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.

Stan Kurkovsky

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.
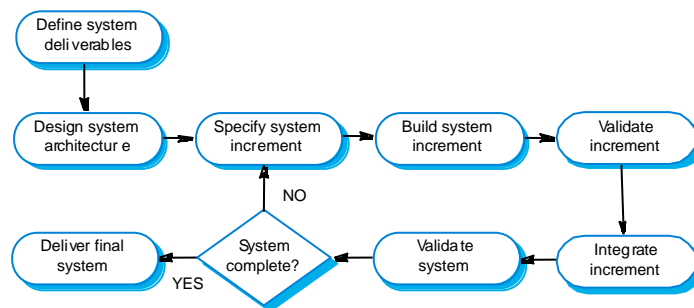
Stan Kurkovsky

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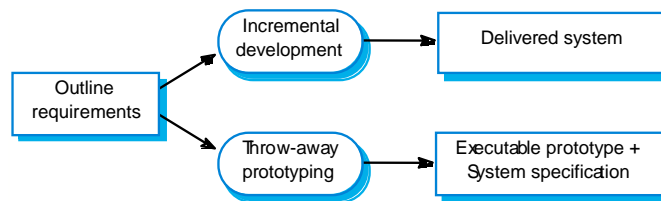
- The objective of incremental development is to deliver a working system to end-users. The development starts with those requirements which are best understood.
- The objective of throw-away prototyping is to validate or derive the system requirements. The prototyping process starts with those requirements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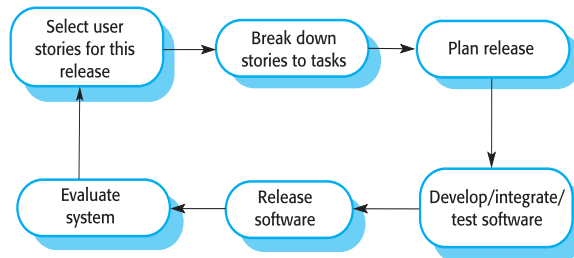
Agile methods

- 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.

Principle	Description
Customer involvement	The customer should be closely involved throughout the development process. Their role is to provide and prioritise new system requirements and to evaluate the iterations of the system.
Incremental delivery	The software is developed in increments with the customer specifying the requirements to be included in each increment.
People not process	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.
Embrace change	Expect the system requirements to change and design the system so that it can accommodate these changes.
Maintain simplicity	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.

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.

Select user stories for this release → Break down stories to tasks → Plan release → Develop/integrate/test software → Release software → Evaluate system → (back to Select user stories for this release)

Extreme programming practices

Incremental planning	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.
Small Releases	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.
Simple Design	Enough design is carried out to meet the current requirements and no more.
Test first development	An automated unit test framework is used to write tests for a new piece of functionality before that functionality itself is implemented.
Refactoring	All developers are expected to refactor the code continuously as soon as possible code improvements are found. This keeps the code simple and maintainable.
Pair Programming	Developers work in pairs, checking each other's work and providing the support to always do a good job.
Collective Ownership	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.
Continuous Integration	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.
Sustainable pace	Large amounts of over-time are not considered acceptable as the net effect is often to reduce code quality and medium term productivity
On-site Customer	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.

Stan Kurkovsky

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.

Downloading and printing an article

First, you select the article that you want from a displayed list. You then have to tell the system how you will pay for it – this can either be through a subscription, through a company account or by credit card.

After this, you get a copyright form from the system to fill in and, when you have submitted this, the article you want is downloaded onto your computer.

You then choose a printer and a copy of the article is printed. You tell the system if printing has been successful.

If the article is a print-only article, you can't keep the PDF version so it is automatically deleted from your computer.

Stan Kurkovsky

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.

Stan Kurkovsky

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.
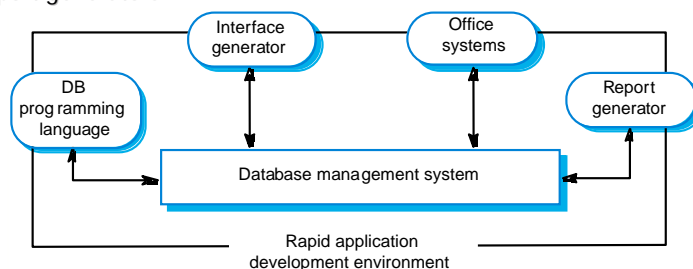
Stan Kurkovsky

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.

Stan Kurkovsky

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

Stan Kurkovsky

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.
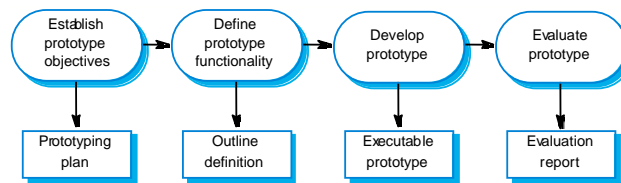 - Complex dependencies between parts of the program can cause maintainability problems.

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.

```
Establish          Define          Develop          Evaluate
prototype   →    prototype   →    prototype   →    prototype
objectives       functionality
    ↓                 ↓                ↓                ↓
Prototyping       Outline         Executable       Evaluation
  plan            definition      prototype          report
```

Stan Kurkovsky

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.

Stan Kurkovsky

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.

Stan Kurkovsky