Software Engineering

Rapid Software Development

Based on Software Engineering, 7th Edition by Ian Sommerville

Objectives

• To explain how an iterative, incremental development process leads to faster delivery of more useful software
• To discuss the essence of agile development methods
• To explain the principles and practices of extreme programming
• To explain the roles of prototyping in the software process
Rapid software development

- Because of rapidly changing business environments, businesses have to respond to new opportunities and competition.
- This requires software and rapid development and delivery is not often the most critical requirement for software systems.
- Businesses may be willing to accept lower quality software if rapid delivery of essential functionality is possible.

Requirements

- Because of the changing environment, it is often impossible to arrive at a stable, consistent set of system requirements.
- Therefore a waterfall model of development is impractical and an approach to development based on iterative specification and delivery is the only way to deliver software quickly.

Characteristics of RAD processes

- The processes of specification, design and implementation are concurrent. There is no detailed specification and design documentation is minimized.
- The system is developed in a series of increments. End users evaluate each increment and make proposals for later increments.
- System user interfaces are usually developed using an interactive development system.
Incremental development

**Advantages**
- Accelerated delivery of customer services
  - Each increment delivers the highest priority functionality to the customer.
- User engagement with the system
  - Users have to be involved in the development which means the system is more likely to meet their requirements and the users are more committed to the system.

**Problems**
- Management problems
  - Progress can be hard to judge and problems hard to find because there is no documentation to demonstrate what has been done.
- Contractual problems
  - The normal contract may include a specification; without a specification, different forms of contract have to be used.
- Validation problems
  - Without a specification, what is the system being tested against?
- Maintenance problems
  - Continual change tends to corrupt software structure making it more expensive to change and evolve to meet new requirements.

Prototyping

- For some large systems, incremental iterative development and delivery may be impractical; this is especially true when multiple teams are working on different sites.
- Prototyping, where an experimental system is developed as a basis for formulating the requirements may be used. This system is thrown away when the system specification has been agreed.

- The objective of **incremental development** is to deliver a working system to end-users. The development starts with those requirements which are best understood.
- The objective of **throw-away prototyping** is to validate or derive the system requirements. The prototyping process starts with those requirements which are poorly understood.
Agile methods

- Dissatisfaction with the overheads involved in design methods led to the creation of agile methods. These methods:
  - Focus on the code rather than the design;
  - Are based on an iterative approach to software development;
  - Are intended to deliver working software quickly and evolve this quickly to meet changing requirements.
- Agile methods are probably best suited to small/medium-sized business systems or PC products.

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<th>Principle</th>
<th>Description</th>
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<td>Customer involvement</td>
<td>The customer should be closely involved throughout the development process. Their role is provide and prioritise new system requirements and to evaluate the iterations of the system.</td>
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<td>Incremental delivery</td>
<td>The software is developed in increments with the customer specifying the requirements to be included in each increment.</td>
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<td>People not process</td>
<td>The skills of the development team should be recognised and exploited. The team should be left to develop their own ways of working without prescriptive processes.</td>
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<td>Embrace change</td>
<td>Expect the system requirements to change and design the system so that it can accommodate these changes.</td>
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<td>Maintain simplicity</td>
<td>Focus on simplicity in both the software being developed and in the development process used. Wherever possible, actively work to eliminate complexity from the system.</td>
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Extreme programming

- Perhaps the best-known and most widely used agile method.
- Extreme Programming (XP) takes an ‘extreme’ approach to iterative development.
  - New versions may be built several times per day;
  - Increments are delivered to customers every 2 weeks;
  - All tests must be run for every build and the build is only accepted if tests run successfully.
Extreme programming practices

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<td>Incremental planning</td>
<td>Requirements are recorded on Story Cards and the Stories to be included in a release are determined by the time available and their relative priority. The developers break these Stories into development Tasks.</td>
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<td>Small Releases</td>
<td>The minimal useful set of functionality that provides business value is developed first. Releases of the system are frequent and incrementally add functionality to the first release.</td>
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<td>Simple Design</td>
<td>Enough design is carried out to meet the current requirements and no more.</td>
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<td>Test first development</td>
<td>An automated unit test framework is used to write tests for a new piece of functionality before that functionality itself is implemented.</td>
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<td>Refactoring</td>
<td>All developers are expected to refactor the code continuously as soon as possible code improvements are found. This keeps the code simple and maintainable.</td>
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<td>Pair Programming</td>
<td>Developers work in pairs, checking each other’s work and providing the support to always do a good job.</td>
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<td>Collective Ownership</td>
<td>The pairs of developers work on all areas of the system, so that no islands of expertise develop and all the developers own all the code. Anyone can change anything.</td>
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<td>Continuous Integration</td>
<td>As soon as work on a task is complete it is integrated into the whole system. After any such integration, all the unit tests in the system must pass.</td>
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<td>Sustainable pace</td>
<td>Large amounts of over-time are not considered acceptable as the net effect is often to reduce code quality and medium term productivity</td>
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<td>On-site Customer</td>
<td>A representative of the end-user of the system (the Customer) should be available full time for the use of the XP team. In an extreme programming process, the customer is a member of the development team and is responsible for bringing system requirements to the team for implementation.</td>
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Requirements scenarios

- In XP, user requirements are expressed as scenarios or user stories.
- These are written on cards and the development team break them down into implementation tasks. These tasks are the basis of schedule and cost estimates.
- The customer chooses the stories for inclusion in the next release based on their priorities and the schedule estimates.

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**XP and change**

- Conventional wisdom in software engineering is to design for change. It is worth spending time and effort anticipating changes as this reduces costs later in the life cycle.
- XP, however, maintains that this is not worthwhile as changes cannot be reliably anticipated.
- Rather, it proposes constant code improvement (refactoring) to make changes easier when they have to be implemented.

**Testing in XP**

- Test-first development.
- Incremental test development from scenarios.
- User involvement in test development and validation.
- Automated test harnesses are used to run all component tests each time that a new release is built.
- Writing tests before code clarifies the requirements to be implemented.
- Tests are written as programs rather than data so that they can be executed automatically. The test includes a check that it has executed correctly.
- All previous and new tests are automatically run when new functionality is added. Thus checking that the new functionality has not introduced errors.
**Pair programming**

- In XP, programmers work in pairs, sitting together to develop code.
- This helps develop common ownership of code and spreads knowledge across the team.
- It serves as an informal review process as each line of code is looked at by more than one person.
- It encourages refactoring as the whole team can benefit from this.
- Measurements suggest that development productivity with pair programming is similar to that of two people working independently.

**Rapid application development (RAD)**

- Agile methods have received a lot of attention but other approaches to rapid application development have been used for many years.
- These are designed to develop data-intensive business applications and rely on programming and presenting information from a database.

- RAD environment tools
  - Database programming language
  - Interface generator
  - Links to office applications
  - Report generators

![RAD Diagram](image-url)
### Interface generation

- Many applications are based around complex forms and developing these forms manually is a time-consuming activity.
- RAD environments include support for screen generation including:
  - Interactive form definition using drag and drop techniques;
  - Form linking where the sequence of forms to be presented is specified;
  - Form verification where allowed ranges in form fields is defined.

- Visual programming
  - Scripting languages such as Visual Basic support visual programming where the prototype is developed by creating a user interface from standard items and associating components with these items.
  - A large library of components exists to support this type of development.
  - These may be tailored to suit the specific application requirements.

- Problems with visual development
  - Difficult to coordinate team-based development.
  - No explicit system architecture.
  - Complex dependencies between parts of the program can cause maintainability problems.

### COTS reuse

- An effective approach to rapid development is to configure and link existing off the shelf systems.
- For example, a requirements management system could be built by using:
  - A database to store requirements;
  - A word processor to capture requirements and format reports;
  - A spreadsheet for traceability management;
**Software prototyping**

- A prototype is an initial version of a system used to demonstrate concepts and try out design options.
- A prototype can be used in:
  - The requirements engineering process to help with requirements elicitation and validation;
  - In design processes to explore options and develop a UI design;
  - In the testing process to run back-to-back tests.
- **Benefits**
  - Improved system usability.
  - A closer match to users’ real needs.
  - Improved design quality.
  - Improved maintainability.
  - Reduced development effort.

**Prototyping plan**

- Establish prototype objectives
- Define prototype functionality
- Develop prototype
- Evaluate prototype

**Throw-away prototypes**

- Prototypes should be discarded after development as they are not a good basis for a production system:
  - It may be impossible to tune the system to meet non-functional requirements;
  - Prototypes are normally undocumented;
  - The prototype structure is usually degraded through rapid change;
  - The prototype probably will not meet normal organizational quality standards.
**Key points**

- An iterative approach to software development leads to faster delivery of software.
- Agile methods are iterative development methods that aim to reduce development overhead and so produce software faster.
- Extreme programming includes practices such as systematic testing, continuous improvement and customer involvement.
- The approach to testing in XP is a particular strength where executable tests are developed before the code is written.
- Rapid application development environments include database programming languages, form generation tools and links to office applications.
- A throw-away prototype is used to explore requirements and design options.
- When implementing a throw-away prototype, start with the requirements you least understand; in incremental development, start with the best-understood requirements.