The software lifecycle and its documents

Supplementary material for Software Architecture course

B. Meyer, May 2006

Lifecycle models

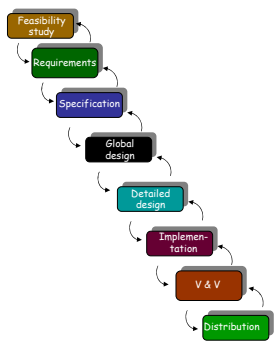
Origin: Royce, 1970, Waterfall model

Scope: describe the set of processes involved in the production of software systems, and their sequencing

"Model" in two meanings of the term:

- Idealized description of reality
- Ideal to be followed

Lifecycle: the waterfall model



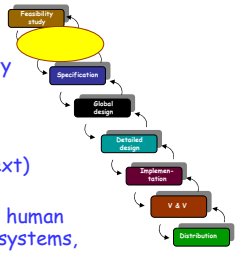
Lifecycle phase: Requirements

Objective:
- Gather user needs
- to define system functionality

Actors:
- Customers
- Development team
- Other "stakeholders" (see next)

Techniques:
- Interviews, study of existing human processes, study of existing systems,

Products:
- Requirements document
- QA plan (in particular test plan)
- Draft user's manual



Properties of successful requirements

- Correct
- Complete
- Consistent
- Unambiguous
- Feasible
- Relevant
- Abstract

- Traceable
- Delimited
- Readable
- Modifiable
- Testable
- Prioritized
- Endorsed

Difficulties of requirements

- Natural language and its imprecision
- Formal techniques and their abstraction
- Users and their vagueness
- Customers and their demands
- The rest of the world and its complexity

Goals of performing requirements

Source: OOSC

- Understand problem or problems that the eventual software system, if any, should solve
- Prompt relevant questions about problem & system
- Provide basis for answering questions about specific properties of problem & system
- Decide what system should do
- Decide what system should not do
- Ascertain that system will satisfy the needs of its stakeholders
- Provide basis for development of system
- Provide basis for V & V* of system

**Validation & Verification*, including testing*

Possible requirements stakeholders

- Clients (tailor-made system)
- Customers (product for general sale)
- Clients' and customers' customers
- Users
- Domain experts
- Market analysts
- Unions?

- Legal experts
- Purchasing agents
- Software developers
- Software project managers
- Software documenters
- Software testers
- Trainers
- Consultants

IEEE 830-1998

"IEEE Recommended Practice for Software Requirements Specifications"

Approved 25 June 1998 (revision of earlier standard)

Descriptions of the content and the qualities of a good software requirements specification (SRS).

Goal: "The SRS should be correct, unambiguous, complete, consistent, ranked for importance and/or stability, verifiable, modifiable, traceable."

IEEE Standard 830-1998

Recommended practice for Software Requirements Specifications

Recommended document structure:

1. Introduction
   - 1.1 Purpose
   - 1.2 Scope
   - 1.3 Definitions, acronyms, and abbreviations ← Glossary!
   - 1.4 References
   - 1.5 Overview
2. Overall description
   - 2.1 Product perspective
   - 2.2 Product functions
   - 2.3 User characteristics
   - 2.4 Constraints
   - 2.5 Assumptions and dependencies
3. Specific requirements

Appendixes

Index

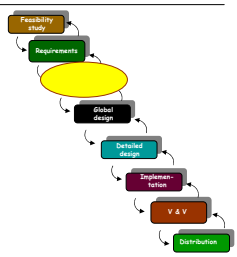
Lifecycle phase: Specification

Objective:
Define precise blueprint for system functionalities

Actors:
Development team

Example techniques:
UML, abstract data types, formal specification languages, Petri nets, State Charts, contracts

Products:
Specification document
Revised draft user's manual



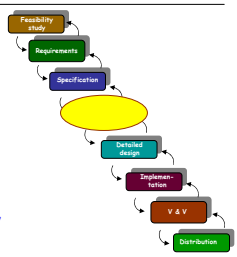
Lifecycle phase: Global Design

Objective:
Define system architecture

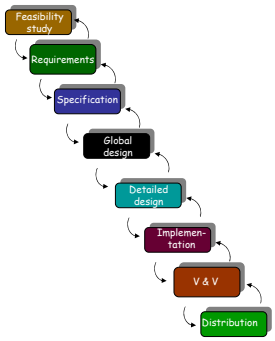
Actors:
Development team

Example techniques:
Design language, design patterns, high-level programming language

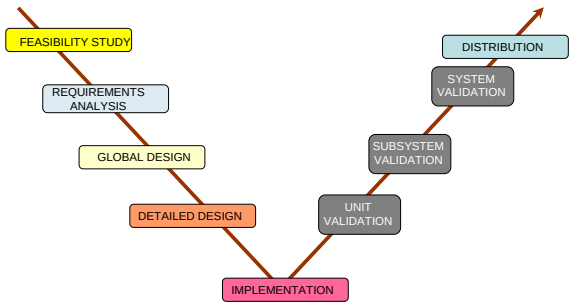
Products:
Specification document



Lifecycle: the waterfall model



V-shaped

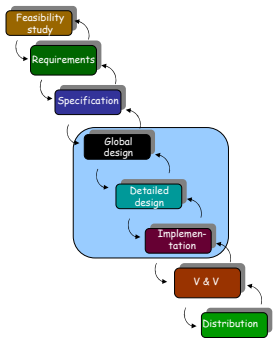


Arguments for the waterfall

(After B.W. Boehm: *Software engineering economics*)

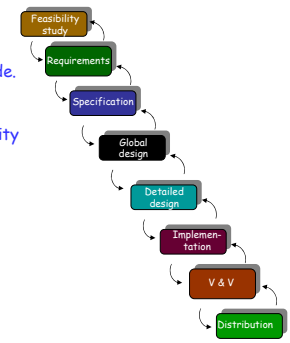
- The activities are necessary
  - (But: merging of middle activities)
- The order is the right one.

Merging of middle activities

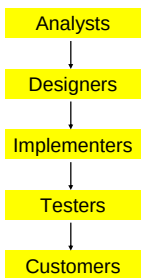


Problems with the waterfall

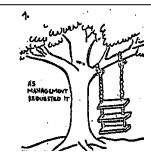
- Late appearance of actual code.
- Lack of support for requirements change — and more generally for extendibility and reusability
- Lack of support for the maintenance activity (70% of software costs?)
- Division of labor hampering Total Quality Management
- Impedance mismatches
- Highly synchronous model



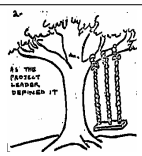
Quality control?



Impedance mismatches



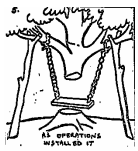
As Management requested it.



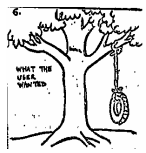
As the Project Leader defined it.

As Systems designed it.

As Programming developed it.



As Operations installed it.

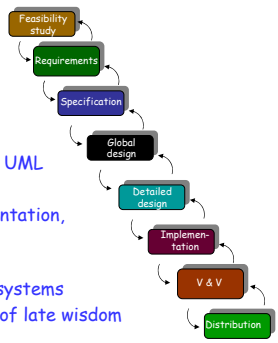


What the user wanted.

(Pre-1970 cartoon; origin unknown)

ETH Software Engineering

Problems with the waterfall



Separate tools:

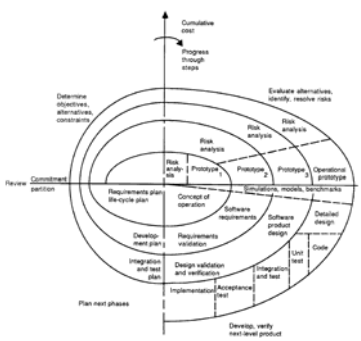
- Programming environment
- Analysis & design tools, e.g. UML

Consequences:

- Hard to keep model, implementation, documentation consistent
- Constantly reconciling views
- Inflexible, hard to maintain systems
- Hard to accommodate bouts of late wisdom

ETH Software Engineering

The Spiral model (Boehm)



ETH Software Engineering

"Prototyping" in software?

In other engineering fields, "prototyping" means one of:

- **1.** Smaller-scale model (e.g. water-processing plant…)
- **2.** Fully functional product, but custom-built, before attempting mass-production (e.g. car…)

In software:

- **1** is dubious
- **2** has no equivalent in ordinary circumstances (except for reuse, see next)

"Prototyping" in software

The term is used in one of the following meanings:

- Experimentation:
  - Requirements capture
  - Try specific techniques: GUI, implementation ("buying information")
- Pilot project
- Incremental development
- Throw-away development

(Fred Brooks, *The Mythical Man-Month*: "Plan to throw one away, you will anyhow").

Risks of "throw-away"prototyping

- If it removes an important constraint, it may be useless
- If you can envision shipping it, it's not an experiment!
- What if you have to ship anyway?

Risks of the spiral and prototyping

M.C Escher: Waterval

Extreme Programming and "agile" methods

Reaction against over-constraining models

Basic ideas:

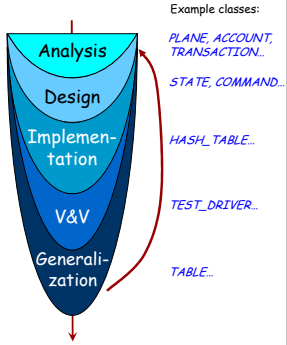
- Short development cycles
- No full initial specification; refine specs as you go
- Test-Driven Development
- Involve customers
- Recommended practices, e.g. Pair Programming

The cluster model

Seamless development:

- Single notation, tools, concepts, principles throughout
- Continuous, incremental development
- Keep model, implementation and documentation consistent

Reversibility: go back and forth



Example classes:

PLANE, ACCOUNT, TRANSACTION…

STATE, COMMAND…

HASH_TABLE…

TEST_DRIVER…

TABLE…

Generalization

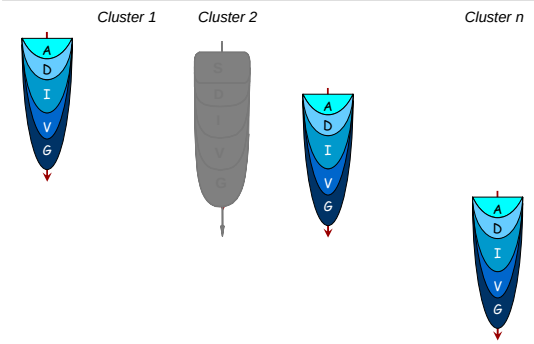
Prepare for reuse

For example:

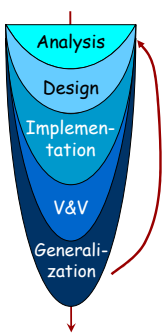
- Remove built-in limits
- Remove dependencies on specifics of project
- Improve documentation, contracts…
- Extract commonalities and revamp inheritance hierarchy

Few companies have the guts to provide the budget for this

The cluster model



Reversibility



Seamless development in Eiffel

- Diagram Tool
  - System diagrams can be produced automatically from software text
  - Works both ways: update diagrams or update text – other view immediately updated
- No need for separate UML tool
- Metrics Tool
- Profiler Tool
- Documentation generation tool
- ...