Agile Software Development

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Version 1.1

Outline

- Agile methodologies
- XP (eXtreme Programming)
- Research Topics
- Test Driven Development

- License
Agile Methodologies

Part 1

Software Development

Building a ship? Growing a garden?
| Agile Software Development |

**Traditional development**

- ..or heavyweight
  - Emphasis on documentation, process
    - Waterfall, prototyping, iterative,
    - Iso 9000, Vision, CMM
  - Still, some projects fail (do they?)

**Agile**

- .. Or lightweight
  - Teamwork and communication
  - Change as a constant, give up on predictability
  - Iterations and reaction to change
    - Actually, nothing really new, but mix is innovative
Agile Manifesto

- In the 90’s several consultants (Beck, Cockburn, Schwabern, ..) observed failed projects, especially in large organizations, developed specific lean processes (XP, Crystal, Scrum) and agreed on a Manifesto

Agile Manifesto

- Individuals and interaction over process and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan
eXtreme Programming

Part 2

Outline

- Principles and Background
- The 12 practices
- XP practices in detail
- Issues in XP adoption
Extreme programming

- Kent Beck: Extreme Programming Explained
  Addison-Wesley, 2000,
  ISBN 0-201-61641-6

Principles and background
When can XP be used?

- Small projects:
  - 2-10 developers, maybe 20
- Developer and customer representative are co-located
- Problems:
  - Point-and-go culture
  - Testing takes hours to execute

Fundamentals of XP

- Distinguish between decisions made by business stakeholders and developers
- Simplistic – keep design as simple as possible “design for today not for tomorrow”
- Write automated test code before writing production code and keep all tests running
- Pair programming
- Very short iterations with fast delivery
Why is XP controversial?

- No specialists – every programmer participates in architecture, design, test, integration
- No up-front detailed analysis and design
- No up-front development of infrastructure
- Not much writing of design & implementation documentation beside tests and code

Cost of change

[Graph showing cost of change over time with Standard SE and XP assumption lines]

Cost of change

Standard SE

XP assumption
Some basic facts

- Producing code is required to deliver a system
- Dollars spent on analysis and design are wasted if the system is never used
- Business requirements have to be the drivers for software development
- Requirements change

Back to the basics

- Coding
- Testing
- Listening
- Designing
Four values

- Communication
  - “problems with projects can invariably be traced to somebody not talking to somebody else about something important” p 29
- Simplicity
  - “what is the simplest thing that could possibly work?”
- Feedback
  - Put system in production ASAP
  - “Have you written a test case for that yet?”
- Courage
  - Hill climbing (simple, complex, simpler,..)
  - Big jumps take courage

Facilities

- Should improve communication
  - Make sure that pairs can work effectively
  - Put developers close to each other
  - Open spaces
Four project variables

- Cost
  - “Adding people to a late project just makes it later”
- Scope
- Time
  - Time-boxed
- Quality

The key practices
12 practices

Customer satisfaction
- On-site customer
- Small releases

Software quality
- Metaphor
- Simple design
- Refactoring
- Pair programming
- Testing

Project management
- Planning game
- Sustainable development
- Collective code ownership
- Continuous integration
- Coding standards

On-site customer

- Many software projects fail because they do not deliver software that meets business needs
- Real customer has to be part of the team
  - Defines business needs
  - Answers questions and resolves issues
  - Prioritizes features
Small releases

- Put system into production ASAP
  - Fast feedback
- Deliver valuable features first
- Short cycle time
  - Planning 1-2 months is easier than planning 6-12 months

Metaphor/Architecture

- How does the whole system work?
- What is the overall idea of the system?
- Initially: Architectural spike
Simple design

- The “right” design
  - Runs all tests
  - No code duplication
  - Fewest possible classes and methods
  - Fulfills all *current* business requirements

- Design for today not the future

Refactoring

- Restructure system without changing the functionality
- Goal: Keep design simple
  - Change bad design when you find it
  - Remove dead code
Pair programming

- “All production code is written with two people looking at one machine”
  - Person 1: Implements the method
  - Person 2: Thinks strategically about potential improvements, test cases, issues
- Pairs change all the time
- Advantages
  - No single expert on any part of the system
  - Training on the job
  - Permanent inspections
- Problems:
  - Wasted development time?
  - Pairs need to function

TDD

- Automatic test drivers
- Write tests before production code
  - Unit tests → developer
  - Feature/acceptance tests → customer
- Strong emphasis on regression testing
  - Unit tests need to execute all the time
  - Tests for completed features need to execute all the time
- Unit tests pass 100%
- Acceptance tests show progress on user stories
The planning game

- Business decisions
  - Scope: which “stories” should be developed
  - Priority of stories
  - Composition of releases
  - Release dates
- Technical decisions
  - Time estimates for features/stories
  - Elaborate consequences of business decisions
  - Team organization and process
  - Scheduling

Sustainable development

- Developing full speed only works with fresh people
- Working overtime for two weeks in a row indicates problem
Collective ownership

- All code can be changed by anybody on the team
- Everybody is required to improve any portion of bad code s/he sees
- Individual code ownership tends to create experts

Continuous integration

- Integration happens after a few hours of development
  - Code is released into current baseline on integration machine
  - All tests are run
  - In case of errors:
    - Reverse to old version
    - Fix problems
    - Goto (1)
Coding standards

- Team has to adopt a coding standard
  - Makes it easier to understand other people’s code
  - Avoids code changes because of syntactic preferences

How everything fits together

From Beck: XP, Page 70
XP Practices in detail

Requirements definition

- User stories
  - On index cards
  - Short descriptions (about 3 sentences) of a feature
  - In customer language, no techno babble
  - Provide value to customer
  - Independent of each other
  - Testable
  - Estimated by developers
  - Small → decompose large stories
- Collect story cards and prioritize them
Architectural spike

- Throw-away prototype
- Answers technical issue
- Reduce technical risk or improve reliability
- Usually: Pair for 1-2 weeks

Planning

- Release planning
  - Chooses a few months worth of user stories
  - Date and scope
  - Can be changed
- Iteration planning
  - Few weeks
  - Set of stories prioritized by customer
  - Define set of tasks for each story
- Never slip a date → change scope
Estimation

- Based on similar stories from the past ("yesterday’s weather")
- Team effort: optimism wins
- Estimates are not commitments
- Ideal Engineering Time (IET) → no interruption

Steering phase

- Iteration (1-3 weeks): task cards
- Recovery after overestimating velocity
- New stories
Management strategy

- Team members accept responsibility
- Committed to do quality work
- Not much management overhead
- Basic measurement
  - Ratio between estimated development time and calendar time
  - Percentage of feature complete
- Coaching

Tracking progress

- Two questions
  - How many ideal hours/days have you worked?
  - How many more does it take
- Project metrics
  - Velocity = IET/Calendar Time
  - Bugs
  - Time worked on a task
  - Stories completed
  - #Acceptance tests defined and passing
  - #unit tests
  - ...
Testing

- Write tests before production code
- Use JUnit
- Acceptance tests for user stories
- Unit tests for methods
- Keep as much functionality out of UI code as meaningful

When is a user story done?

- All unit tests pass
- All acceptance tests pass
- The customer accepts it
- All refactorings are done
What is refactoring?

- Changing the code without changing its functionality
- Goal: make code easier to maintain

Refactoring

- Refactoring book by Fowler
- http://www.refactoring.com
Why refactor?

- To improve the design of software
- To make code easier to understand
- To help find bugs
- As a result
  - Coding becomes faster
  - Outside source code documentation less required

When do you refactor?

- When the code “smells bad”
  - Repeating code
  - Code difficult to understand
  - Long methods
  - Long message chains
  - Switch statements instead of polymorphism
  - …
How do you refactor?

- If code smells bad
  1. make a change
  2. test the system.
  3. if it works goto (1) else goto (2)

- Refactoring is heavily dependent upon
  - automated test drivers and
  - working code.

Stages in Refactoring

- Simple Stuff
- Cleanup and Rearrangement
- Advanced Stuff
Simple Stuff

- Rename variables and procedures
- Replace temp variables with procedure calls
- Replace “Magic Numbers” with constants

Cleanup

- Split up large blocks of code into individual methods
- Make tiny method bodies inline
- Create temp variables to simplify complicated expressions
Advanced Stuff

- Replace Conditional Logic with Polymorphism
- Shorten Parameter Lists
- Move Methods and Fields

Example

- Before
  ```java
  void f() { ...
      // Compute score
      score = a * b + c;
      score -= discount; }
  ```

- After
  ```java
  void f() { ...
      computeScore(); }
  
  void computeScore()
  {
      score = a * b + c;
      score -= discount; }
  ```
Example

- Before
  ```java
  String a, b, c;
  return a + b + c;
  ```

- After
  ```java
  StringBuffer sb = new StringBuffer(a);
  sb.append(b);
  sb.append(c);
  return sb.toString();
  ```

Issues in XP adoption
All techniques?

- Proposers state that combination of all techniques provide highest benefit
- Stepwise adoption
  - Pick your worst problem and apply corresponding XP technique

Business contracts

- Fixed scope/fixed price contracts problematic – why?
- Fixed cost and fixed programmer hours
Colocation and project size

- Co-location of team members required
- Scalability of the process:
  Small teams $\rightarrow$ small projects

Research Topics

Part 3
Research Topics

- Pair programming effectiveness
- TDD effectiveness
- Compatibility between XP and “heavy” practices (e.g. CMM)
- Economics of Agility

Pair programming - effects

- More quality and
- Less productivity?
### Williams

  - University study with 41 students  
  - Higher quality code  
    - Test cases passed individuals: 73.4%-78.1%  
    - Test cases passed pairs: 86.4%-94.4%  
  - Pairs completed assignments 40-50% faster (average 15% higher costs)  
  - Pair programming preferred by students (85%)  

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### Long (on 5 studies)

- Quality  
  - Better quality PP than solo programmers  
  - Meaningful effect  
  - Both with students and professionals  
  - Improves quality of program without impacting quality of programmer  
    - Average programmers benefit from it  
- Not difficult to learn  
  - May be more difficult for more skilled programmers
Long (on 5 studies)

- Productivity
  - PP lower productivity than solo programmer
  - Meaningful effect

- One study suggests that PP may have same productivity in context of difficult algorithms – changing requirements

TDD – effects

- More quality And
- Less productivity?
Erdogmus, Morisio, Torchiano

- Experiment with 25 students
- Test first vs. Test last
- No statistical difference in quality and productivity
- However, TF write more tests
- More tests correlate with more productivity!
- More tests imply a minimum quality level

Long (on 5 studies)

- Quality
  - Quality is higher for TDD
  - Meaningful effect
- Productivity
  - Not clear
- Difficult to learn
CMM and agile

- Agile proponents usually consider them not reconcilable
  - Because of planning, measuring, documentation
- CMM proponents are more flexible
  - XP project could be rated level 2 (Paulk)
  - XP project could raise to level 3 (Glazer)
  - XP has no practices at level 4-5 though
  - XP is a methodology (how), CMM is the management environment (what), they complete each other (Paulish, Siemens)
- Some are harsh
  - Agile is a step back to hacking (Rakitin)

References

Test-Driven Development


Test cases come codice

testRaddoppia2(){
    assertEquals(4, raddoppia(2));
} // PASS

testRaddoppia3(){
    assertEquals(6, raddoppia(3));
} // FAIL
JUnit

- Test framework
  - plugin di Eclipse
  - per fare test cases come codice Java
  - framework: set di classi e convenzioni per usarle

  - Test code
    ```java
testRaddoppia2(){
}
```

  - Production code
    ```java
int raddoppia(){
}
```

---

É possibile usare JUnit all'interno di Eclipse per eseguire i programmi invece di scrivere delle classi con il metodo `main()`. É sufficiente:

- scrivere una sotto-classe della classe `TestCase`
- aggiungere ad essa dei metodi di test
JUnit - set up

- in Eclipse
- aprire project’s property window
- java build path
- libraries
- external jar
  - add org.junit

Elementi del framework

- assert*()
  - funzioni di confronto
- TestCase
  - classe contenente serie di test
  - una per ogni classe di production code
  - vari test per ogni metodo di classe production
- TestSuite
  - classe contenente serie di TestCase
**Assert*()**

- Metodi definiti su TestCase
  - per condizione
    - assertTrue("message when test fails", condition);
  - per valori di ritorno object, int, longs, byte
    - assertEquals(expected_value, expression);
  - per valori di ritorno float, double:
    - assertEquals(expected_value, expression, error);
  - se la condizione testata
    - e' vera, esegue istruzione seguente
    - e' falsa, break a fine metodo
**Agile Software Development**

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### Studente.get/setMediaVoti()

#### Test code

```java
public class TestStudente extends TestCase {
    public void testGetMediaVoti() {
        Studente s = new Studente();
        s.setMediaVoti(25.5);
        assertEquals(25.5, s.getMediaVoti(), 0.005);
    }
}
```

#### Production code

```java
public class Studente {
    int matricola;
    double mediaVoti;
    Studente next;

    void setMediaVoti(double voto) {
        mediaVoti = voto;
    }

    double getMediaVoti() {
        return mediaVoti;
    }
}
```

---

### Regole

#### Test code

```java
public class TestStudente extends TestCase {
    public TestStudente(String name) {
        super(name);
    }

    public void testGetMediaVoti() {
        Studente s = new Studente();
        s.setMediaVoti(25.5);
        assertEquals(25.5, s.getMediaVoti(), 0.005);
    }
}
```

- **Test code**: deve essere
- **nome metodo deve iniziare con “test”**

---
Funzionamento

- Per un test case JUnit:
  - Esegue tutti i suoi metodi di test pubblici
    - Ovvero quelli che iniziano con “test”
  - Ignora tutto il resto
- La classe può contenere metodi di supporto (helper methods)
  - Non sono pubblici o non iniziano con “test”
  - Possono essere chiamati dai metodi di test

Run as JUnit Test

- Run
- Run As..
- Junit Test
Red / Green Bar

Organizzazione tests

- test cases di classe
  - test case e' gia test suite
- suite per test case di tutte classi
Organizzazione

- TestStudente extends TestCase
  - tutti test case di Studente
- TestStudentSet extends TestCase
  - tutti test case di StudentSet
- AllTest extends TestSuite
  - con test case di Studente e StudentSet

Strategie per il test

- Unit tests (developer tests)
- Acceptance tests (customer tests)
Studente

- Nominal: voti tra 0 e 33
- Boundary: 0 e 33
  - testare 0 e 33
- Exceptional
  - testare fuori dal boundary

```java
public class TestStudente extends TestCase {
    public void testGetMediaVoti() {
        Studente s = new Studente();
        s.setMediaVoti(25.5);
        assertEquals(25.5, s.getMediaVoti(), 0.005);
    }
}
```
setMediaVoti() - boundary

```java
public void testMediaVotiBoundary() {
    Studente s = new Studente();
    s.setMediaVoti(0);
    assertEquals(0, s.getMediaVoti(), 0.005);
    s.setMediaVoti(33);
    assertEquals(33, s.getMediaVoti(), 0.005);
}
```

setMediaVoti() - exceptional

```java
public void testMediaVotiNonValida() {
    Studente s = new Studente();
    s.setMediaVoti(-1);
    assertEquals(0, s.getMediaVoti(), 0.005);
    s.setMediaVoti(100);
    assertEquals(33, s.getMediaVoti(), 0.005);
}
```
Regression test

- dato metodo o classe, e test suite TS che passa con successo
- data modifica/estensione di production code
- TS passa ancora con successo?
- Regression test = ripassare TS ogni volta che si modifica production code
- fatto automaticamente da JUnit

Bibliografia Generale

Test Driven Development

Es. Cassa del supermercato

Cassa Supermercato

- L’obiettivo è realizzare il sistema software per la gestione della cassa di un supermercato
- Si tralasciano tutti i problemi relativi alla gestione dell’interfaccia utente e dell’hardware speciale (Es. lettore di codice a barre)
Storia 1 – Sessione di cassa

- Lettura codice e stampa del totale
  - Quando un nuovo cliente arriva alla cassa, la cassiera passa i prodotti sul lettore di codice a barre, poi termina la sessione.
  - Quando la cassiera termina la sessione (con un apposito comando) la cassa stampa la somma dei prezzi dei prodotti letti.
  - La lettura del codice a barre viene simulata con l’inserimento da tastiera dei codici dei prodotti.

> P001
> P002
> P001
> CLOSE
Totale: 7.5

Storia 2 – Stampa descrizione

- Stampa della Descrizione
  - Ogni volta che viene letto il codice di un prodotto la cassa accede ad un database di prodotti e recupera il prezzo e la descrizione del prodotto.
  - Immediatamente dopo la lettura del codice la cassa stampa la descrizione del prodotto seguita dal prezzo.

> P001
Acciughe 3.0
> P002
Aglio 1.5
> P001
Acciughe 3.0
> CLOSE
Totale: 7.5
Storia 3 – Calcolo tasse (IVA)

- Quando la sessione è terminata la cassa deve stampare
  - il totale senza l'IVA,
  - l'IVA, e
  - il totale con l'IVA.

- NB:
  - occorre scorporare l'IVA del 20% dai prezzi

<table>
<thead>
<tr>
<th>Codice</th>
<th>Descrizione</th>
<th>Quantità</th>
<th>Prezzo Senza IVA</th>
<th>Prezzo con IVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>P001</td>
<td>Acciughe</td>
<td>3.0</td>
<td>3.0</td>
<td>7.5</td>
</tr>
<tr>
<td>P002</td>
<td>Aglio</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P001</td>
<td>Acciughe</td>
<td>3.0</td>
<td>3.0</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Storia 4 – Calcolo sconto

- Prima che la sessione sia terminata la cassiera può inserire un codice speciale (SCONTO) seguito da un numero.
  - Questo indica che il totale verrà scontato della percentuale specificata.
- La cassa deve stampare il totale senza lo sconto, e l'importo dello sconto.

<table>
<thead>
<tr>
<th>Codice</th>
<th>Descrizione</th>
<th>Quantità</th>
<th>Prezzo Senza Sconto</th>
<th>Sconto</th>
<th>Prezzo con IVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>P001</td>
<td>Acciughe</td>
<td>3.0</td>
<td>6.25</td>
<td>1.25</td>
<td>7.5</td>
</tr>
<tr>
<td>P002</td>
<td>Aglio</td>
<td>1.5</td>
<td>1.0</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>P001</td>
<td>Acciughe</td>
<td>3.0</td>
<td>5.0</td>
<td></td>
<td>6.0</td>
</tr>
</tbody>
</table>
Storia 5 – Stampa scontrino

- Quando viene terminata la sessione, la cassa deve stampare un sommario (scontrino) con i nomi ed i prezzi di tutti i prodotti acquistati.

\[
\begin{array}{ccc}
\text{P001} & \text{Acciughe} & 3.0 \\
\text{P002} & \text{Aglio} & 1.5 \\
\text{P001} & \text{Acciughe} & 3.0 \\
\text{CLOSE} & & \\
\hline
\text{Acciughe} & 3.0 & \\
\text{Aglio} & 1.5 & \\
\text{Acciughe} & 3.0 & \\
\text{Senza sconto:} & 6.25 & \\
\text{sconto:} & 1.25 & \\
\text{Senza IVA:} & 5.0 & \\
\text{IVA 20%:} & 1.0 & \\
\text{Con IVA:} & 6.0 \\
\end{array}
\]

Storia 6 – Due x Uno

- Quando non c'è nessuna sessione in corso, si può definire una promozione per un prodotto. La cassiera inserisce un codice speciale (PROMO) seguito dal codice del prodotto da promuovere.
  - Per il prodotto in promozione, ogni due prodotti il secondo è gratis.

\[
\begin{array}{ccc}
\text{P001} & \text{Acciughe} & 3.0 \\
\text{P002} & \text{Aglio} & 1.5 \\
\text{P001} & \text{Acciughe *gratis*} & \\
\text{CLOSE} & & \\
\hline
\text{Acciughe} & 3.0 &  \\
\text{Aglio} & 1.5 &  \\
\text{Acciughe *gratis*} & & \\
\text{Senza IVA:} & 3.75 &  \\
\text{IVA 20%:} & 0.75 &  \\
\text{Con IVA:} & 4.5 &  \\
\end{array}
\]
Storia 1 - UML

Storia 1 - implementazione
Storia 1 - test

- Listino prodotti:
  - c’è prodotto, non c’è prodotto
- Cassa
  - sessione vuota
  - sessione un prodotto
  - sessione due prodotti
  - sessione con prodotto mancante

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