-related problem that is encountered during software engineering work, identifies the environment in which the problem has been encountered, and suggests one or more proven solutions to the problem.

Stated in more general terms, a process pattern provides you with a *template* [Amb98] - a consistent method for describing problem solutions within the context of the software process.
Process Pattern Types

- **Stage patterns** - defines a problem associated with a framework activity for the process
- **Task patterns** - defines a problem associated with a software engineering action or work task and relevant to successful software engineering practice
- **Phase patterns** - define the sequence of framework activities that occur with the process, even when the overall flow of activities is iterative in nature
Prescriptive Models

- Prescriptive process models advocate an orderly approach to software engineering

That leads to a few questions …

- If prescriptive process models strive for structure and order, are they inappropriate for a software world that thrives on change?

- Yet, if we reject traditional process models (and the order they imply) and replace them with something less structured, do we make it impossible to achieve coordination and coherence in software work?
The Waterfall Model Revisited

Communication
- project initiation
- requirement gathering

Planning
- estimating
- scheduling
- tracking

Modeling
- analysis
- design

Construction
- code
- test

Deployment
- delivery
- support
- feedback
The V-Model

Requirements modeling → Acceptance Testing

Architectural Design → System Testing

Component Design → Integration Testing

Code Generation → Unit Testing

Executable software
Evolutionary Models: Prototyping
Modeling activity

- Under development
- Awaiting changes
- Under revision
- Under review
- Baselined
- Done

represents the state of a software engineering activity or task.
Still Other Process Models

- **Component based development**—the process to apply when reuse is a development objective
- **Formal methods**—emphasizes the mathematical specification of requirements
- **AOSD**—provides a process and methodological approach for defining, specifying, designing, and constructing aspects
- **Unified Process**—a “use-case driven, architecture-centric, iterative and incremental” software process closely aligned with the Unified Modeling Language (UML)
The Unified Process (UP)

- **Inception**
- **Elaboration**
- **Construction**
- **Transition**
- **Deployment**
- **Planning**
- **Modeling**

- Release
  - Software increment

- Production
UP Phases

**Workflows**
- Requirements
- Analysis
- Design
- Implementation
- Test
- Support

**Iterations**

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<thead>
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<th>Inception</th>
<th>Elaboration</th>
<th>Construction</th>
<th>Transition</th>
<th>Production</th>
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<p>| #1 | #2 |...| #n-1 | #n |</p>
<table>
<thead>
<tr>
<th>Inception phase</th>
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<tbody>
<tr>
<td>Vision document</td>
</tr>
<tr>
<td>Initial use-case model</td>
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<tr>
<td>Initial project glossary</td>
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<tr>
<td>Initial business case</td>
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<tr>
<td>Initial risk assessment.</td>
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<tr>
<td>Project plan,</td>
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<td>phases and iterations.</td>
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<tr>
<td>Business model,</td>
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<tr>
<td>if necessary.</td>
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<tr>
<td>One or more prototypes</td>
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<table>
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<tr>
<th>Elaboration phase</th>
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<tbody>
<tr>
<td>Use-case model</td>
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<tr>
<td>Supplementary requirements including non-functional</td>
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<tr>
<td>Analysis model</td>
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<tr>
<td>Software architecture</td>
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<tr>
<td>Description.</td>
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<tr>
<td>Executable architectural prototype.</td>
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<tr>
<td>Preliminary design model</td>
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<tr>
<td>Revised risk list</td>
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<tr>
<td>Project plan including iteration plan</td>
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<tr>
<td>Adapted workflows</td>
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<tr>
<td>Milestones</td>
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<tr>
<td>Technical work products</td>
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<tr>
<td>Preliminary user manual</td>
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<table>
<thead>
<tr>
<th>Construction phase</th>
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<tr>
<td>Design model</td>
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<tr>
<td>Software components</td>
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<tr>
<td>Integrated software increment</td>
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<td>Test plan and procedure</td>
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<tr>
<td>Test cases</td>
</tr>
<tr>
<td>Support documentation</td>
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<tr>
<td>User manuals</td>
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<tr>
<td>Installation manuals</td>
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<tr>
<td>Description of current increment</td>
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<table>
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<tr>
<th>Transition phase</th>
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<tbody>
<tr>
<td>Delivered software increment</td>
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<tr>
<td>Beta test reports</td>
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<tr>
<td>General user feedback</td>
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Personal Software Process (PSP)

- **Planning.** This activity isolates requirements and develops both size and resource estimates. In addition, a defect estimate (the number of defects projected for the work) is made. All metrics are recorded on worksheets or templates. Finally, development tasks are identified and a project schedule is created.

- **High-level design.** External specifications for each component to be constructed are developed and a component design is created. Prototypes are built when uncertainty exists. All issues are recorded and tracked.

- **High-level design review.** Formal verification methods (Chapter 21 of the course textbook) are applied to uncover errors in the design. Metrics are maintained for all important tasks and work results.

- **Development.** The component level design is refined and reviewed. Code is generated, reviewed, compiled, and tested. Metrics are maintained for all important tasks and work results.

- **Postmortem.** Using the measures and metrics collected (this is a substantial amount of data that should be analyzed statistically), the effectiveness of the process is determined. Measures and metrics should provide guidance for modifying the process to improve its effectiveness.
Team Software Process (TSP)

- Build self-directed teams that plan and track their work, establish goals, and own their processes and plans. These can be pure software teams or integrated product teams (IPT) of three to about 20 engineers.
- Show managers how to coach and motivate their teams and how to help them sustain peak performance.
- Accelerate software process improvement by making CMM Level 5 behavior normal and expected.
  - The Capability Maturity Model (CMM), a measure of the effectiveness of a software process, is discussed in Chapter 30 of the course textbook.
- Provide improvement guidance to high-maturity organizations.
- Facilitate university teaching of industrial-grade team skills.
The Capability Maturity Model for Software (SW-CMM) is used by organizations to guide their software process improvement efforts.

Personal Software Process
  - [http://www.sei.cmu.edu/tsp/psp.html](http://www.sei.cmu.edu/tsp/psp.html)

The Team Software Process (TSP) was designed to implement effective, high-maturity processes for project teams.

If all projects in an organization are using the TSP, does the organization exhibit the characteristics of high process maturity, as described in the SW-CMM?
  - [http://www.sei.cmu.edu/pub/documents/02.reports/pdf/02tr008.pdf](http://www.sei.cmu.edu/pub/documents/02.reports/pdf/02tr008.pdf)
IDEAL is an organizational improvement model
Team Exercise #1 – Groups will present in class

- Research and put together a comparative write-up or traditional Process Models:
  - Waterfall
  - V
  - Phased
  - Evolutionary
  - Spiral
  - CBSE
  - RUP
  - PSP/TSP
Agenda – Software Engineering Lifecycles (SDLCs)

2. Software Engineering LifeCycles SDLCs

- Software Engineering Detailed
- Process Models
- Agile Development
- Software Engineering Knowledge
- Roles and Types of Standards
“We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

• *Individuals and interactions* over processes and tools
• *Working software* over comprehensive documentation
• *Customer collaboration* over contract negotiation
• *Responding to change* over following a plan

That is, while there is value in the items on the right, we value the items on the left more.”

*Kent Beck et al*
What is “Agility”?

- Effective (rapid and adaptive) response to change
- Effective communication among all stakeholders
- Drawing the customer onto the team
- Organizing a team so that it is in control of the work performed

**Yielding …**

- Rapid, incremental delivery of software
Agility and the Cost of Change

devlopment cost

development schedule progress

cost of change using conventional software processes

cost of change using agile processes

idealized cost of change using agile process
An Agile Process

- Is driven by customer descriptions of what is required (scenarios)
- Recognizes that plans are short-lived
- Develops software iteratively with a heavy emphasis on construction activities
- Delivers multiple ‘software increments’
- Adapts as changes occur
1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

4. Business people and developers must work together daily throughout the project.

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

9. Continuous attention to technical excellence and good design enhances agility.

10. Simplicity – the art of maximizing the amount of work not done – is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.
Human Factors Revisited

- *the process molds to the needs of the people and team, not the other way around*

- key traits must exist among the people on an agile team and the team itself:
  - » Competence.
  - » Common focus.
  - » Collaboration.
  - » Decision-making ability.
  - » Fuzzy problem-solving ability.
  - » Mutual trust and respect.
  - » Self-organization.
- A lightweight software methodology
  - Few rules and practices or ones which are easy to follow
  - Emphasizes customer involvement and promotes team work
- See XP’s rules and practices at [http://www.extremeprogramming.org/rules.html](http://www.extremeprogramming.org/rules.html)
Extreme Programming (XP) (1/3)

- The most widely used agile process, originally proposed by Kent Beck
- XP Planning
  - Begins with the creation of “user stories”
  - Agile team assesses each story and assigns a cost
  - Stories are grouped to for a deliverable increment
  - A commitment is made on delivery date
  - After the first increment “project velocity” is used to help define subsequent delivery dates for other increments
Extreme Programming (XP) (2/3)

- **XP Design**
  - Follows the **KISS principle**
  - Encourage the use of **CRC cards** (see textbook ch 8)
  - For difficult design problems, suggests the creation of "**spike solutions**"—a design prototype
  - Encourages "**refactoring**"—an iterative refinement of the internal program design

- **XP Coding**
  - Recommends the **construction of a unit test** for a store *before* coding commences
  - Encourages "**pair programming**"

- **XP Testing**
  - All **unit tests** are executed daily
  - "**Acceptance tests**" are defined by the customer and executed to assess customer visible functionality
Extreme Programming (XP) (3/3)

- User stories
- Values
- Acceptance test criteria
- Iteration plan
- Simple design
- CRC cards
- Spike solutions
- Prototypes
- Design
- Coding
- Refactoring
- Pair programming
- Test
- Unit test
- Continuous integration
- Acceptance testing
- Release
- Software increment
- Project velocity computed
eXtreme Programming (XP) Map

User Stories

Architectural Spike

Release Planning

Iteration

Acceptance Tests

Small Releases

Test Scenarios

New User Story Project Velocity

Bugs

Latest Version

Next Iteration

Customer Approval

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XP Iteration Planning

Release Plan

Next Iteration

User Stories

Project Velocity

Unfinished Tasks

Failed Acceptance Tests

Bugs

Iteration Planning

Iteration

Development

New User Story, Project Velocity

Learn and Communicate

New Functionality

Bug Fixes

Day by Day

Latest Version

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XP Unit Testing

Collective Code Ownership

Next Task or Failed Acceptance Test → Create a Unit Test

Simple Design ⇔ Complex Problem

Pair Up → Failed Unit Test → Passed Unit Test

CRC Cards

Move People Around

Change Pair → We Need Help

Pair Programming

New Unit Tests

Continuous Integration

Refactor Mercilessly

Simple Code

Complex Code

100% Unit Tests Passed

Run All Unit Tests

Run Failed Acceptance Test

Acceptance Test Passed

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Agile Modeling & XP Summarized

- Practices-based software process whose scope is to describe how to model and document in an effective and “agile” manner
- One goal is to address the issue of how to apply modeling techniques on software projects taking an agile approach such as:
  - eXtreme Programming (XP)
  - Dynamic Systems Development Method (DSDM)
  - SCRUM
  - etc.
- Using modeling throughout the XP lifecycle
  - [http://www.agilemodeling.com/essays/agileModelingXPLifecycle.htm](http://www.agilemodeling.com/essays/agileModelingXPLifecycle.htm)
- Additional information
  - [http://www.agilemodeling.com/](http://www.agilemodeling.com/)
  - [http://www.agilemodeling.com/resources.htm](http://www.agilemodeling.com/resources.htm)
- Originally proposed by Jim Highsmith
- ASD — distinguishing features
  - Mission-driven planning
  - Component-based focus
  - Uses “time-boxing” (See textbook Chapter 24)
  - Explicit consideration of risks
  - Emphasizes collaboration for requirements gathering
  - Emphasizes “learning” throughout the process
Adaptive Software Development (2/2)

Adaptive cycle planning
- uses mission statement
- project constraints
- basic requirements
- time-boxed release plan

Requirement gathering
- JAD
- mini-specs

Release
- software increment

Learning
- adjustments for subsequent cycles

Collaboration

 specification

Focus groups for feedback
- formal technical reviews
- post mortems

Component(s) implemented/ tested

Adaptive cycle planning
- uses mission statement
- project constraints
- basic requirements
- time-boxed release plan
Promoted by the DSDM Consortium (www.dsdm.org)

DSDM—distinguishing features

- Similar in most respects to XP and/or ASD
- Nine guiding principles
  - Active user involvement is imperative.
  - DSDM teams must be empowered to make decisions.
  - The focus is on frequent delivery of products.
  - Fitness for business purpose is the essential criterion for acceptance of deliverables.
  - Iterative and incremental development is necessary to converge on an accurate business solution.
  - All changes during development are reversible.
  - Requirements are baselined at a high level
  - Testing is integrated throughout the life-cycle.
DSDM Life Cycle (with permission of the DSDM consortium)
Originally proposed by Schwaber and Beedle

Scrum—distinguishing features

- Development work is partitioned into “packets”
- Testing and documentation are on-going as the product is constructed
- Work occurs in “sprints” and is derived from a “backlog” of existing requirements
- Meetings are very short and sometimes conducted without chairs
- “demos” are delivered to the customer with the time-box allocated
Scrum Process Overview
- Agile based projects are broken down into Releases
- At the end of each Release, a working version of the product is delivered to the Business Users
- Each Release is made up of a number of sprints
- At the end of each Sprint, a working version of the product is deployed with incremental functionalities added over the previous sprint
- During each Sprint, daily scrum calls are held where status update is provided by the team
- Proposed by Cockburn and Highsmith
- Crystal—distinguishing features
  - Actually a family of process models that allow “maneuverability” based on problem characteristics
  - Face-to-face communication is emphasized
  - Suggests the use of “reflection workshops” to review the work habits of the team
Originally proposed by Peter Coad et al

FDD—distinguishing features

- Emphasis is on defining “features”
  - a feature “is a client-valued function that can be implemented in two weeks or less.”

- Uses a feature template
  - <action> the <result> <by | for | of | to> a(n) <object>

- A features list is created and “plan by feature” is conducted

- Design and construction merge in FDD
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Agile Modeling

- Originally proposed by Scott Ambler
- Suggests a set of agile modeling principles
  - Model with a purpose
  - Use multiple models
  - Travel light
  - Content is more important than representation
  - Know the models and the tools you use to create them
  - Adapt locally
Agenda – Software Engineering Lifecycles (SDLCs)

2. Software Engineering LifeCycles SDLCs

- Software Engineering Detailed
- Process Models
- Agile Development
- Software Engineering Knowledge
- Roles and Types of Standards
You often hear people say that software development knowledge has a 3-year half-life: half of what you need to know today will be obsolete within 3 years. In the domain of technology-related knowledge, that’s probably about right. But there is another kind of software development knowledge—a kind that I think of as "software engineering principles"—that does not have a three-year half-life. These software engineering principles are likely to serve a professional programmer throughout his or her career.

Steve McConnell
Principle #1. *Be agile.* Whether the process model you choose is prescriptive or agile, the basic tenets of agile development should govern your approach.

Principle #2. *Focus on quality at every step.* The exit condition for every process activity, action, and task should focus on the quality of the work product that has been produced.

Principle #3. *Be ready to adapt.* Process is not a religious experience and dogma has no place in it. When necessary, adapt your approach to constraints imposed by the problem, the people, and the project itself.

Principle #4. *Build an effective team.* Software engineering process and practice are important, but the bottom line is people. Build a self-organizing team that has mutual trust and respect.
Principles that Guide Process - II

- **Principle #5. Establish mechanisms for communication and coordination.** Projects fail because important information falls into the cracks and/or stakeholders fail to coordinate their efforts to create a successful end product.

- **Principle #6. Manage change.** The approach may be either formal or informal, but mechanisms must be established to manage the way changes are requested, assessed, approved and implemented.

- **Principle #7. Assess risk.** Lots of things can go wrong as software is being developed. It’s essential that you establish contingency plans.

- **Principle #8. Create work products that provide value for others.** Create only those work products that provide value for other process activities, actions or tasks.
Principles that Guide Practice

- **Principle #1. Divide and conquer.** Stated in a more technical manner, analysis and design should always emphasize *separation of concerns* (SoC).

- **Principle #2. Understand the use of abstraction.** At its core, an abstraction is a simplification of some complex element of a system used to communicate meaning in a single phrase.

- **Principle #3. Strive for consistency.** A familiar context makes software easier to use.

- **Principle #4. Focus on the transfer of information.** Pay special attention to the analysis, design, construction, and testing of interfaces.
Principles that Guide Practice

- **Principle #5.** *Build software that exhibits effective modularity.* Separation of concerns (Principle #1) establishes a philosophy for software. *Modularity* provides a mechanism for realizing the philosophy.

- **Principle #6.** *Look for patterns.* Brad Appleton [App00] suggests that: “The goal of patterns within the software community is to create a body of literature to help software developers resolve recurring problems encountered throughout all of software development.

- **Principle #7.** *When possible, represent the problem and its solution from a number of different perspectives.*

- **Principle #8.** *Remember that someone will maintain the software.*
Principle #1. *Listen.* Try to focus on the speaker’s words, rather than formulating your response to those words.

Principle #2. *Prepare before you communicate.* Spend the time to understand the problem before you meet with others.

Principle #3. *Someone should facilitate the activity.* Every communication meeting should have a leader (a facilitator) (1) to keep the conversation moving in a productive direction; (2) to mediate any conflict that does occur, and (3) to ensure that other principles are followed.

Principle #4. *Face-to-face communication is best.* But it usually works better when some other representation of the relevant information is present.
Principle # 5. *Take notes and document decisions.* Someone participating in the communication should serve as a “recorder” and write down all important points and decisions.

**Principle # 6. Strive for collaboration.** Collaboration and consensus occur when the collective knowledge of members of the team is combined …

**Principle # 7. Stay focused, modularize your discussion.** The more people involved in any communication, the more likely that discussion will bounce from one topic to the next.

**Principle # 8. If something is unclear, draw a picture.**

**Principle # 9. (a) Once you agree to something, move on; (b) If you can’t agree to something, move on; (c) If a feature or function is unclear and cannot be clarified at the moment, move on.**

**Principle # 10. Negotiation is not a contest or a game. It works best when both parties win.**
Planning Principles

- **Principle #1. *Understand the scope of the project.*** It’s impossible to use a roadmap if you don’t know where you’re going. Scope provides the software team with a destination.

- **Principle #2. *Involve the customer in the planning activity.*** The customer defines priorities and establishes project constraints.

- **Principle #3. *Recognize that planning is iterative.*** A project plan is never engraved in stone. As work begins, it very likely that things will change.

- **Principle #4. *Estimate based on what you know.*** The intent of estimation is to provide an indication of effort, cost, and task duration, based on the team’s current understanding of the work to be done.
Planning Principles

- **Principle #5. Consider risk as you define the plan.** If you have identified risks that have high impact and high probability, contingency planning is necessary.
- **Principle #6. Be realistic.** People don’t work 100 percent of every day.
- **Principle #7. Adjust granularity as you define the plan.** Granularity refers to the level of detail that is introduced as a project plan is developed.
- **Principle #8. Define how you intend to ensure quality.** The plan should identify how the software team intends to ensure quality.
- **Principle #9. Describe how you intend to accommodate change.** Even the best planning can be obviated by uncontrolled change.
- **Principle #10. Track the plan frequently and make adjustments as required.** Software projects fall behind schedule one day at a time.
In software engineering work, two classes of models can be created:

- **Requirements models (also called analysis models)** represent the customer requirements by depicting the software in three different domains: the information domain, the functional domain, and the behavioral domain.

- **Design models** represent characteristics of the software that help practitioners to construct it effectively: the architecture, the user interface, and component-level detail.
Requirements Modeling Principles

- **Principle #1.** The information domain of a problem must be represented and understood.
- **Principle #2.** The functions that the software performs must be defined.
- **Principle #3.** The behavior of the software (as a consequence of external events) must be represented.
- **Principle #4.** The models that depict information, function, and behavior must be partitioned in a manner that uncovers detail in a layered (or hierarchical) fashion.
- **Principle #5.** The analysis task should move from essential information toward implementation detail.
Design Modeling Principles

- **Principle #1.** Design should be traceable to the requirements model.
- **Principle #2.** Always consider the architecture of the system to be built.
- **Principle #3.** Design of data is as important as design of processing functions.
- **Principle #5.** User interface design should be tuned to the needs of the end-user. However, in every case, it should stress ease of use.
- **Principle #6.** Component-level design should be functionally independent.
- **Principle #7.** Components should be loosely coupled to one another and to the external environment.
- **Principle #8.** Design representations (models) should be easily understandable.
- **Principle #9.** The design should be developed iteratively. With each iteration, the designer should strive for greater simplicity.
Principle #1. *The primary goal of the software team is to build software, not create models.*

Principle #2. *Travel light—don’t create more models than you need.*

Principle #3. *Strive to produce the simplest model that will describe the problem or the software.*

Principle #4. *Build models in a way that makes them amenable to change.*

Principle #5. *Be able to state an explicit purpose for each model that is created.*

Principle #6. *Adapt the models you develop to the system at hand.*

Principle #7. *Try to build useful models, but forget about building perfect models.*

Principle #8. *Don’t become dogmatic about the syntax of the model. If it communicates content successfully, representation is secondary.*

Principle #9. *If your instincts tell you a model isn’t right even though it seems okay on paper, you probably have reason to be concerned.*

Principle #10. *Get feedback as soon as you can.*
The construction activity encompasses a set of coding and testing tasks that lead to operational software that is ready for delivery to the customer or end-user.

- **Coding principles and concepts** are closely aligned programming style, programming languages, and programming methods.
- **Testing principles and concepts** lead to the design of tests that systematically uncover different classes of errors and to do so with a minimum amount of time and effort.
Before you write one line of code, be sure you:

- Understand of the problem you’re trying to solve.
- Understand basic design principles and concepts.
- Pick a programming language that meets the needs of the software to be built and the environment in which it will operate.
- Select a programming environment that provides tools that will make your work easier.
- Create a set of unit tests that will be applied once the component you code is completed.
As you begin writing code, be sure you:

- Constrain your algorithms by following structured programming [Boh00] practice.
- Consider the use of pair programming
- Select data structures that will meet the needs of the design.
- Understand the software architecture and create interfaces that are consistent with it.
- Keep conditional logic as simple as possible.
- Create nested loops in a way that makes them easily testable.
- Select meaningful variable names and follow other local coding standards.
- Write code that is self-documenting.
- Create a visual layout (e.g., indentation and blank lines) that aids understanding.
After you’ve completed your first coding pass, be sure you:

- Conduct a code walkthrough when appropriate.
- Perform unit tests and correct errors you’ve uncovered.
- Refactor the code.
Al Davis suggests the following:

- **Principle #1.** *All tests should be traceable to customer requirements.*

- **Principle #2.** *Tests should be planned long before testing begins.*

- **Principle #3.** *The Pareto principle applies to software testing.*

- **Principle #4.** *Testing should begin “in the small” and progress toward testing “in the large.”*

- **Principle #5.** *Exhaustive testing is not possible.*
Deployment Principles

- Principle #1. *Customer expectations for the software must be managed.* Too often, the customer expects more than the team has promised to deliver, and disappointment occurs immediately.

- Principle #2. *A complete delivery package should be assembled and tested.*

- Principle #3. *A support regime must be established before the software is delivered.* An end-user expects responsiveness and accurate information when a question or problem arises.

- Principle #4. *Appropriate instructional materials must be provided to end-users.*

- Principle #5. *Buggy software should be fixed first, delivered later.*
Agenda – Software Engineering Lifecycles (SDLCs)

2. Software Engineering LifeCycles SDLCs

- Software Engineering Detailed
- Process Models
- Agile Development
- Software Engineering Knowledge
- Roles and Types of Standards
- **Standard CMMI Assessment Method for Process Improvement (SCAMPI)** — provides a five step process assessment model that incorporates five phases: initiating, diagnosing, establishing, acting and learning.

- **CMM-Based Appraisal for Internal Process Improvement (CBA IPI)** — provides a diagnostic technique for assessing the relative maturity of a software organization; uses the SEI CMM as the basis for the assessment [Dun01]

- **SPICE**—The SPICE (ISO/IEC15504) standard defines a set of requirements for software process assessment. The intent of the standard is to assist organizations in developing an objective evaluation of the efficacy of any defined software process. [ISO08]

- **ISO 9001:2000 for Software**—a generic standard that applies to any organization that wants to improve the overall quality of the products, systems, or services that it provides. Therefore, the standard is directly applicable to software organizations and companies. [Ant06]
Other Standards

- ISO 12207
  - http://www.acm.org/tsc/lifecycle.html
  - http://www.12207.com/

- IEEE Standards for Software Engineering Processes and Specifications
  - http://members.aol.com/kaizensepg/standard.htm
Agenda – Summary and Conclusion

1. Session Overview
2. Software Engineering LifeCycles (SDLCs)
3. Summary and Conclusion
Course Assignments

- **Individual Assignments**
  - Reports based on case studies / class presentations

- **Project-Related Assignments**
  - All assignments (other than the individual assessments) will correspond to milestones in the team project.
  - As the course progresses, students will be applying various methodologies to a project of their choice. The project and related software system should relate to a real-world scenario chosen by each team. The project will consist of inter-related deliverables which are due on a (bi-) weekly basis.
  - There will be only one submission per team per deliverable and all teams must demonstrate their projects to the course instructor.
  - A sample project description and additional details will be available under handouts on the course Web site
Team Project

- Project Logistics
  - Teams will pick their own projects, within certain constraints: for instance, all projects should involve multiple distributed subsystems (e.g., web-based electronic services projects including client, application server, and database tiers). Students will need to come up to speed on whatever programming languages and/or software technologies they choose for their projects - which will not necessarily be covered in class.
  - Students will be required to form themselves into "pairs" of exactly two (2) members each; if there is an odd number of students in the class, then one (1) team of three (3) members will be permitted. There may not be any "pairs" of only one member! The instructor and TA(s) will then assist the pairs in forming "teams", ideally each consisting of two (2) "pairs", possibly three (3) pairs if necessary due to enrollment, but students are encouraged to form their own 2-pair teams in advance. If some students drop the course, any remaining pair or team members may be arbitrarily reassigned to other pairs/teams at the discretion of the instructor (but are strongly encouraged to reform pairs/teams on their own). Students will develop and test their project code together with the other member of their programming pair.
Team Project Approach - Overall

- Document Transformation methodology driven approach
  - Strategy Alignment Elicitation
    - Equivalent to strategic planning
      - i.e., planning at the level of a project set
  - Strategy Alignment Execution
    - Equivalent to project planning + SDLC
      - i.e., planning a the level of individual projects + project implementation

- Build a methodology Wiki & partially implement the enablers

- Apply transformation methodology approach to a sample problem domain for which a business solution must be found

- Final product is a wiki/report that focuses on
  - Methodology / methodology implementation / sample business-driven problem solution
Document sample problem domain and business-driven problem of interest

» Problem description
» High-level specification details
» High-level implementation details
» Proposed high-level timeline
Assignments & Readings

- **Readings**
  - Slides and Handouts posted on the course web site
  - Textbook: Chapter 1 & Part One-Chapters 2-4

- **Team Project**
  - Team Project proposal (format TBD in class)

- **Team Exercise #1**
  - Presentation topic proposal (format TBD in class)

- **Project Frameworks Setup (ongoing)**
  - As per reference provided on the course Web site
Next Session: Planning and Managing Requirements
Any Questions?