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 basic values
  - Communication, Simplicity, Feedback, Courage, Respect
- XP practices
  - XP1 vs. XP2
  - Sit together, whole team, informative workspace, energized work, pair programming, stories, weekly cycle, quarterly cycle, slack, ten-minute build, continuous integration, test-first programming, incremental design
- 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

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 87000 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 very 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:
    Stefan Roock: *"eXtreme Programming der zweiten Generation"*, http://typo3.it-agile.com/fileadmin/docs/XP2.pdf
- Ron Jeffries (xprogramming.com) uses a mix of both

- Many more books and articles have been written about XP

XP basic values

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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

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- 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
  - pair programming
  - continuous integration
  - informative workspace
  - effort estimation in the planning game
  - 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:
  - Communicating that one needed to change an oft-used interface
  - Building a simple solution only, although one firmly expects it to become insufficient later
  - 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

Basic values: Respect

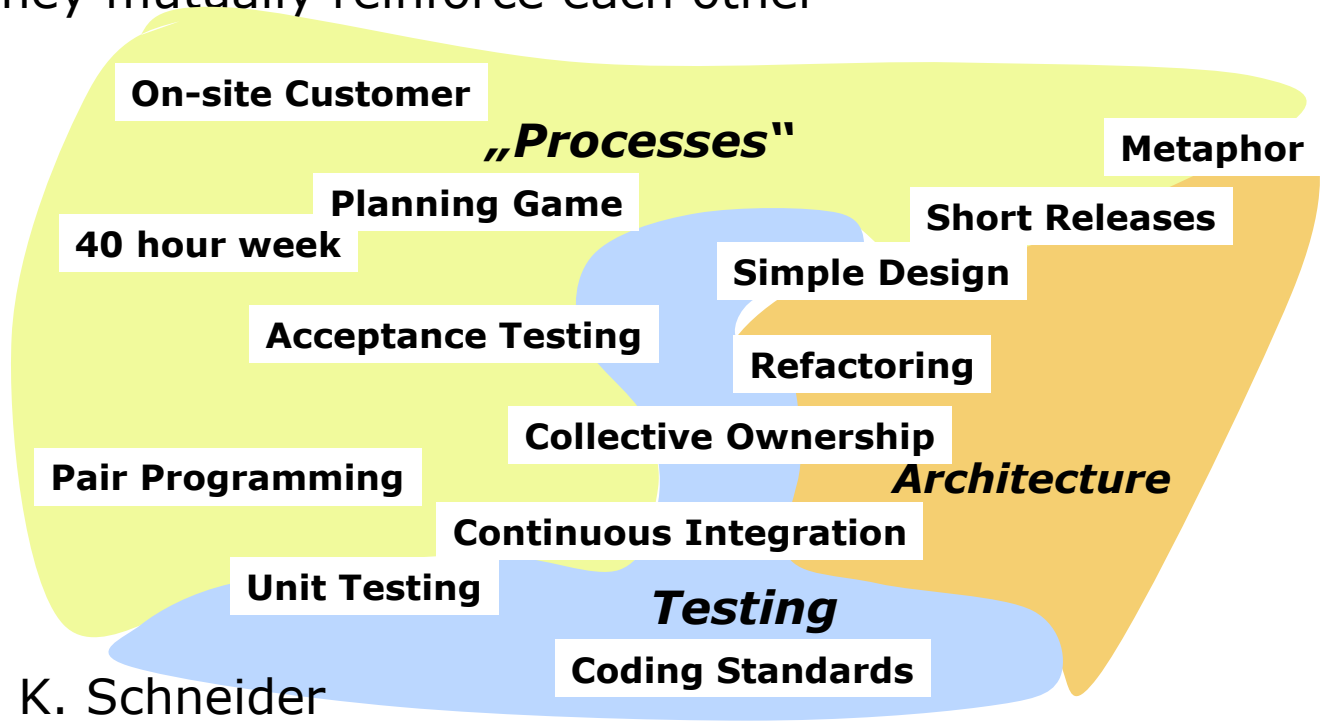
- Respect
  - of one developer for another,
  - of developers for customer, and
  - of customer for developers
- is an important basis for continually realizing
  - communication,
  - feedback, and
  - courage

- Therefore, respect underlies all of XP as a kind of continous admonition
  - although it was not explicitly listed as a value in the 1999 book

XP practices

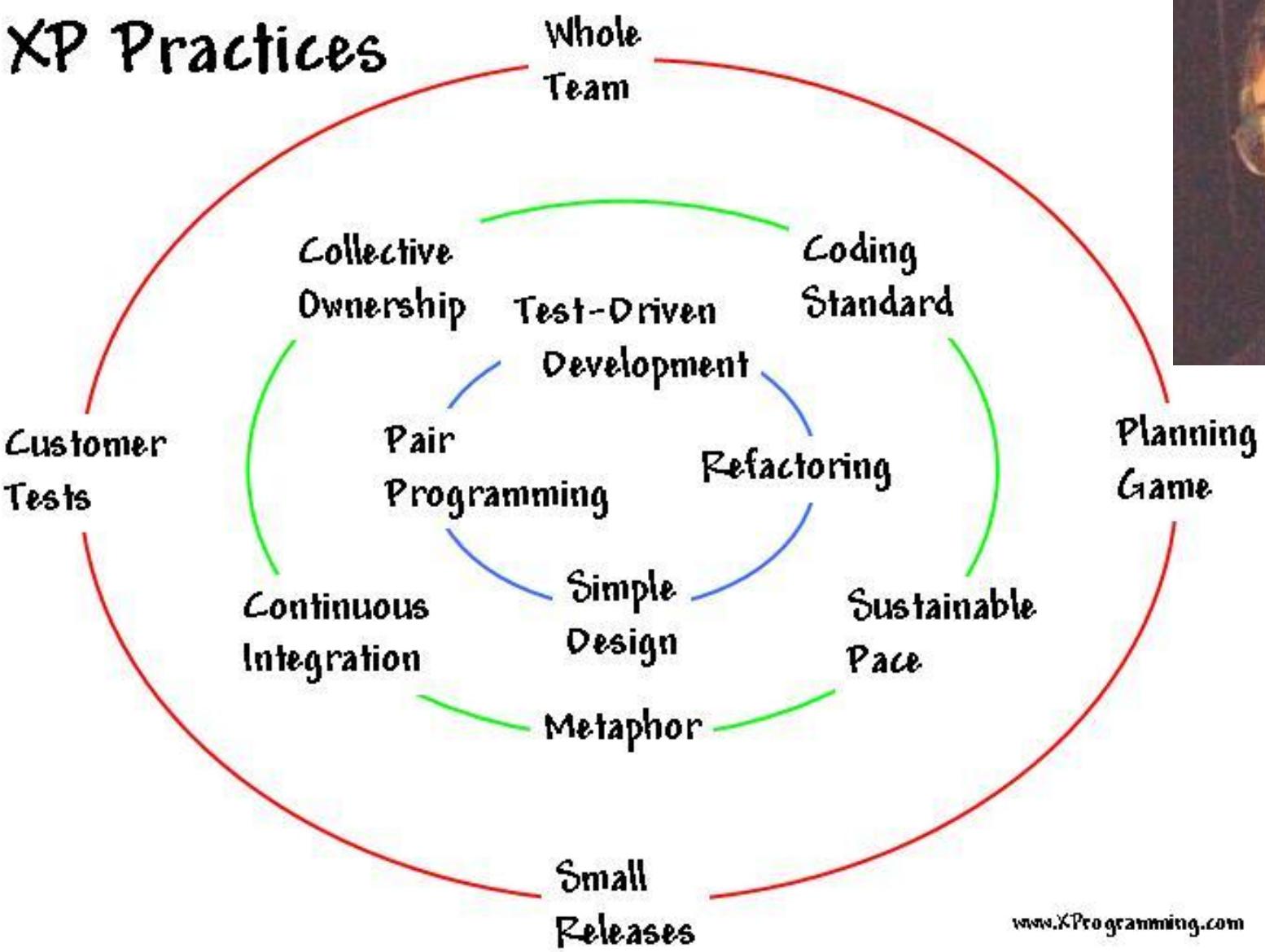
- XP as a method consists of a set of practices
  - Their manner of application can be adapted
  - but all of them are mandatory for a real XP process
    - although in practice very often not all are used.
    - Just picking your favorite five or so is not XP in any case!
  - They mutually reinforce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

XP1:



Graphic: K. Schneider

Ron Jeffries' view
(a mix of XP1 and XP2 practices)



Practices of XP and XP2

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XP1 practices ("traditional"):

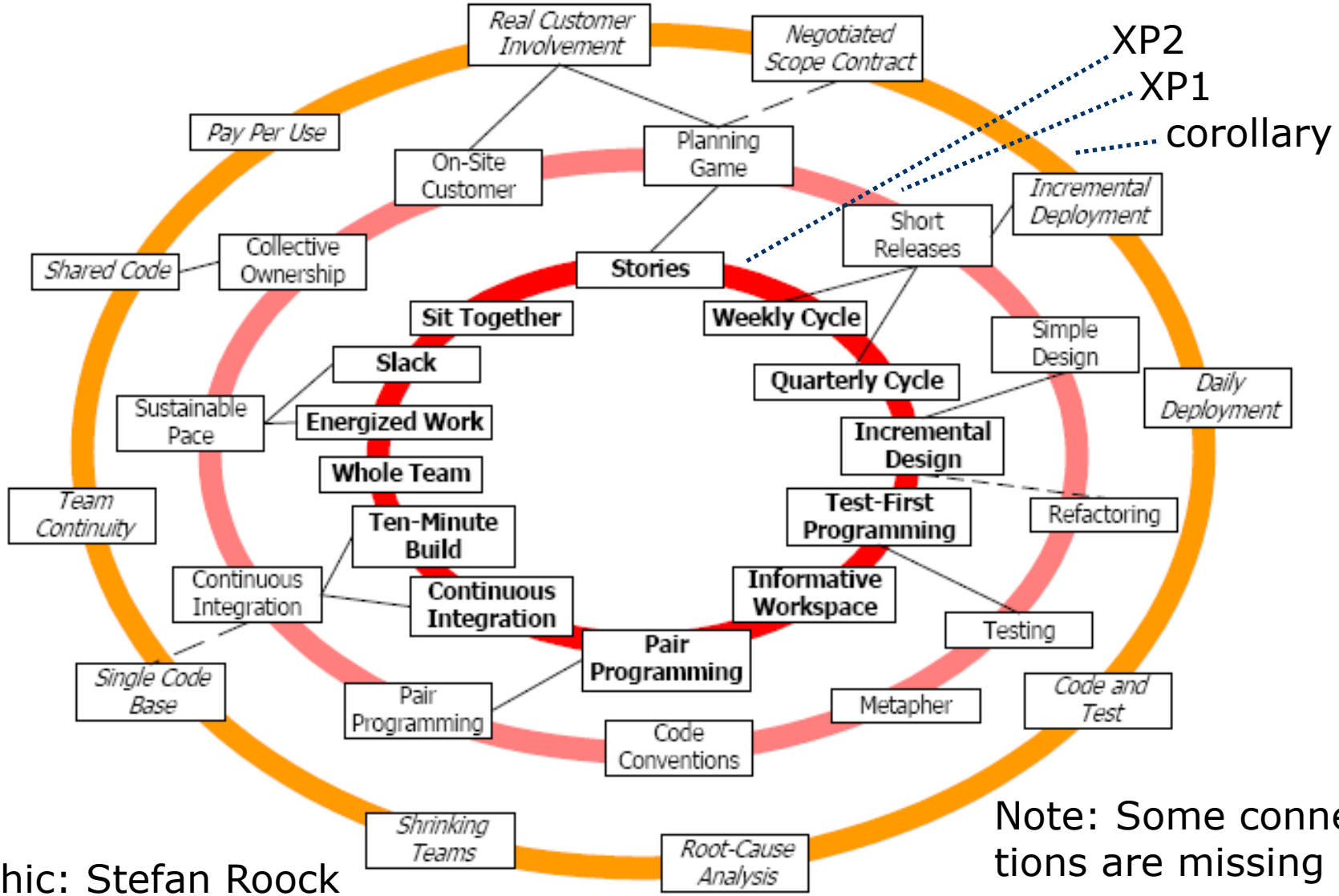
1. The Planning Game
2. Small Releases
3. Metaphor
4. Simple Design
5. Testing
6. Refactoring
7. Pair Programming
8. Collective Ownership
9. Continuous Integration
10. 40-Hour Week (sustain. pace)
11. On-Site Customer
12. Coding Standards

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"

The XP practices, old and new



Note: Some connections are missing

Graphic: Stefan Roock

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
    - This also contributes to simplicity and courage
  - 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

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- 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

informativeworkspace.org

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" and was a little 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 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

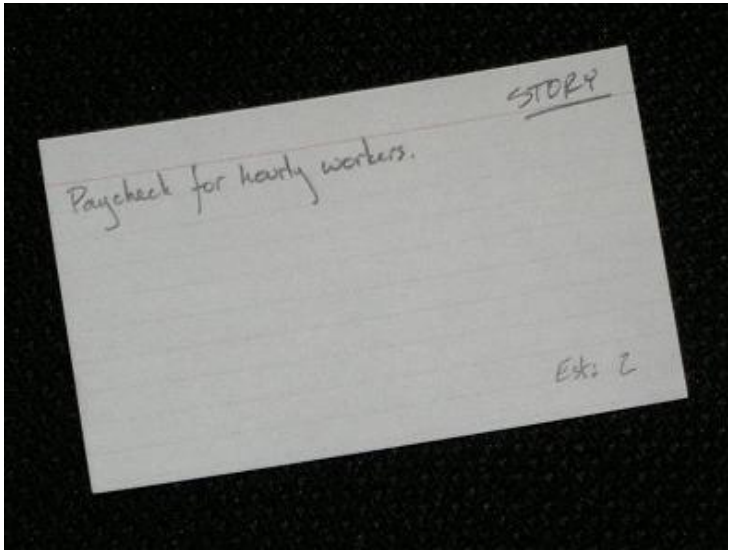
Practice: Pair Programming (2)

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 appears to be lower than with two individual programmers,
  - 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

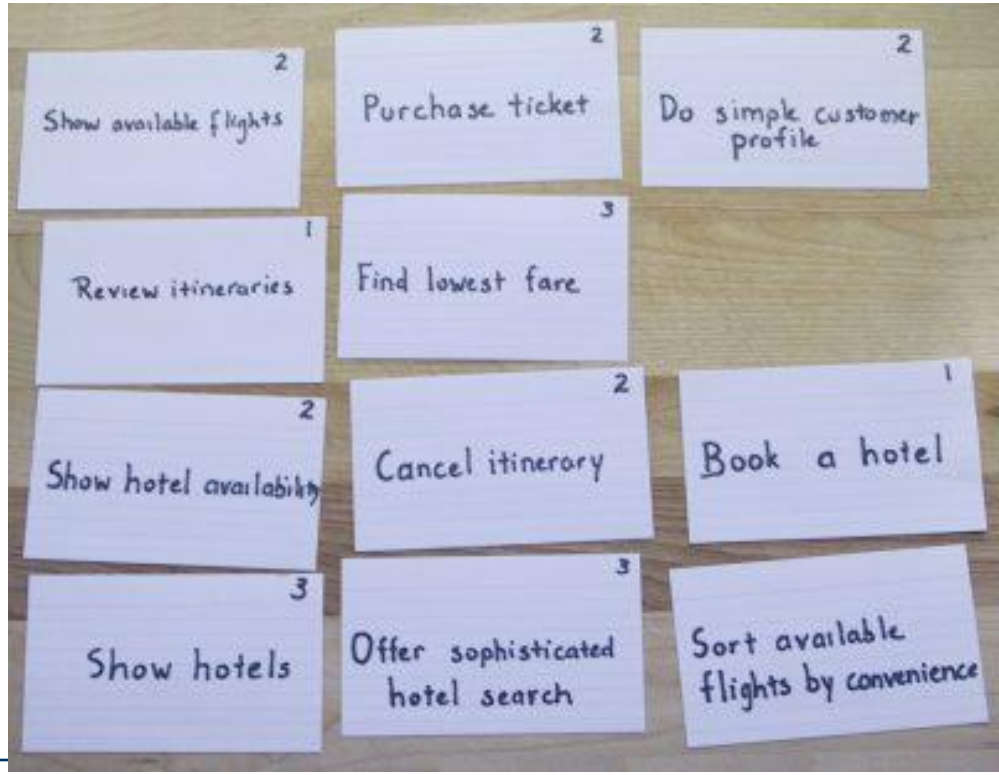
- All requirements are stated in the form of stories
  - A short reminder is written on a card
  - Most of the information transfer is done verbally
  - The number of such cards must be modest
    - Mostly cards for the current iteration, never cards beyond the current release
- Criticism:
  - For some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

- 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.

- 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

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- Before some program element is written (a class, a difficult 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 is often inefficient

Practice: Incremental Design

- The design is completed step-by-step, along with the code
  - It is not invented all at once beforehands
  - At each time, the design is oriented only towards the current requirements, not those just expected to come later
    - "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

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
  - Martin Fowler: "*Refactoring: Improving the Design of Existing Code*", Addison-Wesley 1999

- 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

Note: Simplest design

- 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
  - However, recognizing and eliminating redundancy is difficult!

Note: Simplest design
Option costs example

Assume you build the simplest possible design **D** today:

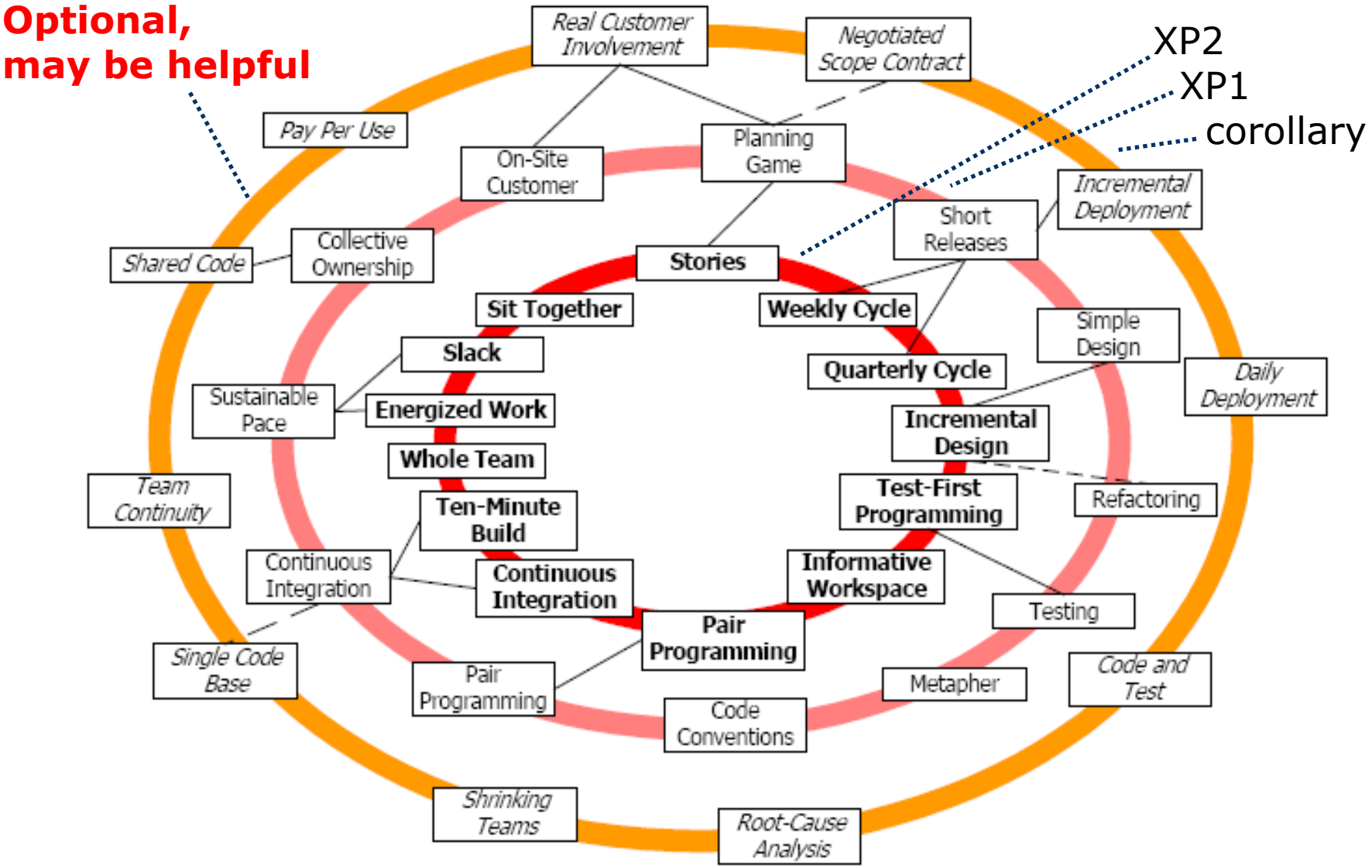
- Assume change A becomes necessary 1 year later:
  - €1000 D cost today
  - €1500 A cost next year
- Assume incompatible change B does instead:
  - €1000 D cost today
  - €1500 B cost next year

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!

The XP corollary practices



Criticism

- Gerold Keefer: "Extreme Programming Considered Harmful for Reliable Software Development 2.0",
  http://www.avoca-vsm.com/Dateien-Download/ExtremeProgramming.pdf
  (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

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(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

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- 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 (→ Planning Game)
  - Continuous Build & Testing

XP roles

- Developer
  - the only role with always more than one representative
- Customer
  - usually (but not necessarily) a business-only 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 XP projects

- Bernhard Rumpe, Astrid Schröder: *"Quantitative Untersuchung des Extreme Programming Prozesses"*, Technischer Bericht ViSEK/006/D, Dezember 2001

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% involved more than one group of customers

A survey of XP projects (2)

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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 practice was used by only some of the teams
  ("used" meaning 3-9 on a 0-9 usage intensity scale)
  - 98% Testing, 98% Refactoring,
    95% Simple Design, 91% Coding Standards
  - 89% Collective Ownership, 89% Pair Programming,
    85% Short Releases, 85% Continuous Integration,
    82% 40-hour week, 80% Planning Game,
  - **54%** Metaphor, **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

M. Paulk: *"Extreme Programming from a CMM perspective"*, IEEE Software, Nov. 2001

- 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)
  - + 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 Innovation and Deployment
  - o Causal Analysis and Resolution

(not a part of CMM)

+ usually available
o avail. in reduced form
- usually mostly absent

CMMI versus XP

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"*
    - (but other people would argue that XP is very strong on this)
  - 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
  - A community portal around the agile approach.
    Has lots of comments on XP.
- http://www.xprogramming.com
  - Ron Jeffries
- http://fairlygoodpractices.com
  - Some more practices that are helpful
    - including practices related to various toys
- http://c2.com/cgi/wiki?ExtremeProgrammingRoadmap
  - 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!