Softwaretechnik

Lecture 02: Processes

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Terms

Software

- organized collections of computer data and instructions
- *disembodied information machines* (D. Gelernter, Mirror Worlds)

Program

- solves isolated task
- developed by a single person

SW System

- multiple components
- developed by team

Programming in the Small

- development of a program or a component
- algorithmic aspects (sometimes)
- procedure:
  - **“stepwise refinement”** (N. Wirth),
  - **“structured programming”** (E. Dijkstra)
  - “structured control flow”
    (if-then-else, for, while, . . . ; no goto)
  - procedural decomposition, top-down
  - flat monolithic structure

Programming in the Large

- development of a **software system**:
  - **long life span**
  - **high probability of changes** (due to aging)
- **requirements** at first **fuzzy**
  - communication problem user ↔ developer
  - understanding the problem
- **decomposition in components** (for programming in the small)
- **information hiding** (D.L. Parnas)
- promising approach: **object-oriented analysis and design**

Process Models

- process model: structured network of activities and artifacts
- an activity transforms artifacts

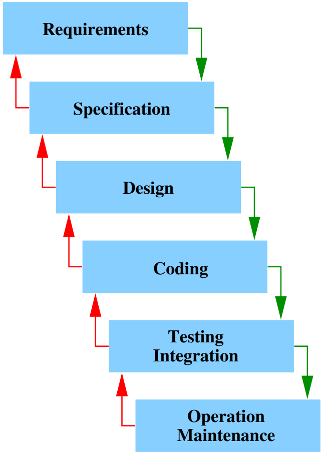
Phases

- Phases provide structure of process model
- Description of a phase
  - goals
  - activities
  - roles
  - required/new artifacts
  - patterns, guidelines, and conventions

Desiderata for Process Models

- the fewer phases, artifacts, roles, the better
- artifacts should cover standard case
- tool support
- quality assurance for each artifact
- traceability

The Classic: Waterfall Model



- early error correction is cheaper (e.g. after analysis phase 100 times cheaper than after deployment)
- hence, after every phase: check of previous phases
- potentially return to previous phase
- phases may overlap

Requirements Analysis

tractability

cost analysis

result:

decision on continuation of project

documents: (*artifacts*)

- **requirement specification** (Lastenheft)
- **cost estimation**
- **project plan**

Definition / Specification

starting point:

vague, incomplete, inconsistent requirements

result:

complete, consistent, unequivocal, accomplishable requirements

documents:

- **system specification** (Pflichtenheft)
- **product model** (e.g. OOA)
- **GUI model**
- **user manual**

- only **external behavior** of system
- **analysis of requirements**
- results in **system specification**
  - fixes the scope of the product
  - serves as basis for **contract** between customer and contractor
  - basis for **final acceptance**
  - contains
    - functionality
    - user interface
    - interfaces to other systems
    - performance (response time, space usage)
    - required hard and software
    - guidelines for documentation
    - time scheduling

Design

starting point: system specification / product model

- decomposition in components / subsystems
- fixes external behavior / interfaces of each component

result: **software architecture** (with specification of components)

Implementation and Testing

- translation of component specification to programming language
- compilation to machine language
- module testing

result: programmed system and testing protocols

Integration, system test, and deployment

- integration:
  - stepwise addition of single components
  - tested with data fixed in advance (functional requirements only)
- system test:
  - check of entire system (incl. hardware)
  - check of non-functional requirements (performance, GUI)
- deployment:
  - transfer of software system in its working environment

result: deployed product, protocol of final acceptance

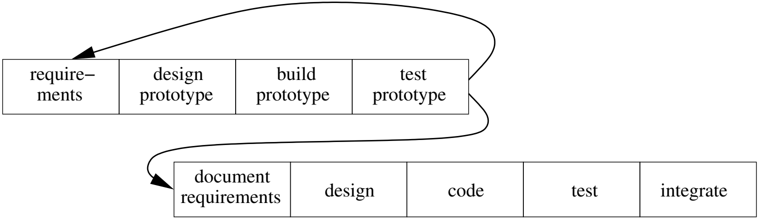
Maintenance

- bug fixes
- changes due to changes in requirements (incl. extensions)

  result: maintained product

Prototyping Model

Lifecycle



Prototyping - Overview

Advantages:

- understanding the requirements for the user interface
- improves understanding between developer and client
- early testing of feasibility, usefulness, performance, etc.

Problems:

- users treat the prototype as the solution
- prototype is only a partial specification
- significant user involvement

Phased Models

Evolutionary Development

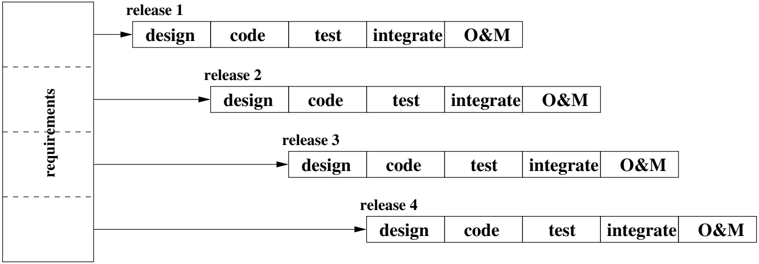
1. model **core requirements**
2. design and implement
3. deploy
4. feedback from customer
5. revise/extend requirements
6. revise/extend design
7. revise/extend implementation
8. iterate from 3 until all requirements met

Incremental Development

1. model **all requirements**
2. design and implement **only core requirements**
3. deploy
4. feedback from customer
5. revise requirements
6. design further requirements
7. implement further requirements
8. iterate from 3 until all requirements met

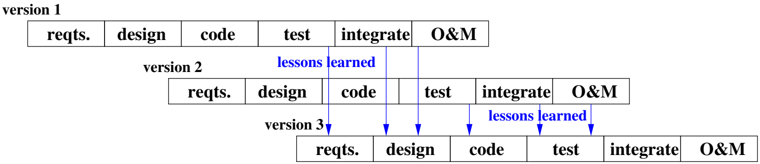
Incremental Development

(each iteration adds more functionality)

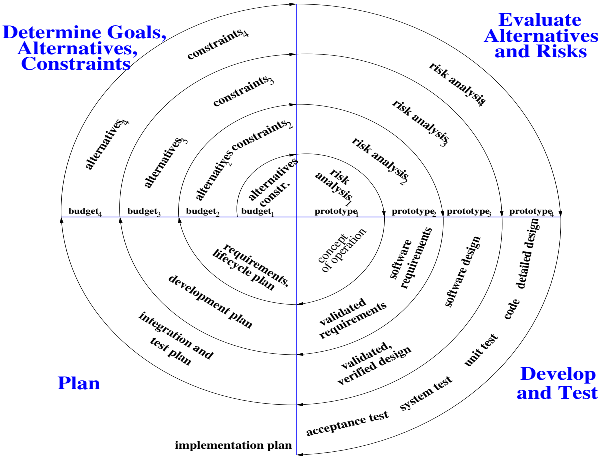


Evolutionary Development

(each iteration incorporates new requirements)



Spiral Model (Barry Boehm 1988)



Comments on Phased Models

- Incremental development
  - avoids 'big bang' implementation
  - but assumes all requirements known up-front
- Evolutionary development
  - allows for lessons from each version to be incorporated into the next
  - but: hard to plan for versions beyond the first;
    lessons may be learned too late
- Spiral model
  - primarily targeted at very large projects
  - iterative model that incorporates prototyping and risk analysis
  - but: cannot cope with unforeseen changes
    not clear how to analyze risk

Agile Development Techniques

Extreme Programming (XP, Kent Beck 1999)

- frequent releases
- short development cycles
- pair programming
- unit testing w tests developed before the code
- features specified by tests
- implement features when needed
- clear progress marks
- don’t spend much time on design
- stakeholder involvement

Agile Development Techniques

Scrum (Hirotaka Takeuchi and Ikujiro Nonaka 1986)

- Flexible approach to development; incremental process
- Adaptability to changing requirements

Roles Product owner, Scrum master, Team; Stakeholders, Managers

Sprint 2-4 weeks of intense development; goal: working increment that implements the sprint backlog; sprint backlog frozen during a sprint; self organization; burn down chart

Sprint Backlog requirements chosen for a sprint

Product Backlog as yet unimplemented requirements

V-Model *"Entwicklungsstandard für Systeme des Bundes"*

V-Model

- Builds on waterfall model
- Emphasizes validation connections between late phases and early phases
- Objectives
  - risk minimization
  - quality assurance
  - cost reduction
  - communication between stakeholders
- Current instance: V-Model XT

The Unified Software Process

Use-Case Driven

- Which user-visible processes are implemented by the system?
- Analysis, design, implementation, and testing driven by use-cases

Architecture centric

- Architecture developed in parallel to use cases (mutual dependency)

Iterative and Incremental

- eliminate risks first
- checkpoint after each iteration
- on failure of an iteration step, only current extension needs to be reconsidered
- small steps speed up project
- easy stepwise identification of the requirements

Structure of the Unified Software Process

- sequence of cycles
- after each cycle: product release with code, manuals, UML models, and test cases

- cycle consists of 4 phases:
  Inception, Elaboration, Construction, Transition
- each phase consists of iterations

Cycle

Main-Workflows and Phases

- each phase ends with a **mile stone**
- each phase processes all workflows (with varying intensity)

Inception Phase

- functionality of system from users' perspective
  most important use cases (stakeholder needs)
- preliminary sketch of suitable architecture
- project plan and cost
- identify most important risks (with priorities)
- plan elaboration phase
- **GOAL:** rough vision of the product

Elaboration Phase

- specify (most) use cases in detail
- design architecture
- implement most important use cases
- result: initial architecture
- plan activities and resources for remaining project
- use cases and architecture stable?
- risk management?
- **GOAL:** prototype (proof-of-concept for architecture)

Construction Phase

- implement system
- high resource needs
- small architectural changes
- **GOAL:** system ready for customer (small errors acceptable)

Transition Phase

- deliver beta-version to customer
- address problems (immediately or in next release)
- train customer

Summary

- Software has unique problems with far-reaching consequences
- Creating software systems requires structured process models
- Classic process phases: waterfall model
- Further process models: prototyping, evolutionary, incremental, spiral, agile, V-model, unified SW process