Course "Softwareprozesse"

**Agile Methods: eXtreme Programming (XP)**

Lutz Prechelt  
Freie Universität Berlin, Institut für Informatik  
http://www.inf.fu-berlin.de/inst/ag-se/

- **XP practices**
  - XP1 vs. XP2
  - Sit together, whole team, informative workspace, energized work, pairprogramming, stories, weekly cycle, quarterly cycle, slack, ten-minute build, continuous integration, test-first programming, incremental design

- **XP basic values**
  - Communication, Simplicity, Feedback, Courage, Respect
  - Criticism
  - When (not) to use XP
  - Empirical results: a survey
  - XP and CMMI
Learning objectives

- Understand the basic idea of eXtreme Programming (XP) and where the name comes from
- Understand the values of XP
- Roughly understand the individual practices that make up XP
- Roughly understand when to and when not to use XP
Preamble: Why we look at XP

• In the early 2000s, XP was the most well-known agile method
  • most popular, most discussed

• Today, it is much less talked about
• This is because many of its practices have become mainstream.
  • Many XP practices are used in most other agile methods
    • Sometimes explicitly, but often as a matter of course
  • So the relevance of knowing XP is as high as it was

• XP is still the most complete agile process model.
  • So the relevance of knowing XP is higher than it is for, say, Scrum or Kanban
Martin Fowler on XP

• "To make agile work, you need solid technical practices.
• A lot of agile education under-emphasizes these, but if you skimp on this you won't gain the productivity and responsiveness benefits that agile development can give you (stranding you at level 1 of the agile fluency model.)
• This is one of the reasons that I still think that Extreme Programming is the most valuable of the named agile methods as a core and starting point."

• http://martinfowler.com/agile.html
History

- XP is based on ideas that have been around for a long time
- XP was developed into a method in the context of one single software project (using Smalltalk)
  - "C3": *Chrysler Comprehensive Compensation*, a project to develop a payroll system for the 87,000 employees of Chrysler Corporation.
  - 1995-01: C3 starts
  - 1996-03: C3 has not delivered any working functionality. Kent Beck is hired as an advisor, brings in Ron Jeffries, reduces project staff, and starts putting C3 into XP mode
  - 1996 to 1998: A period of high productivity in the project
  - 1998-08: C3 system is piloted and payrolls 10,000 employees
  - 2000-02: C3 project is canceled after Chrysler/Daimler-Benz merger
XP sources

• The original, definitive source on XP is Kent Beck's book "Extreme Programming Explained: Embrace Change", Addison-Wesley, 1999

• However, there is now a 2nd edition (2004)
  • Complete rewrite (with Cynthia Andres)
  • Fairly different set of practices:
    • Some removed (too difficult or too easy),
    • some made more precise (e.g. by quantification),
    • some added
  • Thus, the modified method is sometimes called XP2
  • Overview of the differences:

• Ron Jeffries (xprogramming.com) uses a mix of both

• Many more books and articles have been written about XP
XP practices

- XP as a method consists of a set of practices
  - Their manner of application can be adapted
  - but all of them are **mandatory** for a real XP process
    - although in practice very often not all are used.
    - Just picking your favorite five or so is not XP!
  - They mutually reinforce each other

40 hour week
Planning Game
Acceptance Testing
Pair Programming
Unit Testing

XP1:

**Processes**
- On-site Customer

**Architecture**
- Simple Design
- Refactoring
- Collective Ownership
- Continuous Integration

**Testing**
- Short Releases
- Continuous Integration
- Coding Standards

Graphic: K. Schneider
Ron Jeffries' view
(a mix of XP1 and XP2 practices)
Practices of XP and XP2

**XP1 practices ("traditional"):**
1. The Planning Game
2. Small Releases
3. Metaphor
4. Simple Design
5. Testing
6. Refactoring
7. Pair Programming
8. Collective Ownership
9. Continuous Integration
10. 40-Hour Week (sustain. pace)
11. On-Site Customer
12. Coding Standards

**XP2 practices ("evolutionary"):**
1. Sit Together
2. Whole Team
3. Informative Workspace
4. Energized Work
5. Pair Programming
6. Stories
7. Weekly Cycle
8. Quarterly Cycle
9. Slack
10. Ten-Minute Build
11. Continuous Integration
12. Test-First Programming
13. Incremental Design

Furthermore, XP2 has 11 "Corollary Practices"
Practice: Sit Together

• The whole team should work as close together as possible, ideally in a single large office.
  • This greatly simplifies communication and makes it more likely to succeed
  • It greatly increases informal communication
    • by overhearing other pairs working

• Criticism:
  • 10 people in one room leads to high background noise and reduces concentration

Practice: Whole Team

- All qualifications and competences required should be represented in the team
  - this includes special technical knowledge
  - as well as business/requirements knowledge
    - (replaces and extends the former "on-site customer")
  - as well as project-level responsibles (coach, plan tracker)
- Thus, the team can always proceed without interruption

- Criticism:
  - It is often impossible to find a single person representing all requirements knowledge (or to bring several into the team)
  - XP requires all members to be full-time, but very specialized (and rare) technical knowledge may be needed in multiple projects
Practice: Informative Workspace

- All important information about the project status should be available directly in the workspace, e.g.
  - currently open tasks
  - build and test status
  - architectural design sketch

- This can often be done by hanging note cards or flip chart sheets on the walls
Practice: Energized Work

- All members of the team are motivated and work energetically at any time
  - In particular, there are no extended stretches of working overtime
    - This was formerly called "40 hour week" which was too inflexible in practice
  - Also, since Pair Programming (see below) is very intensive, a good routine of breaks and fun interludes is important

- Criticism:
  - Can you really call "working energetically" a practice that you consciously adopt?
Practice: Pair Programming (PP)

- All production code is written by two programmers working together at a single computer
  - Thus, a better design can be found,
  - many mistakes can be caught immediately,
  - the partners learn from each other
    - technology, operating style, design process, project details, etc.
    - at least two people are highly familiar with each piece of code.

- One partner ("driver") uses keyboard and mouse
- Both "driver" and "observer" think about the design, any mistakes they've made, improvements etc.
- These roles may change frequently
  - e.g. every few minutes (but spontaneously)

- Pair composition should change frequently
  - e.g. twice a day
Practice: Pair Programming (2)

Criticism:

• For many kinds of task (in particular simple ones), PP may be rather inefficient

• There are a number of studies on this subject and the evidence is unclear:
  • Immediate productivity is often lower than with two individual programmers, correctness and design quality are better,
  • but the secondary benefits are difficult to quantify

• Some programmers do not accept this style of working

• Pair partners may have incompatible working styles
Practice: Stories

- All requirements are stated in the form of stories
  - A short reminder is written on a card
  - Most of the information transfer is done verbally
  - The number of such cards must be modest
    - Mostly cards for the current iteration, never cards beyond the current release

- Criticism:
  - For some types of functionality, stories are just too imprecise
  - Non-functional requirements cannot be expressed by stories
    - but need to be considered early

www.jamesshore.com/Multimedia/Beyond-Story-Cards.html
Practice: Weekly Cycle

- The finest granularity of project-level planning is the so-called "iteration"
  - Each iteration implements one or more stories
  - An iteration should take about one week, maybe two
- The iteration is the elementary progress step visible for the customer
- During an iteration, requirements are fixed
  - Programmers can work without interruption
  - Programmers can estimate the effort well for work of this size
Practice: Quarterly Cycle

- The larger granularity of project planning is the release
  - There should be about four releases per year
  - A release is deployed into actual use by actual users (at least a pilot group) in actual business processes

- Frequent releases provide regular reality checks of the value generated by the project
  - and provide a rhythm for reflecting on the development process

- Criticism:
  - Rollout of a release is often very difficult and cannot be done frequently (e.g. because of required process changes)
Practice: Slack

• Developers have some freely available time (slack time) to be used for non-project work
  • e.g. learning about new technology.
• This time will also allow to eliminate delays from misestimation

• Criticism:
  • It is extremely difficult to keep up this practice in normal project reality for most organizations
Practice: Ten-Minute Build

• Building the system and running system-level function tests must not take longer than 10 minutes
  • so that it is realistic that programmer-driven function testing occurs after each significant programming session

• Criticism:
  • This may be impossible for multi-platform products
Practice: Continuous Integration

- Developers check in their work into the common code base several times each day
- An automated process rebuilds the system after each such check-in and re-runs the system-level function tests
- This build represents the project state
  - The build should be fully functional most of the time
  - A build that remains broken for some time is often an important alarm signal (indicator of bad project health)

- Criticism:
  - It is expensive or impossible to keep up a functional build during larger refactorings
Practice: Test-First Programming

- **Before** some program element is written (e.g. a modest method), an automated test of this element is always written first
  - The test must fail as long as the element is still missing
  - It must succeed for the element to be considered finished

- **Advantages:**
  - Clarifies the requirements for the element before coding it
  - Defines the interface
  - Provides rapid and constant feedback
  - Thus allows courage during refactoring

- **Criticism:**
  - This amounts to a very high degree of test automation which may be inefficient
Practice: Incremental Design

- The design is completed step-by-step, along with the code
  - It is not invented all at once beforehand
    - which would be known as "Big up-front design" (BUFD)
  - At each time, the design is oriented more towards the current requirements, less to those just expected to come later
    - XP1 (misleadingly): "Use the simplest design that can possibly work"
  - When design changes are required, refactoring is used as the first step (in order to minimize risk)

- Criticism:
  - When used naively, this usually leads to very high amounts of rework, as "architecture breakers" then occur frequently
    - In particular in the XP1 practice "Simple Design"
Note: Refactoring

- Refactoring means modifying the structure of a program without modifying its behavior
  - There are a number of well-defined elementary refactoring operations, e.g.:
    - Rename
    - Change Method Signature, Introduce Parameter
    - Convert Local Variable to Field, Encapsulate Field
    - Extract Class/Interf./Loc. Var./Method (opposite: inline)
    - Introduce Factory
    - Generalize Type, Pull Up, Push Down elements in class hierarchy
- XP allows courageous refactoring: the **automated tests** make it easy to verify whether a refactoring is correct
- Modern IDEs (such as Eclipse for Java) support or even automate several such refactoring operations
What makes a design "simple"?

• To build "the simplest design that can possibly work" implies building the system with the smallest possible number of classes and methods in such a way that
  • code and tests together clearly describe what we want to express and
  • there is no redundancy in the code

• Slogan: "Do everything once and only once" (OAOO)

• Eliminating redundancy automatically leads to a system that is clear, flexible, and that can easily be extended and adapted
  • Slogan: "Don't repeat yourself" (DRY)
  • However, recognizing and eliminating redundancy is difficult!
Assume you build the simplest possible design $D$ today:

- Assume change $A$ becomes necessary 1 year later:
  - €1000 $D$ cost today
  - €1500 $A$ cost next year

- Assume incompatible change $B$ becomes necessary instead:
  - €1000 $D$ cost today
  - €1500 $B$ cost next year

Assume you build $D'$ anticipating a change $A$:

- Assume change $A$ becomes necessary 1 year later:
  - €1500 $D'$ cost today
  - €50 interest (10% of $D'$-$D$)
  - €500 $A$ cost next year

- Assume incompatible change $B$ does instead:
  - €1500 $D'$ cost today
  - €50 interest (10% of $D'$-$D$)
  - €500 $A$ rework cost next year
  - €1500 $B$ cost next year

If the uncertainty of $A$ vs. $B$ is high, $D'$ may be a bad idea!
XP basic values

XP's set of rules and practices is based on five fundamental ideas (called "values"):

- Communication
- Simplicity
- Feedback
- Courage ("Mut")
- Respect

see next slides
Basic values: Communication

• Very many problems in projects are related to communication that failed or simply did not happen
  • e.g. tacit assumptions about requirements
  • e.g. uncoordinated technical decisions
  • e.g. missing information about design ideas
  • e.g. missing notification about technical changes

• Therefore, XP uses practices that enforce early, frequent, successful communication
  • Practices that require communication:
    • continuous integration
    • effort estimation in the planning game
  • Practices that create communication:
    • pair programming
    • informative workspace
    • frequent releases
Basic values: Simplicity

• Simple solutions have many nice properties:
  • they are easy to design
  • they are easy to implement
  • they are easy to test and debug
  • they are easy to communicate and explain
  • they are easy to change

• This is true for both product and process

• Therefore, XP requires to always use the simplest solution that is sufficient for today's requirements
  • and not build something more complicated in the hope that it will be needed later.
  • Slogan: "You Ain't Gonna Need It!" (YAGNI)
Basic values: Feedback

• It is immensely helpful for a project if it always gets quick feedback about the consequences of actions or plans
  • How expensive would it be to realize this new requirement?
  • Is this new piece of code correct?
  • Does it fit with the rest of the system?
  • How useful is the system overall?

• Therefore, XP integrates concrete and immediate feedback into the process wherever possible
  • Immediate effort estimation for each storycard
  • Unit tests for each piece of code
  • Continuous integration
  • Short iterations and frequent releases
Basic values: Courage

- Many aspects of making the first three values a reality require courage:
  - e.g. communicating that you will change an oft-used interface
  - e.g. building a simple solution only, although you firmly expect it to become insufficient later
  - e.g. facing negative feedback about incorrect code, incompatible interfaces, infeasible requirements, or impractical aspects of a delivered system
- Therefore, XP both uses a culture that encourages courage
  - e.g. with pair programming and the planning game
- and creates an infrastructure that allows to be courageous or even bold
  - in particular with automated testing and continuous integration
Basic values: Respect

- Respect
  - of one developer for another,
  - of developers for customer, and
  - of customer for developers

- is an important basis for continually realizing
  - communication,
  - feedback, and
  - courage

- Therefore, respect underlies all of XP as a kind of continuous admonition
  - it was not explicitly listed as a value in the XP1 book
The XP corollary practices

Optional, may be helpful
Criticism

• Gerold Keefer: "Extreme Programming Considered Harmful for Reliable Software Development 2.0",
  (an earlier version appeared in the conference Conquest 2002 by isqi.org)

• Critically reviews the claims and reports about XP and argues that it is recommendable only in rare situations:
  • Requires staff competence far above average
  • Requires unusually high team stability (→ no documentation)
  • Cannot work if finding a suitable architecture is difficult
  • Is applicable only to projects of modest size

• Provides a good overview of the XP-related literature until 2002

• Many other criticisms of XP exist
  • Many of them unbalanced, half-ignorant, and highly polemic
  • Refer to Barry Boehm's balanced judgement as a primary source
When you should **not** use XP

(These points are from Kent Beck's XP book)

- **Too-big teams**
  - XP works for teams of 10, can work for teams of 20
  - For teams of 100, integration (that is, design coordination) will become a bottleneck

- **Unbelieving customers and organizations**
  - XP requires full concentration; it cannot work in a culture of continuous extensive overtime
  - Customers who insist on a thick specification document break the whole XP process

- **Change-hampering technology or constraints**
  - e.g. replacing a database that absolutely must be compatible with 164 different applications
  - e.g. working with technology that makes builds take 10 hours
  - e.g. working with insufficient opportunity for immediate communication
Introducing XP

- It is difficult to introduce all XP practices at once
  - Most need to be learned!

- They can be introduced one-by-one as follows:
  - Find the worst problem/weakness of the current process
  - Select the XP practice that can help most with this problem
  - Introduce it until the problem is much reduced
  - Find the now-worst problem and start over

- Good candidates for first practice to introduce:
  - Sit Together
  - Quarterly Cycles (→ Stories)
  - Continuous Build & Testing
XP roles

• Developer
  • the only role with always more than one representative

• Customer
  • usually (but not necessarily) a non-technical person

• Tester
  • helps the customer write function tests

• Coach
  • responsible for process as a whole; guides the team to proper XP

• Tracker
  • collects and feeds back estimates and plan tracking

• Customer, Tester, Tracker need not be full-time and thus may double as developer
  • but Coach should not.
  • Coach might double as Tracker and Tester
A survey of more-or-less-XP projects.

Characterization of respondents and projects:

- **47 respondents**
  - reached via mailing lists, the XP 2001 conference, and direct contacts
- **Location**: 25% **US**, 20% **D**, 13% **CH**, 13% **UK**, 29% other
- **Size (persons)**: 85% had **10 or fewer** (36% had 5 or fewer)
- **Domain**: 29% web, 16% financial, 16% tool, 38% other
- **Language**: 73% **Java**, 18% C++, 11% Smalltalk
- **Customers**: 56% had **more than one** group of customers
A survey of XP1 projects (2)

Main results:

- More than 90% of the projects were considered successful
  - although 51% used XP for the first time and
  - although 51% had no external coach
    - but 69% had filled the coach role
  - although only 42% percent had teams of "all high" competence
  - although several were traditional projects in jeopardy that had been switched to XP
- 100% of XP users wanted to use it again
- Each XP1 practice was used by only some of the teams
  ("used" meaning 3...9 on a 0...9 usage intensity scale)
  - 98% Testing,
    95% Simple Design,
  - 89% Collective Ownership,
    85% Short Releases,
    82% 40-hour week,
  - 54% Metaphor,
    98% Refactoring,
    91% Coding Standards
  - 89% Pair Programming,
    85% Continuous Integration,
    80% Planning Game,
  - 53% On-site Customer
A survey of XP projects (3)

- **Success factors and risks:**
  - Testing was usually seen as a major success factor
  - as was Pair Programming.
  - 30% saw lack of on-site customer as a main project risk

- **Perceived improvements due to XP:**
  - 74% said their project was "much better" on schedule with XP than with previous methods
    - meaning answers +5 and +4 on a scale from -5 to +5
    - only 5% saw no improvement
  - 74% found work satisfaction "much better"
  - 74% found software quality "much better"

- **Most difficulties were due to psychological barriers:**
  - skeptical management,
  - refusal to send on-site customer,
  - developers not accepting Pair Programming
CMMI process areas in XP


- **Level 2: Managed**
  - + Requirements Mgmt
  - + Project Planning
  - + Project Monitoring & Control
  - - Supplier Agreement Mgmt
  - (Measurement and Analysis)
  - o (Process and) Product Quality Assurance
  - + Configuration Management

- **Level 3: Defined**
  - (Req's. Development)
  - + Technical Solution
  - (Product Integration)

  (not a part of CMM, only CMMI)

  - + Verification
  - (Validation)
  - o Organizational Process Focus
  - o Organ'l Process Definition
  - o Organizational Training
  - + Integrated Project Mgmt.
  - (Risk Management)
  - (Decision Analysis and Resolution)

- **Level 4: Quantitatively Manag'd**
  - - Organizational Process Performance
  - - Quantitative Project Mgmt

- **Level 5: Optimizing**
  - - Organizational Performance Management
  - o Causal Analysis and Resolution

+ usually available
o avail. in reduced form
- usually mostly absent
Paulk's summary:

- XP generally focuses on technical work
  - whereas the CMM generally focuses on management issues.
- Both methods are concerned with "culture"
- The CMM element most lacking in XP is "institutionalization"
  - Establishing a culture of "this is how we do things around here"
    - (lacking on organization level, but strong on team level)
  - XP largely ignores the infrastructure that the CMM identifies as key to institutionalizing good practices
- As systems grow, some XP practices become more difficult to implement
- Modern software projects should capture XP values
- CMM tells organizations what to do but does not say how
  - XP is a set of best practices with specific how-to information
Further resources

- [http://www.agilealliance.com](http://www.agilealliance.com)
  - A community portal around the agile approach. Has lots of comments on XP.

- [http://www.xprogramming.com](http://www.xprogramming.com)
  - Ron Jeffries

- [http://fairlygoodpractices.com](http://fairlygoodpractices.com)
  - Some more practices that are helpful
    - including practices related to various toys

  - A section of the original wiki.
    About many aspects of XP and its development.
Summary

• XP is a set of practices that mutually reinforce and support one another

• It is based on the basic values of
  • intensive and direct communication,
  • simplicity in design and process,
  • early and constant feedback
  • courage in allowing things to change
  • mutual respect

• Successfully using XP requires
  • a highly competent and disciplined team and
  • the right environment: on-site customer, suitable project type
Thank you!