CHAPTER

3

AGILE DEVELOPMENT

KEY CONCEPTS

In 2001, Kent Beck and 16 other noted software developers, writers, and consultants [Bec01a] (referred to as the "Agile Alliance") signed the "Manifesto for Agile Software Development." It stated:

> 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.

QUICK LOOK

What is it? Agile software engineering combines a philosophy and a set of development guidelines. The philosophy encourages customer satisfaction and early incremental delivery of software; small, highly motivated project teams; informal methods; minimal software engineering work products; and overall development simplicity. The development guidelines stress delivery over analysis and design (although these activities are not discouraged), and active and continuous communication between developers and customers.

Who does it? Software engineers and other project stakeholders (managers, customers, end users) work together on an agile team—a team that is self-organizing and in control of its own destiny. An agile team fosters communication and collaboration among all who serve on it.

Why is it important? The modern business environment that spawns computer-based systems and software products is fast-paced and ever-changing. Agile software engineering represents a reasonable alternative to conventional software engineering for certain classes of software and certain types of software projects. It has been demonstrated to deliver successful systems quickly.

What are the steps? Agile development might best be termed "software engineering lite." The basic framework activities—communication, planning, modeling, construction, and deployment—remain. But they morph into a minimal task set that pushes the project team toward construction and delivery (some would argue that this is done at the expense of problem analysis and solution design).

What is the work product? Both the customer and the software engineer have the same view—the only really important work product is an operational "software increment" that is delivered to the customer on the appropriate commitment date.

How do I ensure that I've done it right? If the agile team agrees that the process works, and the team produces deliverable software increments that satisfy the customer, you've done it right.

A manifesto is normally associated with an emerging political movement—one that attacks the old guard and suggests revolutionary change (hopefully for the better). In some ways, that's exactly what agile development is all about.

Although the underlying ideas that guide agile development have been with us for many years, it has been less than two decades since these ideas have crystallized into a "movement." In essence, agile[1] methods were developed in an effort to overcome perceived and actual weaknesses 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.

In the modern economy, it is often difficult or impossible to predict how a computer-based system (e.g., a Web-based application) 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 respond to a fluid business environment.

Fluidity implies change, and change is expensive. Particularly if it is uncontrolled or poorly managed. One of the most compelling characteristics of the agile approach is its ability to reduce the costs of change throughout the software process.

Does this mean that a recognition of challenges posed 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. It can be adapted easily to meet the challenges posed by a demand for agility.

Quote:

"Agility: 1, everything else: 0."

Tom DeMarco

In a thought-provoking book on agile software development, Alistair Cockburn [Coc02] argues that the prescriptive process models introduced in Chapter 2 have a major failing: *they forget the frailties of the people who build computer software.* 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. Cockburn argues that process models can "deal with people's common weaknesses with [either] discipline or tolerance" and that most prescriptive process models choose discipline. He states: "Because consistency in action is a human weakness, high discipline methodologies are fragile."

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 (as Cockburn admits) they may be less productive. Like most things in life, trade-offs must be considered.

1 Agile methods are sometimes referred to as *light methods* or *lean methods*.

3.1 What Is Agility?

Just what is agility in the context of software engineering work? Ivar Jacobson [Jac02a] provides a useful discussion:

> *Agility* has become today's buzzword when describing a modern software process. Everyone is agile. An agile team is a nimble team able to appropriately respond to changes. Change is what software development is very much about. Changes in the software being built, changes to the team members, changes because of new technology, changes of all kinds that may have an impact on the product they build or the project that creates the product. Support for changes should be built-in everything we do in software, something we embrace because it is the heart and soul of software. An agile team recognizes that software is developed by individuals working in teams and that the skills of these people, their ability to collaborate is at the core for the success of the project.

In Jacobson's view, the pervasiveness of change is the primary driver for agility. Software engineers must be quick on their feet if they are to accommodate the rapid changes that Jacobson describes.

Don't make the mistake of assuming that agility gives you license to hack out solutions. A process is required and discipline is essential.

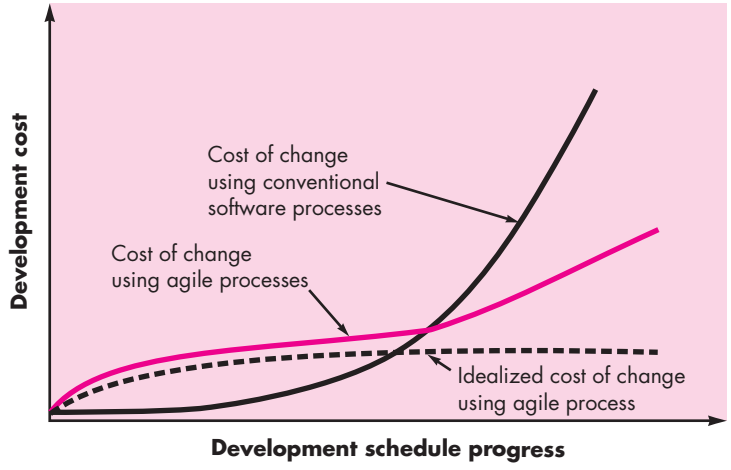
But agility is more than an effective response to change. It also encompasses the philosophy espoused in the manifesto noted at the beginning of this chapter. It encourages team structures and attitudes that make communication (among team members, between technologists and business people, between software engineers and their managers) more facile. It emphasizes rapid delivery of operational software and de-emphasizes the importance of intermediate work products (not always a good thing); it 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; it recognizes that planning in an uncertain world has its limits and that a project plan must be flexible.

Agility can be applied to any software process. However, to accomplish this, it is essential that the process be designed in a way that allows the project team to adapt 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, and emphasize an incremental delivery strategy that gets working software to the customer as rapidly as feasible for the product type and operational environment.

3.2 Agility and the Cost of Change

The conventional wisdom in software development (supported by decades of experience) is that the cost of change increases nonlinearly as a project progresses (Figure 3.1, solid black curve). It is relatively easy to accommodate a change when a software team is gathering requirements (early in a project). A usage scenario might have to be modified, a list of functions may be extended, or a written specification can be edited. The costs of doing this work are minimal, and the time required will

FIGURE 3.1
Change costs as a function of time in development



Quote:

"Agility is dynamic, content specific, aggressively change embracing, and growth oriented."

–Steven Goldman et al.

not adversely affect the outcome of the project. But what if we fast-forward a number of months? The team is in the middle of validation testing (something that occurs relatively late in the project), and an important stakeholder is requesting a major functional change. The change requires a modification to the architectural design of the software, the design and construction of three new components, modifications to another five components, the design of new tests, 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.

KEY POINT

An agile process reduces the cost of change because software is released in increments and change can be better controlled within an increment.

Proponents of agility (e.g., [Bec00], [Amb04]) argue that a well-designed agile process "flattens" the cost of change curve (Figure 3.1, shaded, solid curve), allowing a software team to accommodate changes late in a software project without dramatic cost and time impact. You've already learned that the agile process encompasses incremental delivery. When incremental delivery is coupled with other agile practices such as continuous unit testing and pair programming (discussed later in this chapter), the cost of making a change is attenuated. Although debate about the degree to which the cost curve flattens is ongoing, there is evidence [Coc01a] to suggest that a significant reduction in the cost of change can be achieved.

3.3 What Is an Agile Process?

Any agile software process is characterized in a manner that addresses a number of key assumptions [Fow02] about the majority of software projects:

1. 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.

WebRef

A comprehensive collection of articles on the agile process can be found at **www.aanpo.org/articles/index**.

2. For many types of software, design and construction are interleaved. That is, both activities should be performed in tandem so that design models are proven as they are created. It is difficult to predict how much design is necessary before construction is used to prove the design.
3. Analysis, design, construction, and testing are not as predictable (from a planning point of view) as we might like.

Given these three assumptions, an important question arises: How do we create a process that can manage *unpredictability?* The answer, as I have already noted, lies in process adaptability (to rapidly changing project and technical conditions). An agile process, therefore, must be *adaptable.*

But continual adaptation without forward progress accomplishes little. Therefore, an agile software process must adapt *incrementally.* To accomplish incremental adaptation, an agile team requires customer feedback (so that the appropriate adaptations can be made). An effective catalyst for customer feedback is an operational prototype or a portion of an operational system. Hence, an *incremental development strategy* should be instituted. *Software increments* (executable prototypes or portions of an operational system) must be delivered in short time periods so that adaptation keeps pace with change (unpredictability). 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.

3.3.1 Agility Principles

KEY POINT

Although agile processes embrace change, it is still important to examine the reasons for change.

The Agile Alliance (see [Agi03], [Fow01]) defines 12 agility principles for those who want to achieve agility:

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.

ADVICE

Working software is important, but don't forget that it must also exhibit a variety of quality attributes including reliability, usability, and maintainability.

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 (or at least downplay) the importance of one or more of the principles. However, the principles define an *agile spirit* that is maintained in each of the process models presented in this chapter.

3.3.2 The Politics of Agile Development

There is considerable debate (sometimes strident) about the benefits and applicability of agile software development as opposed to more conventional software engineering processes. Jim Highsmith [Hig02a] (facetiously) states the extremes when he characterizes the feeling of the 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." As a counterpoint, he states (again, facetiously) the position of the traditional 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."

You don't have to choose between agility and software engineering. Rather, define a software engineering approach that is agile.

Like all software technology arguments, this methodology debate risks degenerating into a religious war. If warfare breaks out, rational thought disappears and beliefs rather than facts guide decision making.

No one is against agility. The real question is: What is the best way to achieve it? As important, 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?

There are no absolute answers to either of these questions. Even within the agile school itself, there are many proposed process models (Section 3.4), each with a subtly different approach to the agility problem. Within each model there is a set of "ideas" (agilists are loath to call them "work tasks") that represent a significant departure from traditional software engineering. And yet, many agile concepts are simply adaptations of good software engineering concepts. Bottom line: there is much that can be gained by considering the best of both schools and virtually nothing to be gained by denigrating either approach.

If you have further interest, see [Hig01], [Hig02a], and [DeM02] for an entertaining summary of other important technical and political issues.

3.3.3 Human Factors

Quote:

"Agile methods derive much of their agility by relying on the tacit knowledge embodied in the team, rather than writing the knowledge down in plans."

Barry Boehm

Proponents of agile software development take great pains to emphasize the importance of "people factors." As Cockburn and Highsmith [Coc01a] state, "Agile development focuses on the talents and skills of individuals, molding the process to specific people and teams." The key point in this statement is that *the process molds to the needs of the people and team,* not the other way around.[2]

If members of the software team are to drive the characteristics of the process that is applied to build software, a number of key traits must exist among the people on an agile team and the team itself:

? What key traits must exist among the people on an effective software team?

Competence. In an agile development (as well as software engineering) context, "competence" encompasses innate talent, specific software-related skills, and overall knowledge of the process that the team has chosen to apply. Skill and knowledge of process can and should be taught to all people who serve as agile team members.

Common focus. Although members of the agile team may perform different tasks and bring different skills to the project, all should be focused on one goal—to deliver a working software increment to the customer within the time promised. To achieve this goal, the team will also focus on continual adaptations (small and large) that will make the process fit the needs of the team.

Collaboration. Software engineering (regardless of process) is about assessing, analyzing, and using information that is communicated to the software team; creating information that will help all stakeholders understand the work of the team; and building information (computer software and relevant databases) that provides business value for the customer. To accomplish these tasks, team members must collaborate—with one another and all other stakeholders.

Quote:

"What counts as barely sufficient for one team is either overly sufficient or insufficient for another."

Alistair Cockburn

Decision-making ability. Any good software team (including agile teams) must be allowed the freedom to control its own destiny. This implies that the team is given autonomy—decision-making authority for both technical and project issues.

Fuzzy problem-solving ability. Software managers must recognize that the agile team will continually have to deal with ambiguity and will continually be buffeted by change. In some cases, the team must accept the fact that the problem they are solving today may not be the problem that needs to be solved tomorrow. However, lessons learned from any problem-solving

2 Successful software engineering organizations recognize this reality regardless of the process model they choose.

activity (including those that solve the wrong problem) may be of benefit to the team later in the project.

Mutual trust and respect. The agile team must become what DeMarco and Lister [DeM98] call a "jelled" team (Chapter 24). A jelled team exhibits the trust and respect that are necessary to make them "so strongly knit that the whole is greater than the sum of the parts." [DeM98]

Self-organization. In the context of agile development, self-organization implies three things: (1) the agile team organizes itself for the work to be done, (2) the team organizes the process to best accommodate its local environment, (3) the team organizes the work schedule to best achieve delivery of the software increment. Self-organization has a number of technical benefits, but more importantly, it serves to improve collaboration and boost team morale. In essence, the team serves as its own management. Ken Schwaber [Sch02] addresses these issues when he writes: "The team selects how much work it believes it can perform within the iteration, and the team commits to the work. Nothing demotivates a team as much as someone else making commitments for it. Nothing motivates a team as much as accepting the responsibility for fulfilling commitments that it made itself."

A self-organizing team is in control of the work it performs. The team makes its own commitments and defines plans to achieve them.

3.4 Extreme Programming (XP)

In order to illustrate an agile process in a bit more detail, I'll provide you with an overview of *Extreme Programming* (XP), the most widely used approach to agile software development. Although early work on the ideas and methods associated with XP occurred during the late 1980s, the seminal work on the subject has been written by Kent Beck [Bec04a]. More recently, a variant of XP, called *Industrial XP* (IXP) has been proposed [Ker05]. IXP refines XP and targets the agile process specifically for use within large organizations.

3.4.1 XP Values

Beck [Bec04a] defines a set of five *values* that establish a foundation for all work performed as part of XP—communication, simplicity, feedback, courage, and respect. Each of these values is used as a driver for specific XP activities, actions, and tasks.

In order to achieve effective *communication* between software engineers and other stakeholders (e.g., to establish required features and functions for the software), XP emphasizes close, yet informal (verbal) collaboration between customers and developers, the establishment of effective metaphors[3] for communicating important concepts, continuous feedback, and the avoidance of voluminous documentation as a communication medium.

3 In the XP context, a *metaphor* is "a story that everyone—customers, programmers, and managers—can tell about how the system works" [Bec04a].

ADVICE

Keep it simple whenever you can, but recognize that continual "refactoring" can absorb significant time and resources.

To achieve *simplicity,* XP restricts developers to design only for immediate needs, rather than consider future needs. The intent is to create a simple design that can be easily implemented in code). If the design must be improved, it can be *refactored*[4] at a later time.

Feedback is derived from three sources: the implemented software itself, the customer, and other software team members. By designing and implementing an effective testing strategy (Chapters 17 through 20), the software (via test results) provides the agile team with feedback. XP makes use of the *unit test* as its primary testing tactic. As each class is developed, the team develops a unit test to exercise each operation according to its specified functionality. As an increment is delivered to a customer, the *user stories* or *use cases* (Chapter 5) that are implemented by the increment are used as a basis for acceptance tests. The degree to which the software implements the output, function, and behavior of the use case is a form of feedback. Finally, as new requirements are derived as part of iterative planning, the team provides the customer with rapid feedback regarding cost and schedule impact.

Quote:

"XP is the answer to the question, 'How little can we do and still build great software?'"

Anonymous

Beck [Bec04a] argues that strict adherence to certain XP practices demands *courage.* A better word might be *discipline.* For example, there is often significant pressure to design for future requirements. Most software teams succumb, arguing that "designing for tomorrow" will save time and effort in the long run. An agile XP team must have the discipline (courage) to design for today, recognizing that future requirements may change dramatically, thereby demanding substantial rework of the design and implemented code.

By following each of these values, the agile team inculcates *respect* among it members, between other stakeholders and team members, and indirectly, for the software itself. As they achieve successful delivery of software increments, the team develops growing respect for the XP process.

3.4.2 The XP Process

WebRef

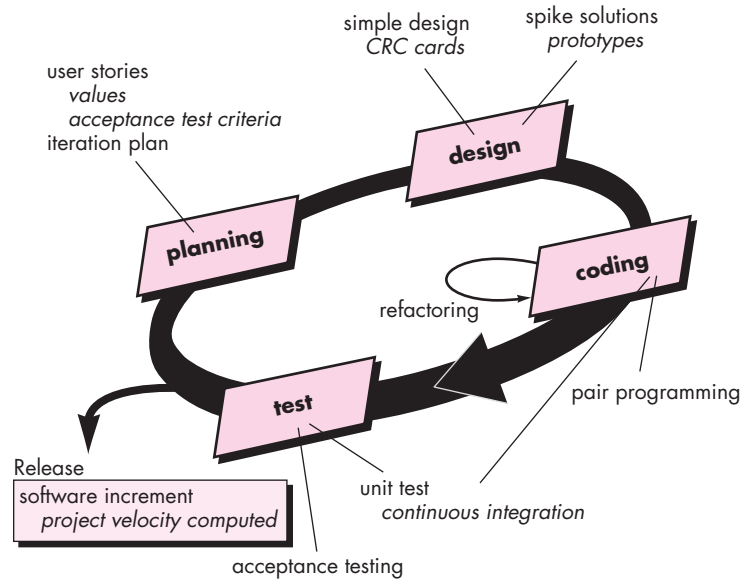
An excellent overview of "rules" for XP can be found at **www.extremeprogramming.org/rules.html**.

Extreme Programming uses an object-oriented approach (Appendix 2) as its preferred development paradigm and encompasses a set of rules and practices that occur within the context of four framework activities: planning, design, coding, and testing. Figure 3.2 illustrates the XP process and notes some of the key ideas and tasks that are associated with each framework activity. Key XP activities are summarized in the paragraphs that follow.

Planning. The planning activity (also called *the planning game*) begins with *listening*—a requirements gathering activity that enables the technical members of the XP team to understand the business context for the software and to get a broad

4 Refactoring allows a software engineer to improve the internal structure of a design (or source code) without changing its external functionality or behavior. In essence, refactoring can be used to improve the efficiency, readability, or performance of a design or the code that implements a design.

FIGURE 3.2
The Extreme Programming process



feel for required output and major features and functionality. Listening leads to the creation of a set of "stories" (also called *user stories*) that describe required output, features, and functionality for software to be built. Each *story* (similar to use cases described in Chapter 5) is written by the customer and is placed on an index card. The customer assigns a *value* (i.e., a priority) to the story based on the overall business value of the feature or function.[5] Members of the XP team then assess each story and assign a *cost*—measured in development weeks—to it. 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. It is important to note that new stories can be written at any time.

? What is an XP "story"?

WebRef
A worthwhile XP "planning game" can be found at: **c2.com/cgi/wiki?planningGame**.

Customers and developers work together to decide how to group stories into the next release (the next software increment) to be developed by the XP team. Once a basic *commitment* (agreement on stories to be included, delivery date, and other project matters) is made for a release, the XP team orders the stories that will be developed in one of three ways: (1) all stories will be implemented immediately (within a few weeks), (2) the stories with highest value will be moved up in the schedule and implemented first, or (3) the riskiest stories will be moved up in the schedule and implemented first.

After the first project release (also called a software increment) has been delivered, the XP team computes project velocity. Stated simply, *project velocity* is the

5 The value of a story may also be dependent on the presence of another story.

Project velocity is a subtle measure of team productivity.

number of customer stories implemented during the first release. Project velocity can then be 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. If an overcommitment occurs, the content of releases is modified or end delivery dates are changed.

As development work proceeds, the customer can add stories, change the value of an existing story, split stories, or eliminate them. The XP team then reconsiders all remaining releases and modifies its plans accordingly.

Design. XP design rigorously follows the KIS (keep it simple) principle. A simple design is always preferred over a more complex representation. In addition, the design provides implementation guidance for a story as it is written—nothing less, nothing more. The design of extra functionality (because the developer assumes it will be required later) is discouraged.[6]

XP deemphasizes the importance of design. Not everyone agrees. In fact, there are times when design should be emphasized.

XP encourages the use of CRC cards (Chapter 7) as an effective mechanism for thinking about the software in an object-oriented context. CRC (class-responsibility-collaborator) cards identify and organize the object-oriented classes[7] that are relevant to the current software increment. The XP team conducts the design exercise using a process similar to the one described in Chapter 8. The CRC cards are the only design work product produced as part of the XP process.

If a difficult design problem is encountered as part of the design of a story, XP recommends the immediate creation of an operational prototype of that portion of the design. Called a *spike solution*, the design prototype 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.

WebRef

Refactoring techniques and tools can be found at: **www.refactoring.com**.

In the preceding section, we noted that XP encourages *refactoring*—a construction technique that is also a method for design optimization. Fowler [Fow00] describes refactoring in the following manner:

> Refactoring is the process of changing a software system in such a way that it does not alter the external behavior of the code yet improves the internal structure. It is a disciplined way to clean up code [and modify/simplify the internal design] that minimizes the chances of introducing bugs. In essence, when you refactor you are improving the design of the code after it has been written.

Because XP design uses virtually no notation and produces few, if any, work products other than CRC cards and spike solutions, design is viewed as a transient artifact that can and should be continually modified as construction proceeds. The intent of refactoring is to control these modifications by suggesting small design changes

6 These design guidelines should be followed in every software engineering method, although there are times when sophisticated design notation and terminology may get in the way of simplicity.

7 Object-oriented classes are discussed in Appendix 2, in Chapter 8, and throughout Part 2 of this book.

that "can radically improve the design" [Fow00]. It should be noted, however, that the effort required for refactoring can grow dramatically as the size of an application grows.

A central notion in XP is that design occurs both before *and after* coding commences. Refactoring means that design occurs continuously as the system is constructed. In fact, the construction activity itself will provide the XP team with guidance on how to improve the design.

KEY POINT
Refactoring improves the internal structure of a design (or source code) without changing its external functionality or behavior.

Coding. After stories are developed and preliminary design work is done, the team does *not* move to code, but rather develops a series of unit tests that will exercise each of the stories that is to be included in the current release (software increment).[8] Once the unit test[9] has been created, the developer is better able to focus on what must be implemented to pass the test. Nothing extraneous is added (KIS). Once the code is complete, it can be unit-tested immediately, thereby providing instantaneous feedback to the developers.

WebRef
Useful information on XP can be obtained at **www.xprogramming.com**.

A key concept during the coding activity (and one of the most talked about aspects of XP) is *pair programming*. XP recommends that two people work together at one computer workstation to create code for a story. This provides a mechanism for real-time problem solving (two heads are often better than one) and real-time quality assurance (the code is reviewed as it is created). It also keeps the developers focused on the problem at hand. In practice, each person takes on a slightly different role. For example, one person might think about the coding details of a particular portion of the design while the other ensures that coding standards (a required part of XP) are being followed or that the code for the story will satisfy the unit test that has been developed to validate the code against the story.

What is pair programming?

ADVICE
Many software teams are populated by individualists. You'll have to work to change that culture if pair programming is to work effectively.

As pair programmers complete their work, the code they develop is integrated with the work of others. In some cases this is performed on a daily basis by an integration team. In other cases, the pair programmers have integration responsibility. This "continuous integration" strategy helps to avoid compatibility and interfacing problems and provides a "smoke testing" environment (Chapter 17) that helps to uncover errors early.

Testing. I have already noted that the creation of unit tests before coding commences is a key element of the XP approach. The unit tests that are created should be implemented using a framework that enables them to be automated (hence, they can be executed easily and repeatedly). This encourages a regression testing strategy (Chapter 17) whenever code is modified (which is often, given the XP refactoring philosophy).

How are unit tests used in XP?

8 This approach is analogous to knowing the exam questions before you begin to study. It makes studying much easier by focusing attention only on the questions that will be asked.

9 Unit testing, discussed in detail in Chapter 17, focuses on an individual software component, exercising the component's interface, data structures, and functionality in an effort to uncover errors that are local to the component.

As the individual unit tests are organized into a "universal testing suite" [Wel99], integration and validation testing of the system can occur on a daily basis. This provides the XP team with a continual indication of progress and also can raise warning flags early if things go awry. Wells [Wel99] states: "Fixing small problems every few hours takes less time than fixing huge problems just before the deadline."

XP *acceptance tests*, also called *customer tests,* are specified by the customer and focus on overall system features and functionality that are visible and reviewable by the customer. Acceptance tests are derived from user stories that have been implemented as part of a software release.

KEY POINT
XP acceptance tests are derived from user stories.

3.4.3 Industrial XP

Joshua Kerievsky [Ker05] describes *Industrial Extreme Programming* (IXP) in the following manner: "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." IXP incorporates six new practices that are designed to help ensure that an XP project works successfully for significant projects within a large organization.

? What new practices are appended to XP to create IXP?

Readiness assessment. Prior to the initiation of an IXP project, the organization should conduct a *readiness assessment.* The assessment ascertains whether (1) an appropriate development environment exists to support IXP, (2) the team will be populated by the proper set of stakeholders, (3) the organization has a distinct quality program and supports continuous improvement, (4) the organizational culture will support the new values of an agile team, and (5) the broader project community will be populated appropriately.

Quote:
"Ability is what you're capable of doing. Motivation determines what you do. Attitude determines how well you do it."
Lou Holtz

Project community. Classic XP suggests that the right people be used to populate the agile team to ensure success. The implication is that people on the team must be well-trained, adaptable and skilled, and have the proper temperament to contribute to a self-organizing team. When XP is to be applied for a significant project in a large organization, the concept of the "team" should morph into that of a *community.* A community may have a technologist and customers who are central to the success of a project as well as many other stakeholders (e.g., legal staff, quality auditors, manufacturing or sales types) who "are often at the periphery of an IXP project yet they may play important roles on the project" [Ker05]. In IXP, the community members and their roles should be explicitly defined and mechanisms for communication and coordination between community members should be established.

Project chartering. The IXP team 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 of the

organization. Chartering also examines the context of the project to determine how it complements, extends, or replaces existing systems or processes.

Test-driven management. An IXP project requires measurable criteria for assessing the state of the project and the progress that has been made to date. Test-driven management establishes a series of measurable "destinations" [Ker05] and then defines mechanisms for determining whether or not these destinations have been reached.

Retrospectives. An IXP team conducts a specialized technical review (Chapter 15) after a software increment is delivered. Called a *retrospective,* the review examines "issues, events, and lessons-learned" [Ker05] across a software increment and/or the entire software release. The intent is to improve the IXP process.

Continuous learning. Because learning is a vital part of continuous process improvement, members of the XP team are encouraged (and possibly, incented) to learn new methods and techniques that can lead to a higher-quality product.

In addition to the six new practices discussed, IXP modifies a number of existing XP practices. *Story-driven development* (SDD) insists that stories for acceptance tests be written before a single line of code is generated. *Domain-driven design* (DDD) is an improvement on the "system metaphor" concept used in XP. DDD [Eva03] suggests the evolutionary creation of a domain model that "accurately represents how domain experts think about their subject" [Ker05]. *Pairing* extends the XP pair-programming concept to include managers and other stakeholders. The intent is to improve knowledge sharing among XP team members who may not be directly involved in technical development. *Iterative usability* discourages front-loaded interface design in favor of usability design that evolves as software increments are delivered and users' interaction with the software is studied.

IXP makes smaller modifications to other XP practices and redefines certain roles and responsibilities to make them more amenable to significant projects for large organizations. For further discussion of IXP, visit **http://industrialxp.org**.

3.4.4 The XP Debate

All new process models and methods spur worthwhile discussion and in some instances heated debate. Extreme Programming has done both. In an interesting book that examines the efficacy of XP, Stephens and Rosenberg [Ste03] argue that many XP practices are worthwhile, but others have been overhyped, and a few are problematic. The authors suggest that the codependent nature of XP practices are both its strength and its weakness. Because many organizations adopt only a subset of XP practices, they weaken the efficacy of the entire process. Proponents counter that XP is continuously evolving and that many of the issues raised by critics have been

addressed as XP practice matures. Among the issues that continue to trouble some critics of XP are:[10]

What are some of the issues that lead to an XP debate?

- *Requirements volatility*. Because the customer is an active member of the XP team, changes to requirements are requested informally. As a consequence, the scope of the project can change and earlier work may have to be modified to accommodate current needs. Proponents argue that this happens regardless of the process that is applied and that XP provides mechanisms for controlling scope creep.
- *Conflicting customer needs*. Many projects have multiple customers, each with his own set of needs. In XP, the team itself is tasked with assimilating the needs of different customers, a job that may be beyond their scope of authority.
- *Requirements are expressed informally*. User stories and acceptance tests are the only explicit manifestation of requirements in XP. Critics argue that a more formal model or specification is often needed to ensure that omissions, inconsistencies, and errors are uncovered before the system is built. Proponents counter that the changing nature of requirements makes such models and specification obsolete almost as soon as they are developed.
- *Lack of formal design*. XP deemphasizes the need for architectural design and in many instances, suggests that design of all kinds should be relatively informal. Critics argue that when complex systems are built, design must be emphasized to ensure that the overall structure of the software will exhibit quality and maintainability. XP proponents suggest that the incremental nature of the XP process limits complexity (simplicity is a core value) and therefore reduces the need for extensive design.

You should note that every software process has flaws and that many software organizations have used XP successfully. The key is to recognize where a process may have weaknesses and to adapt it to the specific needs of your organization.

SAFEHOME

Considering Agile Software Development

The scene: Doug Miller's office.

The Players: Doug Miller, software engineering manager; Jamie Lazar, software team member; Vinod Raman, software team member.

The conversation:

(A knock on the door, Jamie and Vinod enter Doug's office)

Jamie: Doug, you got a minute?

10 For a detailed look at some thoughtful criticism that has been leveled at XP, visit www.softwarereality.com/ExtremeProgramming.jsp.

Doug: Sure Jamie, what's up?

Jamie: We've been thinking about our process discussion yesterday . . . you know, what process we're going to choose for this new *SafeHome* project.

Doug: And?

Vinod: I was talking to a friend at another company, and he was telling me about Extreme Programming. It's an agile process model . . . heard of it?

Doug: Yeah, some good, some bad.

Jamie: Well, it sounds pretty good to us. Lets you develop software really fast, uses something called pair programming to do real-time quality checks . . . it's pretty cool, I think.

Doug: It does have a lot of really good ideas. I like the pair-programming concept, for instance, and the idea that stakeholders should be part of the team.

Jamie: Huh? You mean that marketing will work on the project team with us?

Doug (nodding): They're a stakeholder, aren't they?

Jamie: Jeez . . . they'll be requesting changes every five minutes.

Vinod: Not necessarily. My friend said that there are ways to "embrace" changes during an XP project.

Doug: So you guys think we should use XP?

Jamie: It's definitely worth considering.

Doug: I agree. And even if we choose an incremental model as our approach, there's no reason why we can't incorporate much of what XP has to offer.

Vinod: Doug, before you said "some good, some bad." What was the "bad"?

Doug: The thing I don't like is the way XP downplays analysis and design . . . sort of says that writing code is where the action is . . .

(The team members look at one another and smile.)

Doug: So you agree with the XP approach?

Jamie (speaking for both): Writing code is what we do, Boss!

Doug (laughing): True, but I'd like to see you spend a little less time coding and then recoding and a little more time analyzing what has to be done and designing a solution that works.

Vinod: Maybe we can have it both ways, agility with a little discipline.

Doug: I think we can, Vinod. In fact, I'm sure of it.

3.5 Other Agile Process Models

Quote:

"Our profession goes through methodologies like a 14-year-old goes through clothing."

Stephen Hawrysh and Jim Ruprecht

The history of software engineering is littered with dozens of obsolete process descriptions and methodologies, modeling methods and notations, tools, and technology. Each flared in notoriety and was then eclipsed by something new and (purportedly) better. With the introduction of a wide array of agile process models—each contending for acceptance within the software development community—the agile movement is following the same historical path.[11]

As I noted in the last section, the most widely used of all agile process models is Extreme Programming (XP). But many other agile process models have been proposed and are in use across the industry. Among the most common are:

- Adaptive Software Development (ASD)
- Scrum
- Dynamic Systems Development Method (DSDM)

11 This is not a bad thing. Before one or more models or methods are accepted as a de facto standard, all must contend for the hearts and minds of software engineers. The "winners" evolve into best practice, while the "losers" either disappear or merge with the winning models.

- Crystal
- Feature Drive Development (FDD)
- Lean Software Development (LSD)
- Agile Modeling (AM)
- Agile Unified Process (AUP)

In the sections that follow, I present a very brief overview of each of these agile process models. It is important to note that *all* agile process models conform (to a greater or lesser degree) to the *Manifesto for Agile Software Development* and the principles noted in Section 3.3.1. For additional detail, refer to the references noted in each subsection or for a survey, examine the "agile software development" entry in Wikipedia.[12]

3.5.1 Adaptive Software Development (ASD)

WebRef

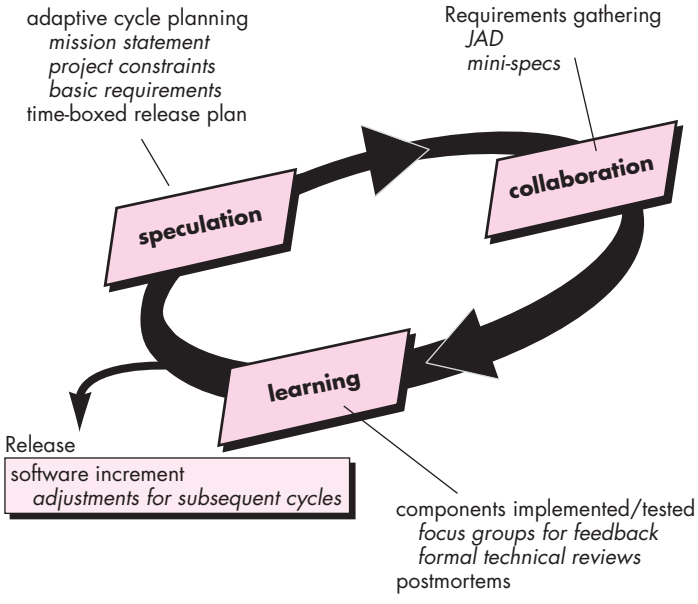
Useful resources for ASD can be found at **www.adaptivesd.com**.

Adaptive Software Development (ASD) has been proposed by Jim Highsmith [Hig00] as a technique for building complex software and systems. The philosophical underpinnings of ASD focus on human collaboration and team self-organization.

Highsmith argues that an agile, adaptive development approach based on collaboration is "as much a source of *order* in our complex interactions as discipline and engineering." He defines an ASD "life cycle" (Figure 3.3) that incorporates three phases, speculation, collaboration, and learning.

FIGURE 3.3

Adaptive software development



12 See http://en.wikipedia.org/wiki/Agile_software_development#Agile_methods.

During *speculation,* the 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 dates or user descriptions), and basic requirements—to define the set of release cycles (software increments) that will be required for the project.

Effective collaboration with your customer will only occur if you jettison any "us and them" attitudes.

No matter how complete and farsighted the cycle plan, it will invariably change. Based on information obtained at the completion of the first cycle, the plan is reviewed and adjusted so that planned work better fits the reality in which an ASD team is working.

Motivated people use *collaboration* in a way that multiplies their talent and creative output beyond their absolute numbers. This approach is a recurring theme in all agile methods. But collaboration is not easy. It encompasses communication and teamwork, but it also emphasizes individualism, because individual creativity plays an important role in collaborative thinking. It is, above all, a matter of trust. People working together must trust one another to (1) criticize without animosity, (2) assist without resentment, (3) work as hard as or harder than they do, (4) have the skill set to contribute to the work at hand, and (5) communicate problems or concerns in a way that leads to effective action.

ASD emphasizes learning as a key element in achieving a "self-organizing" team.

As members of an ASD team begin to develop the components that are part of an adaptive cycle, the emphasis is on "learning" as much as it is on progress toward a completed cycle. In fact, Highsmith [Hig00] 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. ASD teams learn in three ways: focus groups (Chapter 5), technical reviews (Chapter 14), and project postmortems.

The ASD philosophy has merit regardless of the process model that is used. ASD's overall emphasis on the dynamics of self-organizing teams, interpersonal collaboration, and individual and team learning yield software project teams that have a much higher likelihood of success.

3.5.2 Scrum

Scrum (the name is derived from an activity that occurs during a rugby match[13]) is an agile software development method that was conceived by Jeff Sutherland and his development team in the early 1990s. In recent years, further development on the Scrum methods has been performed by Schwaber and Beedle [Sch01a].

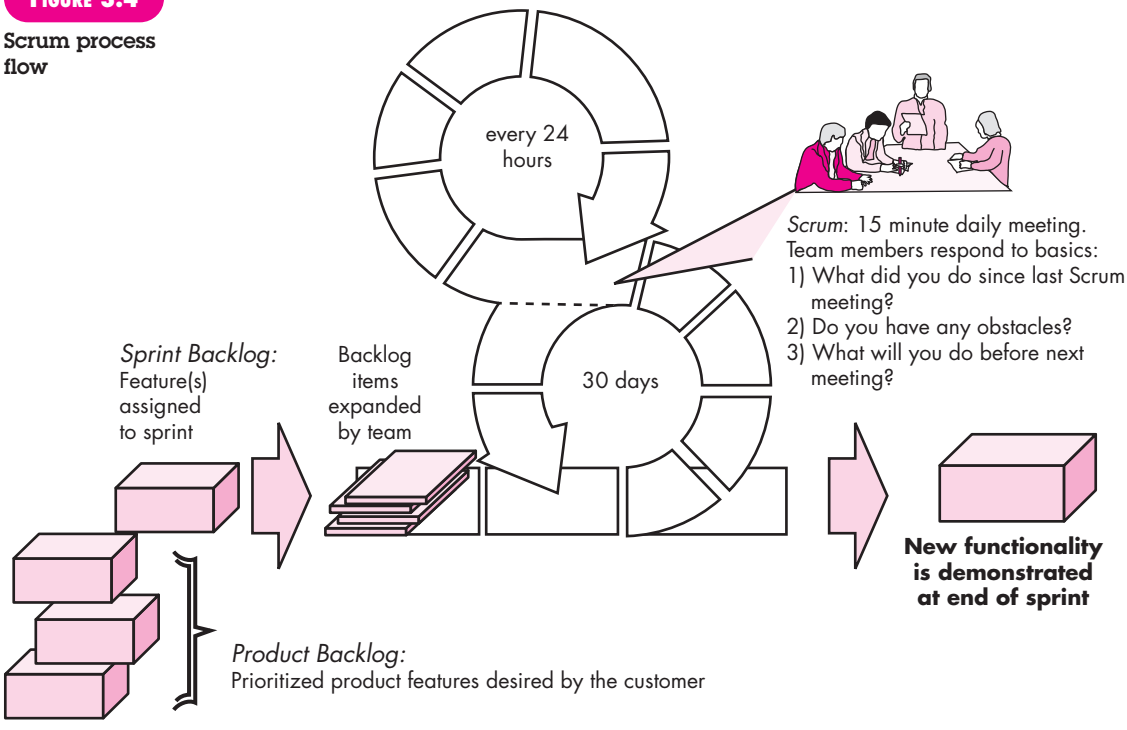
WebRef

Useful Scrum information and resources can be found at **www.controlchaos.com**.

Scrum principles are consistent with the agile manifesto and are used to guide development activities within a process that incorporates the following framework activities: requirements, analysis, design, evolution, and delivery. Within each

13 A group of players forms around the ball and the teammates work together (sometimes violently!) to move the ball downfield.

FIGURE 3.4
Scrum process flow



framework activity, work tasks occur within a process pattern (discussed in the following paragraph) called a *sprint.* The work conducted within a sprint (the number of sprints required for each framework activity will vary depending on product complexity and size) is adapted to the problem at hand and is defined and often modified in real time by the Scrum team. The overall flow of the Scrum process is illustrated in Figure 3.4.

Scrum emphasizes the use of a set of software process patterns [Noy02] that have proven effective for projects with tight timelines, changing requirements, and business criticality. Each of these process patterns defines a set of development actions:

KEY POINT

Scrum incorporates a set of process patterns that emphasize project priorities, compartmentalized work units, communication, and frequent customer feedback.

Backlog—a prioritized list of project requirements or features that provide business value for the customer. Items can be added to the backlog at any time (this is how changes are introduced). The product manager assesses the backlog and updates priorities as required.

Sprints—consist of work units that are required to achieve a requirement defined in the backlog that must be fit into a predefined time-box[14] (typically 30 days).

14 A *time-box* is a project management term (see Part 4 of this book) that indicates a period of time that has been allocated to accomplish some task.

Changes (e.g., backlog work items) are not introduced during the sprint. Hence, the sprint allows team members to work in a short-term, but stable environment.

Scrum meetings—are short (typically 15 minutes) meetings held daily by the Scrum team. Three key questions are asked and answered by all team members [Noy02]:

- What did you do since the last team meeting?
- What obstacles are you encountering?
- What do you plan to accomplish by the next team meeting?

A team leader, called a *Scrum master,* leads the meeting and assesses the responses from each person. The Scrum meeting helps the team to uncover potential problems as early as possible. Also, these daily meetings lead to "knowledge socialization" [Bee99] and thereby promote a self-organizing team structure.

Demos—deliver the software increment to the customer so that functionality that has been implemented can be demonstrated and evaluated by the customer. It is important to note that the demo may not contain all planned functionality, but rather those functions that can be delivered within the time-box that was established.

Beedle and his colleagues [Bee99] present a comprehensive discussion of these patterns in which they state: "Scrum assumes up-front the existence of chaos. . . . " The Scrum process patterns enable a software team to work successfully in a world where the elimination of uncertainty is impossible.

3.5.3 Dynamic Systems Development Method (DSDM)

WebRef
Useful resources for DSSD can be found at **www.dsdm.org**.

The *Dynamic Systems Development Method* (DSDM) [Sta97] is 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" [CCS02]. The DSDM philosophy is borrowed from a modified version of the Pareto principle—80 percent of an application can be delivered in 20 percent of the time it would take to deliver the complete (100 percent) application.

DSDM is an iterative software process in which each iteration follows the 80 percent rule. That is, only enough work is required for each increment to facilitate movement to the next increment. The remaining detail can be completed later when more business requirements are known or changes have been requested and accommodated.

The DSDM Consortium (**www.dsdm.org**) is a worldwide group of member companies that collectively take on the role of "keeper" of the method. The consortium has defined an agile process model, called the *DSDM life cycle* that defines three different iterative cycles, preceded by two additional life cycle activities:

Feasibility study—establishes the basic business requirements and constraints associated with the application to be built and then assesses whether the application is a viable candidate for the DSDM process.

KEY POINT
DSDM is a process framework that can adopt the tactics of another agile approach such as XP.

Business study—establishes the functional and information requirements that will allow the application to provide business value; also, defines the basic application architecture and identifies the maintainability requirements for the application.

Functional model iteration—produces a set of incremental prototypes that demonstrate functionality for the customer. (Note: All DSDM prototypes are intended to evolve into the deliverable application.) The intent during this iterative cycle is to gather additional requirements by eliciting feedback from users as they exercise the prototype.

Design and build iteration—revisits prototypes built during *functional model iteration* to ensure that each has been engineered in a manner that will enable it to provide operational business value for end users. In some cases, *functional model iteration* and *design and build iteration* occur concurrently.

Implementation—places the latest software increment (an "operationalized" prototype) into the operational environment. It should be noted that (1) the increment may not be 100 percent complete or (2) changes may be requested as the increment is put into place. In either case, DSDM development work continues by returning to the functional model iteration activity.

DSDM can be combined with XP (Section 3.4) to provide a combination approach that defines a solid process model (the DSDM life cycle) with the nuts and bolts practices (XP) that are required to build software increments. In addition, the ASD concepts of collaboration and self-organizing teams can be adapted to a combined process model.

3.5.4 Crystal

Alistair Cockburn [Coc05] and Jim Highsmith [Hig02b] created the *Crystal family of agile methods*[15] in order to achieve a software development approach that puts a premium on "maneuverability" during what Cockburn characterizes as "a resource-limited, cooperative game of invention and communication, with a primary goal of delivering useful, working software and a secondary goal of setting up for the next game" [Coc02].

KEY POINT
Crystal is a family of process models with the same "genetic code" but different methods for adapting to project characteristics.

To achieve maneuverability, Cockburn and Highsmith have defined a set of methodologies, each with core elements that are common to all, and roles, process patterns, work products, and practice that are unique to each. The Crystal family is actually a set of example agile processes that have been proven effective for different types of projects. The intent is to allow agile teams to select the member of the crystal family that is most appropriate for their project and environment.

15 The name "crystal" is derived from the characteristics of geological crystals, each with its own color, shape, and hardness.

3.5.5 Feature Driven Development (FDD)

Feature Driven Development (FDD) was originally conceived by Peter Coad and his colleagues [Coa99] as a practical process model for object-oriented software engineering. Stephen Palmer and John Felsing [Pal02] have extended and improved Coad's work, describing an adaptive, agile process that can be applied to moderately sized and larger software projects.

WebRef

A wide variety of articles and presentations on FDD can be found at: **www.featuredrivendevelopment.com/**.

Like other agile approaches, FDD adopts a philosophy that (1) emphasizes collaboration among people on an FDD team; (2) manages problem and project complexity using feature-based decomposition followed by the integration of software increments, and (3) communication of technical detail using verbal, graphical, and text-based means. FDD emphasizes software quality assurance activities by encouraging an incremental development strategy, the use of design and code inspections, the application of software quality assurance audits (Chapter 16), the collection of metrics, and the use of patterns (for analysis, design, and construction).

In the context of FDD, a *feature* "is a client-valued function that can be implemented in two weeks or less" [Coa99]. The emphasis on the definition of features provides the following benefits:

- Because features are small blocks of deliverable functionality, users can describe them more easily; understand how they relate to one another more readily; and better review them for ambiguity, error, or omissions.
- Features can be organized into a hierarchical business-related grouping.
- Since a feature is the FDD deliverable software increment, the team develops operational features every two weeks.
- Because features are small, their design and code representations are easier to inspect effectively.
- Project planning, scheduling, and tracking are driven by the feature hierarchy, rather than an arbitrarily adopted software engineering task set.

Coad and his colleagues [Coa99] suggest the following template for defining a feature:

<action> the **<result>** **<by** | **for** | **of** | **to>** a(n) **<object>**

where an **<object>** is "a person, place, or thing (including roles, moments in time or intervals of time, or catalog-entry-like descriptions)." Examples of features for an e-commerce application might be:

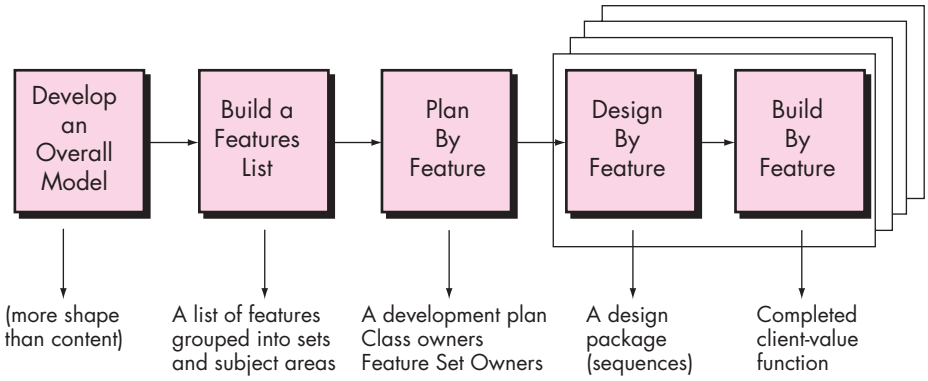
Add the product to shopping cart

Display the technical-specifications of the product

Store the shipping-information for the customer

FIGURE 3.5

Feature Driven Development [Coa99] (with permission)



A feature set groups related features into business-related categories and is defined [Coa99] as:

<action><-ing> a(n) **<object>**

For example: *Making a product sale* is a feature set that would encompass the features noted earlier and others.

The FDD approach defines five "collaborating" [Coa99] framework activities (in FDD these are called "processes") as shown in Figure 3.5.

FDD provides greater emphasis on project management guidelines and techniques than many other agile methods. As projects grow in size and complexity, ad hoc project management is often inadequate. It is essential for developers, their managers, and other stakeholders to understand project status—what accomplishments have been made and problems have been encountered. If deadline pressure is significant, it is critical to determine if software increments (features) are properly scheduled. To accomplish this, FDD defines six milestones during the design and implementation of a feature: "design walkthrough, design, design inspection, code, code inspection, promote to build" [Coa99].

3.5.6 Lean Software Development (LSD)

Lean Software Development (LSD) has adapted the principles of lean manufacturing to the world of software engineering. The lean principles that inspire the LSD process can be summarized ([Pop03], [Pop06a]) as *eliminate waste, build quality in, create knowledge, defer commitment, deliver fast, respect people,* and *optimize the whole.*

Each of these principles can be adapted to the software process. For example, *eliminate waste* within the context of an agile software project can be interpreted to mean [Das05]: (1) adding no extraneous features or functions, (2) assessing the cost and schedule impact of any newly requested requirement, (3) removing any superfluous process steps, (4) establishing mechanisms to improve the way team members find information, (5) ensuring the testing finds as many errors as possible,

(6) reducing the time required to request and get a decision that affects the software or the process that is applied to create it, and (7) streamlining the manner in which information is transmitted to all stakeholders involved in the process.

For a detailed discussion of LSD and pragmatic guidelines for implementing the process, you should examine [Pop06a] and [Pop06b].

3.5.7 Agile Modeling (AM)

WebRef

Comprehensive information on agile modeling can be found at: **www.agilemodeling.com**.

There are many situations in which software engineers must build large, business-critical systems. The scope and complexity of such systems must be modeled so that (1) all constituencies can better understand what needs to be accomplished, (2) the problem can be partitioned effectively among the people who must solve it, and (3) quality can be assessed as the system is being engineered and built.

Over the past 30 years, a wide variety of software engineering modeling methods and notation have been proposed for analysis and design (both architectural and component-level). These methods have merit, but they have proven to be difficult to apply and challenging to sustain (over many projects). Part of the problem is the "weight" of these modeling methods. By this I mean the volume of notation required, the degree of formalism suggested, the sheer size of the models for large projects, and the difficulty in maintaining the model(s) as changes occur. Yet analysis and design modeling have substantial benefit for large projects—if for no other reason than to make these projects intellectually manageable. Is there an agile approach to software engineering modeling that might provide an alternative?

Quote:

"I was in the drug store the other day trying to get a cold medication . . . not easy. There's an entire wall of products you need. You stand there going, Well, this one is quick acting but this is long lasting. . . . Which is more important, the present or the future?"

Jerry Seinfeld

At "The Official Agile Modeling Site," Scott Ambler [Amb02a] describes *agile modeling* (AM) in the following manner:

> Agile Modeling (AM) is a practice-based methodology for effective modeling and documentation of software-based systems. Simply put, Agile Modeling (AM) is a collection of values, principles, and practices for modeling software that can be applied on a software development project in an effective and light-weight manner. Agile models are more effective than traditional models because they are just barely good, they don't have to be perfect.

Agile modeling adopts all of the values that are consistent with the agile manifesto. The agile modeling philosophy recognizes that an agile team must have the courage to make decisions that may cause it to reject a design and refactor. The team must also have the humility to recognize that technologists do not have all the answers and that business experts and other stakeholders should be respected and embraced.

Although AM suggests a wide array of "core" and "supplementary" modeling principles, those that make AM unique are [Amb02a]:

> **Model with a purpose.** A developer who uses AM should have a specific goal (e.g., to communicate information to the customer or to help better understand some aspect of the software) in mind before creating the model. Once the goal for the model is identified, the type of notation to be used and level of detail required will be more obvious.

Use multiple models. There are many different models and notations that can be used to describe software. Only a small subset is essential for most projects. AM suggests that to provide needed insight, each model should present a different aspect of the system and only those models that provide value to their intended audience should be used.

"Traveling light" is an appropriate philosophy for all software engineering work. Build only those models that provide value … no more, no less.

Travel light. As software engineering work proceeds, keep only those models that will provide long-term value and jettison the rest. Every work product that is kept must be maintained as changes occur. This represents work that slows the team down. Ambler [Amb02a] notes that "Every time you decide to keep a model you trade-off agility for the convenience of having that information available to your team in an abstract manner (hence potentially enhancing communication within your team as well as with project stakeholders)."

Content is more important than representation. Modeling should impart information to its intended audience. A syntactically perfect model that imparts little useful content is not as valuable as a model with flawed notation that nevertheless provides valuable content for its audience.

Know the models and the tools you use to create them. Understand the strengths and weaknesses of each model and the tools that are used to create it.

Adapt locally. The modeling approach should be adapted to the needs of the agile team.

A major segment of the software engineering community has adopted the Unified Modeling Language (UML)[16] as the preferred method for representing analysis and design models. The Unified Process (Chapter 2) has been developed to provide a framework for the application of UML. Scott Ambler [Amb06] has developed a simplified version of the UP that integrates his agile modeling philosophy.

3.5.8 Agile Unified Process (AUP)

The *Agile Unified Process* (AUP) adopts a "serial in the large" and "iterative in the small" [Amb06] philosophy for building computer-based systems. By adopting the classic UP phased activities—*inception, elaboration, construction,* and *transition*—AUP provides a serial overlay (i.e., a linear sequence of software engineering activities) that enables a team to visualize the overall process flow for a software project. However, within each of the activities, the team iterates to achieve agility and to deliver meaningful software increments to end users as rapidly as possible. Each AUP iteration addresses the following activities [Amb06]:

- *Modeling.* UML representations of the business and problem domains are created. However, to stay agile, these models should be "just barely good enough" [Amb06] to allow the team to proceed.

16 A brief tutorial on UML is presented in Appendix 1.

- *Implementation.* Models are 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 discussed in Chapters 1 and 2, deployment in this context focuses on the delivery of a software increment and the acquisition of feedback from end users.
- *Configuration and project management.* In the context of AUP, configuration management (Chapter 22) addresses change management, risk management, and the control of any persistent work products[17] that are produced by the team. Project management tracks and controls the progress of the team and coordinates team activities.
- *Environment management.* Environment management coordinates a process infrastructure that includes standards, tools, and other support technology available to the team.

Although the AUP has historical and technical connections to the Unified Modeling Language, it is important to note that UML modeling can be using in conjunction with any of the agile process models described in Section 3.5.

SOFTWARE TOOLS

Agile Development

Objective: The objective of agile development tools is to assist in one or more aspects of agile development with an emphasis on facilitating the rapid generation of operational software. These tools can also be used when prescriptive process models (Chapter 2) are applied.

Mechanics: Tool mechanics vary. In general, agile tool sets encompass automated support for project planning, use case development and requirements gathering, rapid design, code generation, and testing.

Representative Tools:[18]

Note: Because agile development is a hot topic, most software tools vendors purport to sell tools that support the agile approach. The tools noted here have characteristics that make them particularly useful for agile projects.

OnTime, developed by Axosoft (**www.axosoft.com**), provides agile process management support for various technical activities within the process.

Ideogramic UML, developed by Ideogramic (**www.ideogramic.com**) is a UML tool set specifically developed for use within an agile process.

Together Tool Set, distributed by Borland (**www.borland.com**), provides a tools suite that supports many technical activities within XP and other agile processes.

17 A *persistent work product* is a model or document or test case produced by the team that will be kept for an indeterminate period of time. It will *not* be discarded once the software increment is delivered.

18 Tools noted here do not represent an endorsement, but rather a sampling of tools in this category. In most cases, tool names are trademarked by their respective developers.

3.6 A Tool Set for the Agile Process

The "tool set" that supports agile processes focuses more on people issues than it does on technology issues.

Some proponents of the agile philosophy argue that automated software tools (e.g., design tools) should be viewed as a minor supplement to the team's activities, and not at all pivotal to the success of the team. However, Alistair Cockburn [Coc04] suggests that tools can have a benefit and that "agile teams stress using tools that permit the rapid flow of understanding. Some of those tools are social, starting even at the hiring stage. Some tools are technological, helping distributed teams simulate being physically present. Many tools are physical, allowing people to manipulate them in workshops."

Because acquiring the right people (hiring), team collaboration, stakeholder communication, and indirect management are key elements in virtually all agile process models, Cockburn argues that "tools" that address these issues are critical success factors for agility. For example, a hiring "tool" might be the requirement to have a prospective team member spend a few hours pair programming with an existing member of the team. The "fit" can be assessed immediately.

Collaborative and communication "tools" are generally low tech and incorporate any mechanism ("physical proximity, whiteboards, poster sheets, index cards, and sticky notes" [Coc04]) that provides information and coordination among agile developers. Active communication is achieved via the team dynamics (e.g., pair programming), while passive communication is achieved by "information radiators" (e.g., a flat panel display that presents the overall status of different components of an increment). Project management tools deemphasize the Gantt chart and replace it with earned value charts or "graphs of tests created versus passed . . . other agile tools are used to optimize the environment in which the agile team works (e.g., more efficient meeting areas), improve the team culture by nurturing social interactions (e.g., collocated teams), physical devices (e.g., electronic whiteboards), and process enhancement (e.g., pair programming or time-boxing)" [Coc04].

Are any of these things really tools? They are, if they facilitate the work performed by an agile team member and enhance the quality of the end product.

3.7 Summary

In a modern economy, market conditions change rapidly, customer and end-user needs evolve, and new competitive threats emerge without warning. Practitioners must approach software engineering in a manner that allows them to remain agile—to define maneuverable, adaptive, lean processes that can accommodate the needs of modern business.

An agile philosophy for software engineering stresses four key issues: the importance of self-organizing teams that have control over the work they perform, communication and collaboration between team members and between practitioners and their customers, a recognition that change represents an opportunity, and

an emphasis on rapid delivery of software that satisfies the customer. Agile process models have been designed to address each of these issues.

Extreme programming (XP) is the most widely used agile process. Organized as four framework activities—planning, design, coding, and testing—XP suggests a number of innovative and powerful techniques that allow an agile team to create frequent software releases that deliver features and functionality that have been described and then prioritized by stakeholders.

Other agile process models also stress human collaboration and team self-organization, but define their own framework activities and select different points of emphasis. For example, ASD uses an iterative process that incorporates adaptive cycle planning, relatively rigorous requirement gathering methods, and an iterative development cycle that incorporates customer focus groups and formal technical reviews as real-time feedback mechanisms. Scrum emphasizes the use of a set of software process patterns that have proven effective for projects with tight time lines, changing requirements, and business criticality. Each process pattern defines a set of development tasks and allows the Scrum team to construct a process that is adapted to the needs of the project. The Dynamic Systems Development Method (DSDM) advocates the use of time-box scheduling and suggests that only enough work is required for each software increment to facilitate movement to the next increment. Crystal is a family of agile process models that can be adopted to the specific characteristics of a project.

Feature Driven Development (FDD) is somewhat more "formal" than other agile methods, but still maintains agility by focusing the project team on the development of features—a client-valued function that can be implemented in two weeks or less. Lean Software Development (LSD) has adapted the principles of lean manufacturing to the world of software engineering. Agile modeling (AM) suggests that modeling is essential for all systems, but that the complexity, type, and size of the model must be tuned to the software to be built. The Agile Unified Process (AUP) adopts a "serial in the large" and "iterative in the small" philosophy for building software.

Problems and Points to Ponder

3.1. Reread "The Manifesto for Agile Software Development" at the beginning of this chapter. Can you think of a situation in which one or more of the four "values" could get a software team into trouble?

3.2. Describe agility (for software projects) in your own words.

3.3. Why does an iterative process make it easier to manage change? Is every agile process discussed in this chapter iterative? Is it possible to complete a project in just one iteration and still be agile? Explain your answers.

3.4. Could each of the agile processes be described using the generic framework activities noted in Chapter 2? Build a table that maps the generic activities into the activities defined for each agile process.

3.5. Try to come up with one more "agility principle" that would help a software engineering team become even more maneuverable.

3.6. Select one agility principle noted in Section 3.3.1 and try to determine whether each of the process models presented in this chapter exhibits the principle. [Note: I have presented an overview of these process models only, so it may not be possible to determine whether a principle has been addressed by one or more of the models, unless you do additional research (which is not required for this problem).]

3.7. Why do requirements change so much? After all, don't people know what they want?

3.8. Most agile process models recommend face-to-face communication. Yet today, members of a software team and their customers may be geographically separated from one another. Do you think this implies that geographical separation is something to avoid? Can you think of ways to overcome this problem?

3.9. Write an XP user story that describes the "favorite places" or "bookmarks" feature available on most Web browsers.

3.10. What is a spike solution in XP?

3.11. Describe the XP concepts of refactoring and pair programming in your own words.

3.12. Do a bit more reading and describe what a time-box is. How does this assist an ASD team in delivering software increments in a short time period?

3.13. Do the 80 percent rule in DSDM and the time-boxing approach defined for ASD achieve the same result?

3.14. Using the process pattern template presented in Chapter 2, develop a process pattern for any one of the Scrum patterns presented in Section 3.5.2.

3.15. Why is Crystal called a family of agile methods?

3.16. Using the FDD feature template described in Section 3.5.5, define a feature set for a Web browser. Now develop a set of features for the feature set.

3.17. Visit the Official Agile Modeling Site and make a complete list of all core and supplementary AM principles.

3.18. The tool set proposed in Section 3.6 supports many of the "soft" aspects of agile methods. Since communication is so important, recommend an actual tool set that might be used to enhance communication among stakeholders on an agile team.

Further Readings and Information Sources

The overall philosophy and underlying principles of agile software development are considered in depth in many of the books referenced in the body of this chapter. In addition, books by Shaw and Warden (*The Art of Agile Development,* O'Reilly Media, Inc., 2008), Hunt (*Agile Software Construction,* Springer, 2005), and Carmichael and Haywood (*Better Software Faster,* Prentice-Hall, 2002) present useful discussions of the subject. Aguanno (*Managing Agile Projects,* Multi-Media Publications, 2005), Highsmith (*Agile Project Management: Creating Innovative Products,* Addison-Wesley, 2004), and Larman (*Agile and Iterative Development: A Manager's Guide,* Addison-Wesley, 2003) present a management overview and consider project management issues. Highsmith (*Agile Software Development Ecosystems,* Addison-Wesley, 2002) presents a survey of agile principles, processes, and practices. A worthwhile discussion of the delicate balance between agility and discipline is presented by Booch and his colleagues (*Balancing Agility and Discipline,* Addison-Wesley, 2004).

Martin (*Clean Code: A Handbook of Agile Software Craftsmanship,* Prentice-Hall, 2009) presents the principles, patterns, and practices required to develop "clean code" in an agile software engineering environment. Leffingwell (*Scaling Software Agility: Best Practices for Large Enterprises,* Addison-Wesley, 2007) discusses strategies for scaling up agile practices for large projects. Lippert and Rook (*Refactoring in Large Software Projects: Performing Complex Restructurings Successfully,* Wiley, 2006) discuss the use of refactoring when applied in large, complex systems.

Stamelos and Sfetsos (*Agile Software Development Quality Assurance,* IGI Global, 2007) discuss SQA techniques that conform to the agile philosophy.

Dozens of books have been written about Extreme Programming over the past decade. Beck (*Extreme Programming Explained: Embrace Change,* 2d ed., Addison-Wesley, 2004) remains the definitive treatment of the subject. In addition, Jeffries and his colleagues (*Extreme Programming Installed,* Addison-Wesley, 2000), Succi and Marchesi (*Extreme Programming Examined,* Addison-Wesley, 2001), Newkirk and Martin (*Extreme Programming in Practice,* Addison-Wesley, 2001), and Auer and his colleagues (*Extreme Programming Applied: Play to Win,* Addison-Wesley, 2001) provide a nuts-and-bolts discussion of XP along with guidance on how best to apply it. McBreen (*Questioning Extreme Programming,* Addison-Wesley, 2003) takes a critical look at XP, defining when and where it is appropriate. An in-depth consideration of pair programming is presented by McBreen (*Pair Programming Illuminated,* Addison-Wesley, 2003).

ASD is addressed in depth by Highsmith [Hig00]. Schwaber (*The Enterprise and Scrum,* Microsoft Press, 2007) discusses the use of Scrum for projects that have a major business impact. The nuts and bolts of Scrum are discussed by Schwaber and Beedle (*Agile Software Development with SCRUM,* Prentice-Hall, 2001). Worthwhile treatments of DSDM have been written by the DSDM Consortium (*DSDM: Business Focused Development,* 2d ed., Pearson Education, 2003) and Stapleton (*DSDM: The Method in Practice,* Addison-Wesley, 1997). Cockburn (*Crystal Clear,* Addison-Wesley, 2005) presents an excellent overview of the Crystal family of processes. Palmer and Felsing [Pal02] present a detailed treatment of FDD. Carmichael and Haywood (*Better Software Faster,* Prentice-Hall, 2002) provides another useful treatment of FDD that includes a step-by-step journey through the mechanics of the process. Poppendieck and Poppendieck (*Lean Development: An Agile Toolkit for Software Development Managers,* Addison-Wesley, 2003) provide guidelines for managing and controlling agile projects. Ambler and Jeffries (*Agile Modeling,* Wiley, 2002) discuss AM in some depth.

A wide variety of information sources on agile software development are available on the Internet. An up-to-date list of World Wide Web references that are relevant to the agile process can be found at the SEPA website: **www.mhhe.com/engcs/compsci/pressman/professional/olc/ser.htm**.