

Softwaretechnik / Software-Engineering

Lecture 1: Introduction

2015-04-20

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software engineering — (1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software. [2] The study of approaches as in (1).
IEEE 610.12 (1990)

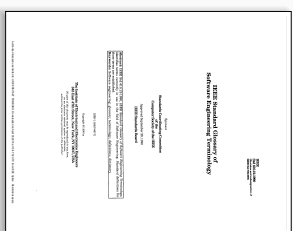
Software engineering — the establishment and use of sound engineering principles to obtain economically software that is reliable and works efficiently on real machines.
F. L. Bauer (1971)

Software Engineering Multi-person Development of Multi-version Programs. **D. L. Parnas (2011)**

software engineering — 1. the systematic application of engineering principles to the design, implementation, testing, and documentation of software. 2. the study of approaches to the development, operation, and maintenance of software; that is, the application of engineering to software.
ISO/IEC/IEEE 24766 (2010)



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software engineering — (1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software. [2] here is no universally accepted definition of software engineering.
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The course's working definition of Software Engineering

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	workshop (technical product)	studio (artwork)
Material prerequisite	the existing and available technical know-how	artist's inspiration, among others
Deadlines	can usually be planned with sufficient precision	cannot be planned due to inspiration on artist's
Price	oriented on cost, thus calculable	determined by market value, not by cost
Norms and standards	well-known and usually respected	are rare and, if known, not respected
Evaluation and comparison	can be conducted using objective, quantified criteria	is only subjectively possible, results are disputed
Author	remains anonymous, often lacks emotional ties to the product	considers the artwork as part of him/herself
Warranty and liability	are clearly regulated, cannot be excluded	are not defined and in practice hardly enforceable

(Ludewig and Lehter, 2013)

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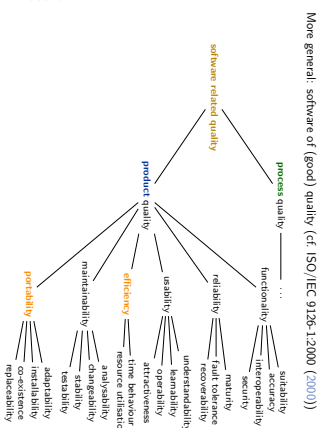
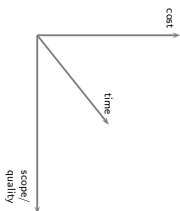
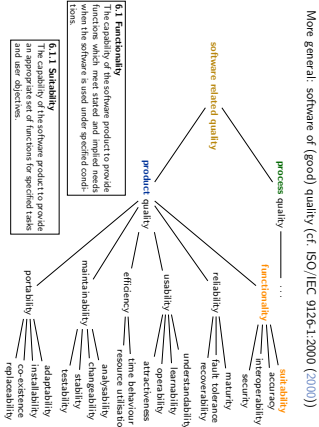
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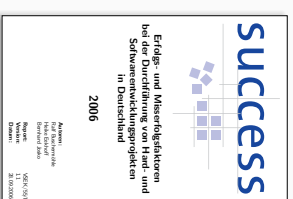
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software — Computer programs, procedures, and possibly associated documentation and data pertaining to the operation of a computer system. See also: **application software**; **support software**; **system software**. Contrast with: **hardware**.
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Note: not all software created in a software project is visible in the final product, e.g. **build scripts, test drivers, stubs**, etc.

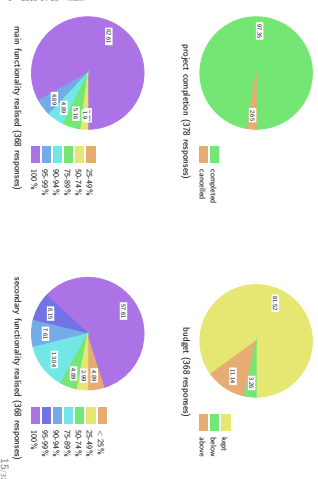
s, etc.



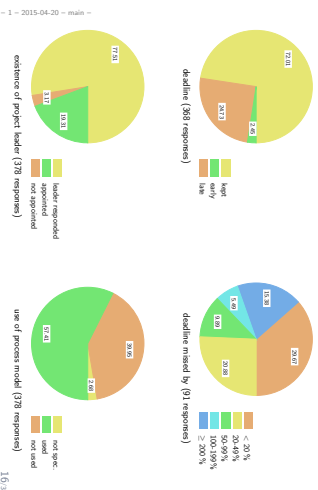
Characteristics of Software Projects in SUCCESS



Projects success, Budget, Functionality



Deadlines, Project Leader, Process Model



Course Goals and Content

- **First of all:**
 - communicate/cooperate with "real" software engineers
 - enable further study of today's software engineering research
- **To this end:**
 - provide a broad overview over software engineering research
 - point out areas, landmarks and elaborate example techniques/formalisms/tools
- ... with an emphasis on **formal methods**

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A Glimpse of Formal Methods

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Example "Requirements Engineering":

- introduction to RE
- common notions, problems, goals, approaches (informal, abstract)
- formalisation and formal analysis of requirements (formal, concrete)
- point out further reading

Introduction	L: 1, 20.4, Mo
Development Process, Metrics	L: 2, 27.4, Mo
Requirements Engineering	L: 3, 4.5, Mo
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- “The **techniques** of a formal method help
- **construct** a specification, and/or
 - **analyse** a specification, and/or
 - **transform** (refine) one (or more) specification(s) into a **program**.

The **techniques** of a formal method, (besides the specification languages) are typically software packages that help developers use the techniques and other tools.

The aim of developing software, either

- **formally** (all arguments are formal) or
- **rigorously** (some arguments are made and they are formal) or
- **systematically** (some arguments are made on a form that can be made formal) is to (be able to) **reason in a precise manner about properties** of what is being developed.” (Björner and Havelund, 2014)

Definition. Software is a finite description S of a (possibly infinite) set $\llbracket S \rrbracket$ of (finite or infinite) computation paths of the form

$$\sigma_0 \xrightarrow{\alpha_0} \sigma_1 \xrightarrow{\alpha_1} \sigma_2 \dots$$

where

- $\sigma_i \in \Sigma, i \in \mathbb{N}_0$, is called **state** (or **configuration**), and
- $\alpha_i \in A, i \in \mathbb{N}_0$, is called **action** (or **event**).

The (possibly partial) function $\llbracket \cdot \rrbracket : S \mapsto \llbracket S \rrbracket$ is called **interpretation** of S .

Example: Software, formally

Software is a finite description S of a (possibly infinite) set $\llbracket S \rrbracket$ of (finite or infinite) computation paths of the form $\sigma_0 \xrightarrow{\alpha_0} \sigma_1 \xrightarrow{\alpha_1} \sigma_2 \dots$
 α_i : state/configuration; α_i : action/event.

- **Programs.**
- **HTML.**

```
S: 1: <head>
2: </head>
3: <title>SWT 2015</title>
4: </head>
5: <body>
6: </body>
7: </html>
```

$$\llbracket S \rrbracket = \left\{ \begin{array}{c} \text{[Diagram: A sequence of states } \sigma_0, \sigma_1, \sigma_2 \text{ connected by arrows labeled } \alpha_0, \alpha_1, \alpha_2 \text{]} \\ \vdots \end{array} \right\}$$

Example: Software, formally

Software is a finite description S of a (possibly infinite) set $\llbracket S \rrbracket$ of (finite or infinite) computation paths of the form $\sigma_0 \xrightarrow{\alpha_0} \sigma_1 \xrightarrow{\alpha_1} \sigma_2 \dots$
 α_i : state/configuration; α_i : action/event.

- **Programs.**
- **HTML.**
- **Global Invariants.**

$$x \geq 0$$

Example: Software, formally

Software is a finite description S of a (possibly infinite) set $\llbracket S \rrbracket$ of (finite or infinite) computation paths of the form $\sigma_0 \xrightarrow{\alpha_0} \sigma_1 \xrightarrow{\alpha_1} \sigma_2 \dots$
 α_i : state/configuration; α_i : action/event.

- **Programs.**

```
S: 1: public int f( int x, int y ) {
2:   x = x * y;
3:   y = y * x;
4:   return y;
5: }
```

$$\llbracket S \rrbracket = \left\{ \sigma_0 \xrightarrow{\alpha_0} \sigma_1 \xrightarrow{\alpha_1} \sigma_2 \xrightarrow{\alpha_2} \sigma_3 \xrightarrow{\alpha_3} \sigma_4 \xrightarrow{\alpha_4} \sigma_5 \dots \right\}$$

Example: Software, formally

Software is a finite description S of a (possibly infinite) set $\llbracket S \rrbracket$ of (finite or infinite) computation paths of the form $\sigma_0 \xrightarrow{\alpha_0} \sigma_1 \xrightarrow{\alpha_1} \sigma_2 \dots$
 α_i : state/configuration; α_i : action/event.

- **Programs.**
- **HTML.**
- **Global Invariants.**
- **State Machines.**



Example: Software, formally

Software is a finite description S of a (possibly infinite) set $[S]$ of (finite or infinite) computation paths of the form $\sigma_0 \xrightarrow{a_0} \sigma_1 \xrightarrow{a_1} \sigma_2 \dots$,
 or: state/configuration, a_i : action/event.

- Programs.
- HTML.
- Global Invariants.
- State Machines.
- User's Manual.

Software Specification, formally

Definition. A software specification is a finite description \mathcal{S} of a (possibly infinite) set $[\mathcal{S}]$ of softwares, i.e.

$$[\mathcal{S}] = \{\langle \delta_i, \perp \rangle, \dots \}.$$

The (possibly partial) function $\llbracket \cdot \rrbracket : \mathcal{S} \mapsto [\mathcal{S}]$ is called **interpretation** of \mathcal{S} .

Example: Software Specification

Alphabet:

- M – dispense cash only.
- C – return card only.
- C' – dispense cash and return card.



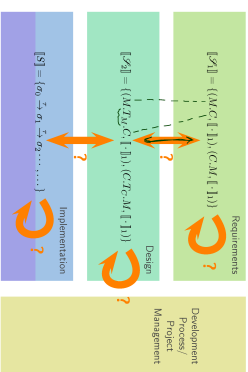
- **Customer 1** "don't care"

$$(MC|_{C,M} \mid M)$$
- **Customer 2** "you choose, but be consistent"

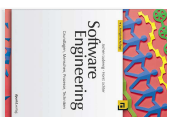
$$(MC) \text{ or } (C;M)$$
- **Customer 3** "consider human errors"

$$(C;M)$$

Formal Software Development

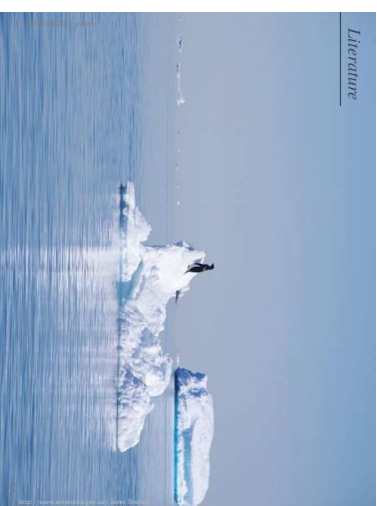


Literature



... more on lecture's homepage.

Literature



... more on lecture's homepage.

Any questions so far?

Formula

Who's Who

- **Lecturer:** Dr. Bernd Westphal
- **Assistant:** Sergio Freo Arenas, MSc
- **Tutors:** Belem, Claus, Jan, Michael

- **Homepage:**
<http://swi.infematik.uni-freiburg.de/teaching/SS2015/swt1>

- **Course language:** [via English or German...](#)?
- **Script/Media:**
 - **slides without** annotations on **homepage** with beginning of lecture the latest
 - **slides with** annotations on **homepage** typically soon after the lecture
 - **recording on ILIAS** (stream and download) with max. 1 week delay (link on **homepage**)

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Questions and Interaction

- **Interaction:**
absence often moaned but **it takes two**, so please ask/comment immediately.
- **Questions:**
 - **"online"**: ask immediately or in the break
 - **"offline"**:
 - (i) try to solve yourself
 - (ii) discuss with colleagues
 - (iii) = Exercises: contact tutor (cf. homepage)
 - = Rest: contact lecturer (cf. homepage) or just drop by: Building 52, Room 00-020
- **Break:**
 - We'll have a **10 min. break** in the middle of each lecture from now on, unless a majority objects **now**.

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Exam

- **Exam Admission:**
Achieving 50% of the regular **admission points** (→ next slide) in total is sufficient for admission to exam.
Typically, 20 regular admission points per exercise sheet.
- **Exam Form:**
 - **written** exam
 - Friday, September, 11th, 2015, 9:00 c.t.
 - Building 101, Room: 026+036
 - Scores from the exercises **do not** contribute to the final grade.

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Exercises & Tutorials

- **Schedule/Submission:**
 - exercises **online** with first lecture of a block,
 - **early turn** in 24h before tutorial (usually Wednesday, 12:15, local time),
 - **regular turn** in right before tutorial (usually Thursday, 12:15, local time),
 - should work in groups of **approx. 3**, clearly give **names** on submission
 - please submit **electronically** via **ILIAS**; paper submissions are **tolerated**
- **Rating system:** "most complicated rating system ever"
 - **Admission points** (good-will rating, upper bound)
 - ("reasonable proposal given student's knowledge **before** tutorial")
 - **Exercise points** (evil rating, lower bound)
 - ("reasonable proposal given student's knowledge **after** tutorial")
- **10% bonus** for **early** submission.
- **Tutorial: Penalty.**
 - Together develop **one** good proposal, starting from discussion of the early submissions (anonymous).
 - Tutorial notes provided as print-outs in subsequent lecture.

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- **Mid-term Evaluation(s):**
 - In addition to the mandatory final evaluation, we will have **intermediate evaluation(s)**.
 - If you decide to leave the course earlier you may want to **do us a favour** and tell us the reasons – by participating in the evaluation(s) (will be announced on homepage).
- **Note:** we're **always** interested in comments/tips/proposals/wishes/... concerning **form** or **content**.
Feel free to approach us (tutors, Sergio, me) in any form. **We don't bite.**

References

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