Chapter 5

■ Agile Development

*Slide Set to accompany Software Engineering: A Practitioner’s Approach, 8/e by Roger S. Pressman*


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The Manifesto for Agile Software Development

“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*
Agile Development

- It has been less than two decades since these ideas have crystallized into a “movement”
- Agile methods were developed in an effort to overcome perceived and actual weakness in conventional software engineering
- Agile development can provide important benefits, but it is not applicable to all projects, all products, all people, and all situations
- It is also not antithetical to solid software engineering practice and can be applied as an overriding philosophy for all software work
Agile Development: Motivation

- Challenges by modern realities
  - In the modern economy, it is often difficult or impossible to predict how a computer-based system will evolve as time passes
  - Market conditions change rapidly, end-user needs evolve, and new competitive threats emerge without warning
  - In many situations, you won’t be able to define requirements fully before the project begins

→ You must be agile enough to response to a fluid business environment
Agile Development

- Agile development does not mean no documents are created,
- it means only creating documents that will be referred to later in the development process
Agile Development

- Fluidity implies change, and change is expensive
- Agile development can reduce the costs of change through the software process

- Does this mean that a recognition of challenges posted by modern realities causes you to discard valuable software engineering principles, concepts, methods, and tools? ➔ Absolutely not!
- Like all engineering disciplines, software engineering continues to evolve
- Software engineering can be adapted easily to meet the challenges posted by a demand for agility
Prescriptive Process Models: Critics by Cockburn ‘02

- Prescriptive process models forget the frailties of the people who build computer software
  - (Argued by Alistair Cockburn ’02)
- Software engineers are not robots. They exhibit great variation in working styles; significant differences in skill level, creativity, orderliness, consistency, and spontaneity
- Some communicate well in written form, others do not
- Process models can deal with people’s common weaknesses with discipline or tolerance and that most prescriptive process models choose discipline
- Because consistency in action is a human weakness, high disciple methodologies are fragile
Process Models: Discipline-based and Tolerance-based

- If process models are to work, they must provide a realistic mechanism for encouraging the discipline that is necessary,
- Or they must be characterized in a manner that shows tolerance for the people who do software engineering work
- Invariably, tolerant practices are easier for software people to adopt and sustain, but they may be less productive
- Trade-offs b/w discipline-based and tolerance-based approaches must be considered
What is Agility?

In (Jacobson 02)’s view, the pervasiveness of change is the primary deriver for agility. Software engineers must be quick on their feet if they are to accommodate the rapid changes.

Agility

- More than an effective response to change
- Encompasses the philosophy espoused in the manifesto
- Encourages team structures and attitudes that make communication more facile
- Emphasizes rapid delivery of operational software and deemphasizes the importance of intermediate work products
- Adopts the customer as a part of the development team and works to eliminate the “us and them” attitude that continues to pervade many software projects
- Recognizes that planning in an uncertain world has its limits and that a project plan must be flexible
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: For Software Process

- When we apply agility to software process,
- Design process in a way that allows the project team to adopt tasks and to streamline them
- Conduct planning in a way that understands the fluidity of an agile development approach
- Eliminate all but the most essential work products and keep them lean
- Emphasize an incremental delivery strategy that gets working software to the customer as rapidly as feasible for the product type and operational environment
The Cost of Change: The Conventional Wisdom

- The cost of change increases non-linearly as a project progresses.
- Early in a project: If there are any changes, the costs of doing this work are minimal.
  - It is relatively easy to accommodate a change when a team is gathering requirements early in a project
- In the middle of validation testing: Costs escalate quickly
  - The change requires a modification to the architectural design, construction of new components, changes to other existing components, new testing and so on.
  - Costs escalate quickly, and the time and cost required to ensure that the change is made without unintended side effects is nontrivial
Agility and The Cost of Change

- A well-designed agile process may “flatten” the cost of change curve
  - It allows a software team to accommodate changes late in a software project without dramatic cost and time impact
- In agile process, software is released in increments
- By coupling incremental delivery with other agile practices such as continuous unit testing and pair programming, the change can be better controlled and the cost of making a change is attenuated
Agility and the Cost of Change
Agile Process: Key assumptions are in Unpredictability

- It is difficult to predict in advance which software requirements will persist and which will change
  - It is equally difficult to predict how customer priorities will change as the project proceeds
- It is difficult to predict how much design is necessary before construction is used to prove the design
  - For many types of software, design and construction are interleaved. Both activities should be performed in tandem so that design models are proven as they are created.
- Analysis, design, construction, and testing are not as predictable (from a planning point of view) as we might like
Agile Process

- How do we create a process that can manage unpredictability?
  - Adaptability

- But continual adaptation without forward progress accomplishes little → Adopt incrementally

- To accomplish incremental adaptation, an agile team requires customer feedback

- Incremental development strategy should be instituted

- Software increments must be delivered in short time periods so that adaptation keeps pace with change

  - This iterative approach enables the customer to evaluate the software increment regularly, provide necessary feedback to the software team, and influence the process adaptations that are made to accommodate the feedback
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
Agility Principles - I

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.
Agility Principles - II

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.

⇒ Not every agile process model applies these 12 principles with equal weight, and some models choose to ignore the importance of one or more of the principles.
Human Factors

- *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.** (talent, skills, knowledge)
  - **Common focus.** (deliver a working software increment)
  - **Collaboration.** (peers and stakeholders)
  - **Decision-making ability.** (freedom to control its own destiny)
  - **Fuzzy problem-solving ability.** (ambiguity and constant changes, today problem may not be tomorrow’s problem)
  - **Mutual trust and respect.**
  - **Self-organization.** (themselves for the work done, process for its local environment, the work schedule)
Politics of Agile Development

- Debate about the benefits and applicability of agile software development as opposed to more conventional software engineering processes

- [Jim Highsmith states the extremes]
  - Pro-agility camp (agilists): Traditional methodologists are a bunch of stick-in-the-muds who’d rather produce flawless documentation than a working system that meets business needs

  - Software engineering camp: Lightweight, er, ‘agile’ methodologists are a bunch of glorified hackers who are going to be in for a heck of a surprise when they try to scale up their toys into enterprise-wide software
Politics of Agile Development

- No one is against agility. What is the best way to achieve agility? How do you build software that meets customers’ needs today and exhibits the quality characteristics that will enable it to be extended and scaled to meet customers’ needs over the long term?
- No absolute answer.
- Many proposed models in agile school itself consisting of a set of “ideas” (work tasks) that represents a significant departure from traditional SE
- Yet, many agile concepts are simply adaptations of good software engineering concepts

You don’t have to choose b/w agility and software engineering. Rather define a software engineering approach that is agile
Extreme Programming (XP)

- The most widely used agile process models, originally proposed by Kent Beck
- Uses an object-oriented approach as its preferred development paradigm
- Encompasses a set of rules and practices that occur within the context of four framework activities: Planning, design, coding, and testing
The XP Process: Planning

- 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
The XP Process: Planning

- **Listening**
  - a requirement gathering activity that enables the technical members of the XP team to understand business context for the software

- Create a set of **user stories**
  - That describes required output, features, and functionality for software to be built. Each story is written by the customer and is placed on an index card

- The customer **assigns a value** to the story
  - Based on the overall business value of the feature or function
The XP Process: Planning

- Members of the XP team assigns a cost to the story
  - Measured in development weeks
  - If the story is estimated to require more than three development weeks, the customer is asked to split the story into smaller stories and the assignment of value and cost occurs again

- Make a basic commitment
  - Agreement on stories to be included, delivery date, and other project matters
    - After Customer and developers decide how to group stories into the next release to be developed by the XP team

- The XP team orders the stories that will be developed
  1) All storied to be implemented immediately
  2) Stories with highest values
  3) The riskiest stories
The XP Process: Planning

- After the first project release, the XP team computes project velocity
  - Project velocity: a subtle measure of team productivity
    - The number of customer stories implemented during the first release
      - Used to 1) help estimate delivery dates and schedule for subsequent releases and 2) determine whether an overcommitment has been made for all stories across the entire development project

- As development work proceeds, the customer can add stories, change the value of an existing story, split stories, or eliminate them

- The XP team reconsiders all remaining releases and modifies its plan accordingly
Extreme Programming (XP)

- **XP Design**
  - Follows the KIS principle
  - Encourage the use of CRC cards (see Chapter 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
The XP Process: Design

- Follows the KIS principle (keep it simple)
  - Nothing more nothing less than the story.
  - The design of extra functionality is discouraged.

- Encourage the use of CRC (class-responsibility-collaborator) cards in an object-oriented context.
  - The only design work product of XP.
  - They identify and organize the classes that are relevant to the current software increment.
The XP Process: Design

- For difficult design problems, suggests the creation of "spike solutions"
  - a design prototype for that portion is implemented and evaluated.
  - The intent is to lower risk when true implementation starts and to validate the original estimates for the story containing the design problem

- Encourages "refactoring"
  - An iterative refinement of the internal program design.
  - Does not alter the external behavior yet improve the internal structure. Minimize chances of bugs. More efficient, easy to read.
The XP Process: Coding

- Recommends the construction of a unit test for a story before coding commences.
  - The team does not move to code, but rather develops a series of unit tests that will exercise each of the stories.
  - The developer is better able to focus on what must be implemented to pass the test. ➔ goal
  - Once the code is completed, it can be unit-tested immediately, thereby providing instantaneous feedback to the developers.
The XP Process: Coding

- Encourages “pair programming”.
  - Two people work together at one workstation for real time problem solving, real time review for quality assurance.
  - It also keeps the developers focused on the problem at hand
  - Each person takes on a slightly different role
    - One person might think about the coding details of a particular portion of the design
    - Another ensures that coding standards are being followed or that the code for the story will satisfy the unit test

- As pair programmers complete their work, the code they develop is integrated with the work of others
  - Performed on a daily basis by an integration team or by the pair programmers themselves
  - This continuous integration strategy helps to avoid compatibility and interfacing problems and provides a smoke testing environment which helps to uncover errors early
The XP Process: Testing

- All **unit tests** are executed daily and ideally should be automated.
  - Regression tests are conducted to test current and previous components.
- As the individual unit tests are organized into a "universal testing suite", integration and validation testing of the system can occur on a daily basis
  - Provides the XP team with a continual indication of progress and also can raise warning flags early if things go awry
- "Acceptance tests" (customer tests) are specified by the customer, derived from user stories
  - Focus on overall system features and functionality that are visible and reviewable by the customer.
Extreme Programming (XP)

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

- **Requirements volatility:** customer is an active member of XP team, changes to requirements are requested informally and frequently.

- **Conflicting customer needs:** different customers' needs need to be assimilated. Different vision or beyond their authority.
The XP Debate

- **Requirements are expressed informally:** Use stories and acceptance tests are the only explicit manifestation of requirements. Formal models may avoid inconsistencies and errors before the system is built. Proponents said changing nature makes such models obsolete as soon as they are developed.

- **Lack of formal design:** XP deemphasizes the need for architectural design. Complex systems need overall structure to exhibit quality and maintainability. Proponents said incremental nature limits complexity as simplicity is a core value.
Industrial XP (IXP)

- IXP is an organic evolution of XP
- It is imbued with XP’s minimalist, customer-centric, test-driven spirit
- IXP differs most from the original XP in its greater inclusion of management, its expanded role for customers, and its upgraded technical practices
Industrial XP (IXP): Practice

- **Reading assessment**: Ascerts whether all members of the project community are on board, have proper environment established, and understand the skill levels involved.

- **Project community**: Determines whether the right people with the right skills and training have been staged for the project.

- **Project chartering**: Assesses the project itself to determine whether an appropriate business justification for the project exists and whether the project will further the overall goals and objectives.

- **Test-driven management**: Establishes a series of measurable “destinations” that assess progress to date.

- **Retrospectives**: Conducts a specialized technical review after an increment is made.

- **Continuous learning**: Encourage to learn new methods/techniques.
Adaptive Software Development

- Originally proposed by Jim Highsmith 2000, focusing on human collaboration and team self-organization as a technique to build complex software and system.

ASD — distinguishing features

- Mission-driven planning
- Component-based focus
- Uses “time-boxing”
- Explicit consideration of risks
- Emphasizes collaboration for requirements gathering
- Emphasizes “learning” throughout the process
Three Phases of ASD: Speculation

- Project is initiated and adaptive cycle planning is conducted.
- Adaptive cycle planning uses project initiation information - the customer’s mission statement, project constraints (e.g. delivery date), and basic requirements to define the set of release cycles (increments) that will be required for the project.
- Based on the information obtained at the completion of the first cycle, the plan is reviewed and adjusted so that planned work better fits the reality.
Three Phases of ASD: Collaborations

- Used to multiply their talent and creative output beyond absolute number (1+1>2).
- It encompasses communication and teamwork, but it also emphasizes individualism, because individual creativity plays an important role in collaborative thinking.
- It is a matter of trust.
  - 1) criticize without animosity,
  - 2) assist without resentments,
  - 3) work as hard as or harder than they do.
  - 4) have the skill set to contribute to the work at hand,
  - 5) communicate problems or concerns in a way that leads to effective action.
Three Phases of ASD: Learning

- As members of ASD team begin to develop the components, the emphasis is on “learning”.

- Highsmith argues that software developers often overestimate their own understanding of the technology, the process, and the project and that learning will help them to improve their level of real understanding.

- Three ways: focus groups, technical reviews and project postmortems.
Other Agile Process Models

- Scrum
- DSSD
- Agile modeling (AM)
- Agile Unified Process (AUP)
Adaptive Software Development

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

requirement gathering
  JAD
  mini-specs

speculation

collaboration

learning

release
  software increment
  adjustments for subsequent cycles

component(s) implemented/tested
  focus groups for feedback
  formal technical reviews
  post mortems

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Scrum

- Originally proposed by Schwaber and Beedle
- Scrum principles are consistent with the agile manifesto
- Development activities within a process
- Framework activities: Requirements, analysis, design, evolution, and delivery
- Within each framework activity, work tasks occur within a process pattern called sprint
- The work conducted within a sprint is adapted to the problem at hand and is defined and often modified in real time
Scrum: Development activities

- **Backlog**
  - A prioritized list of project requirements or features that provide business value for the customer

- **Sprints**
  - Consist of work units that are required to achieve a requirement defined in the backlog that must be a predefined time-box (30 days).
  - Changes are not introduced during the sprint

- **Scrum meetings**: Short meetings held daily, asking some questions
  - E.g.) What did you do since the last team meeting?
  - A team leader (Scrum master), leads the meeting and assesses the responses from each person

- **Demos**: Deliver software increment to the customer
Scrum

**Daily Scrum**
- Every 24 hours

**Sprint**
- For 30 days

**Sprint Backlog**
- Feature(s) assigned to sprint
- Backlog items expanded by team

**Product Backlog**
- Prioritized product features desired by the customer

**Scrum**
- 15 minute daily meeting
- Teams member respond to basics:
  1. What did you do since last Scrum Meeting?
  2. Do you have any obstacles?
  3. What will you do before next meeting?

**New functionality is demonstrated at end of sprint**

*Fig 2*
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
  - What did you do since last meeting? What obstacles are you encountering? What do you plan to accomplish by next meeting?
- “demos” are delivered to the customer with the time-box allocated
  - May not contain all functionalities. So customers can evaluate and give feedbacks.
Dynamic Systems Development Method

- An agile software development approach that provides a framework for building and maintaining systems which meet tight time constraints through the use of incremental prototyping in a controlled project environment.
- Promoted by the DSDM Consortium (www.dsdm.org)
- DSDM philosophy
  - borrowed from a modified version of the Pareto principle – 80% of application can be delivered in 20% of the time it would take to deliver the complete application (100%)
- DSDM—distinguishing features
  - Similar in most respects to XP and/or ASD
Dynamic Systems Development Method (DSDM)

- 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.
Dynamic Systems Development Method (DSDM)

- **Functional model iteration**: produces a set of incremental prototypes that demonstrate functionality for the customer.
- **Design and build iteration**: revisits prototypes to ensure that each has been engineered in a manner that will enable it to provide operational business value for end users.
- **Implementation**: Places the latest software increment into the operational environment.
Dynamic Systems Development Method: Iterative cycles
Agile Modeling: Motivation

- Software engineers must build large, business-critical systems
- The scope and complexity of such system must be modeled such that
  - All constituencies can better understand what needs to be accomplished
  - The problem can be partitioned effectively among the people who must solve it
  - Quality can be assessed as the system is being engineered and built
- In some cases, there is the difficulty of modeling the scope and complexity of system
Agile Modeling

- Originally proposed by Scott Ambler
- Adopts all of the values that are consistent with the agile manifesto
- 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
Agile Unified Process (AUP)

- Adopts “a serial in the large” and “iterative in the small” philosophy for building computer-based systems
- Adopts the classic UP phrased activities
  - Inception, elaboration, construction, and transition
- Provides a serial overlay that enables a team to visualize the overall process flow for a software project
Agile Unified Process (AUP): Activity

- **Modeling**: UML representations of the business and problem domains are created. To stay agile, these models should be just barely good enough.
- **Implementation**: Translated into source code.
- **Testing**: Like XP, the team designs and executes a series of tests to uncover errors and ensure that the source code meets its requirements.
- **Deployment**: Like the generic process activity, focuses on the delivery of a software increment and the acquisition of feedback from end users.
- **Configuration and project management**: Addresses change management, risk management, the control of any persistent work products.
- **Environment management**: Coordinates a process infrastructure that includes standards, tools, and other support technology available to the team.
Chapter 5: Summary

- An agile philosophy for SE stresses
  - 1) the importance of self-organizing teams that have control over the work they perform
  - 2) communication and collaboration b/w team members b/w practitioners and their customers
  - 3) a recognition that change represents an opportunity
  - 3) An emphasis on rapid delivery of software that satisfies the customer

- EX: the most widely used agile process
  - Planning, design, coding, testing
  - Suggests a number of innovative and powerful techniques that allow an agile team to create frequent software releases
Chapter 5: Summary

- Other agile process models
  - Also stress human collaboration and team self-organization, but define their own framework activities and select different points of emphasis
  - Scrum: Uses a set of software process patterns
  - DSDM: Advocates the use of time-box scheduling
  - AM: Modeling is essential for all systems
  - AUP: A “serial in the large” and “iterative in the small”