Softwaretechnik / Software-Engineering

Lecture 1: Introduction

2017-04-24

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Content

- **Software, Engineering, Software Engineering**
- **Successful Software Development**
  - working definition: success
  - unsuccessful software development exists
  - common reasons for non-success
- **Course**
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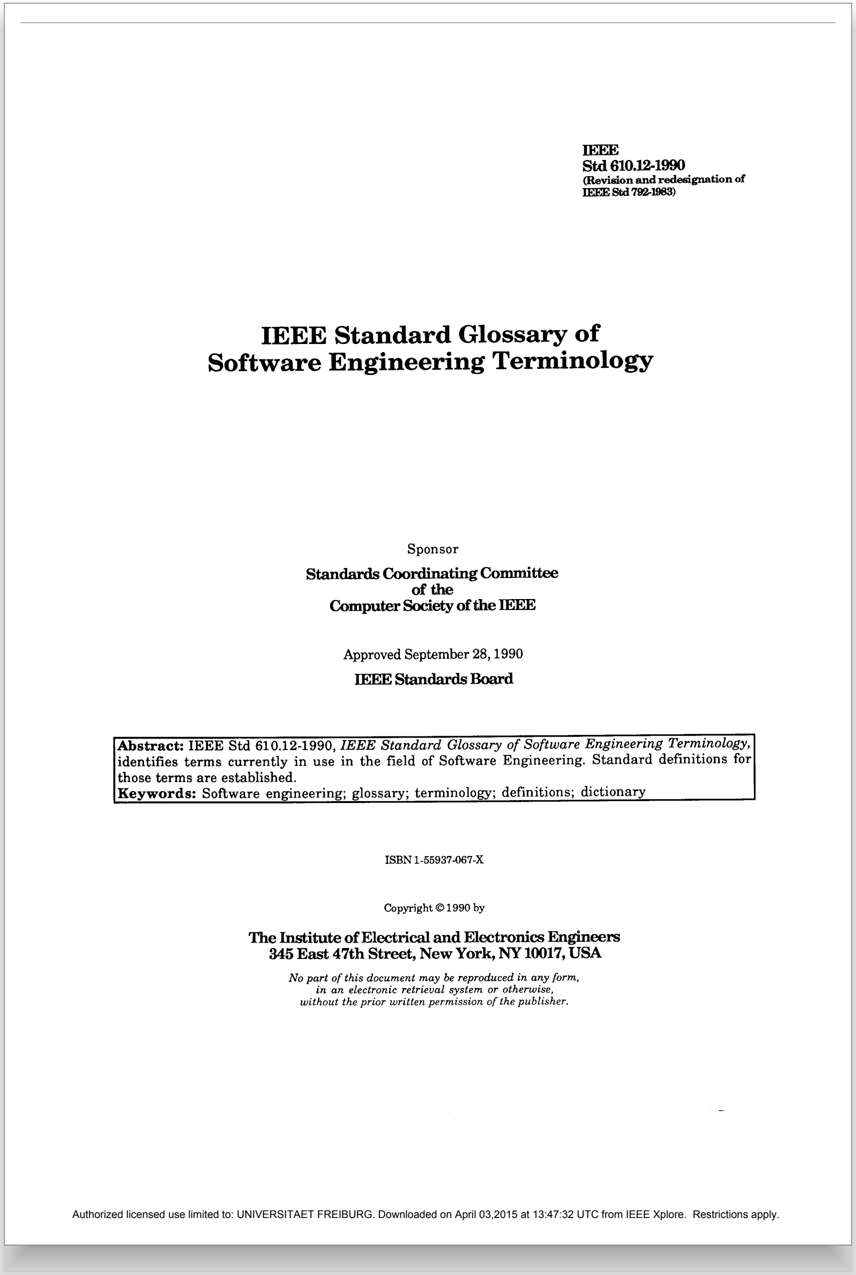
    - topic areas
    - structure of topic areas
    - emphasis: formal methods
    - relation to other courses
    - literature
  - Organisation
    - lectures
    - tutorials
    - exam

Software, Engineering, Software Engineering



IEEE
Std 610.12-1990
(Revision and redesignation of
IEEE Std 792-1983)

IEEE Standard Glossary of Software Engineering Terminology

Sponsor

Standards Coordinating Committee
of the
Computer Society of the IEEE

Approved September 28, 1990

IEEE Standards Board

Abstract: IEEE Std 610.12-1990, *IEEE Standard Glossary of Software Engineering Terminology*, identifies terms currently in use in the field of Software Engineering. Standard definitions for those terms are established.

Keywords: Software engineering; glossary; terminology; definitions; dictionary

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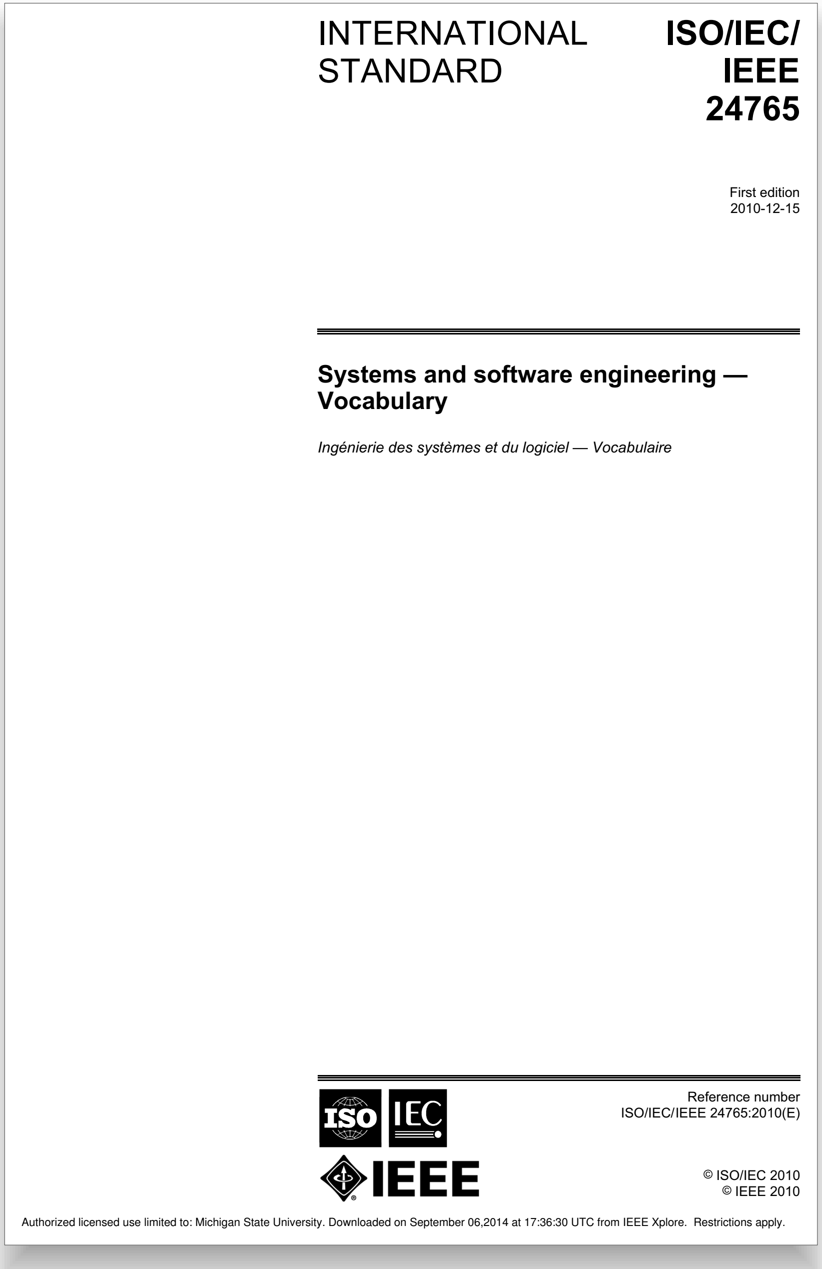
The Institute of Electrical and Electronics Engineers
345 East 47th Street, New York, NY 10017, USA



INTERNATIONAL STANDARD

ISO/IEC/
IEEE
24765

First edition
2010-12-15

Systems and software engineering — Vocabulary

Ingénierie des systèmes et du logiciel — Vocabulaire

Reference number
ISO/IEC/IEEE 24765:2010(E)

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**. **IEEE 610.12** (1990)

Software –

1. all or part of the programs, procedures, rules, and associated documentation of an information processing system. [...]
2. see 610.12
3. program or set of programs used to run a computer. [...]

NOTE: includes firmware, documentation, data, and execution control statements.

IEEE 24765 (2010)

Engineering vs. Non-Engineering

	workshop (technical product)	studio (artwork)
Mental 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 dependency on artist's inspiration
Price	oriented on cost, thus calculable	determined by market value, not by cost
Norms and standards	exist, are known, and are usually respected	are rare and, if known, not respected
Evaluation and comparison	can be conducted using objective, quantified criteria	is only possible subjectively, 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 Lichter, 2013)

Software Engineering

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 –

1. the systematic application of scientific and technological knowledge, methods, and experience to the design, implementation, testing, and documentation of software.
2. see IEEE 610.12 (1)

ISO/IEC/IEEE 24765 (2010)

Software Engineering–
Multi-person Development of Multi-version Programs.

D. L. Parnas (2011)

fiff.informatik.uni-bremen.de/2001/assets/images/

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)

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Software Engineering – (1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and mainte

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(2) The stu

There is no universally accepted definition of software engineering.

Software Engineering – **1.** the systematic application of scientific and technological knowledge, methods, and experience to the design, implementation, testing, and documentation of software.

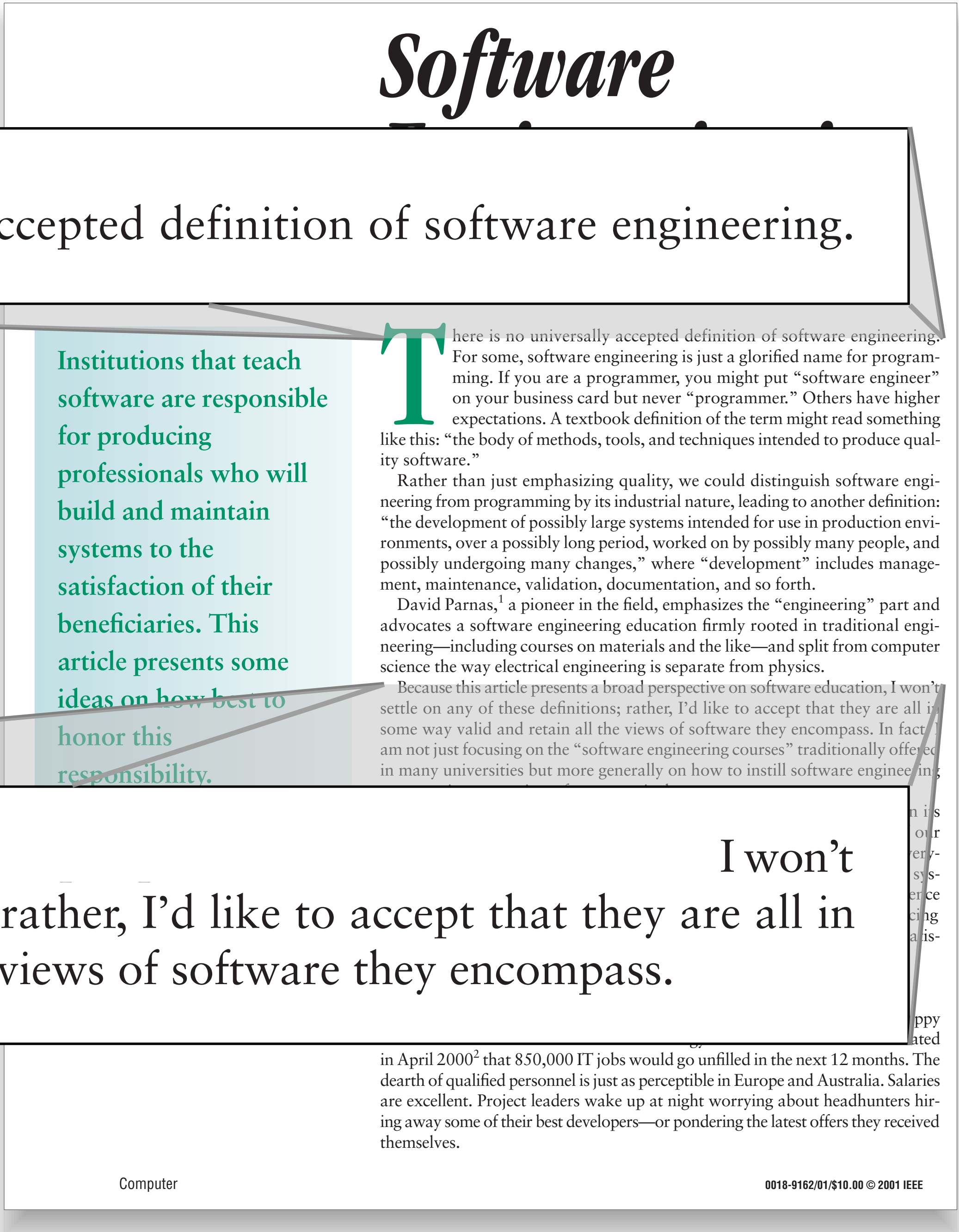
2. see 610.12 (1). **ISO/IEC/IEEE 24765** (2010)

Software

version Pr

I won't settle on any of these definitions; rather, I'd like to accept that they are all in some way valid and retain all the views of software they encompass.

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

Institutions that teach software are responsible for producing professionals who will build and maintain systems to the satisfaction of their beneficiaries. This article presents some ideas on how best to honor this responsibility.

There is no universally accepted definition of software engineering. For some, software engineering is just a glorified name for programming. If you are a programmer, you might put “software engineer” on your business card but never “programmer.” Others have higher expectations. A textbook definition of the term might read something like this: “the body of methods, tools, and techniques intended to produce quality software.”

Rather than just emphasizing quality, we could distinguish software engineering from programming by its industrial nature, leading to another definition: “the development of possibly large systems intended for use in production environments, over a possibly long period, worked on by possibly many people, and possibly undergoing many changes,” where “development” includes management, maintenance, validation, documentation, and so forth.

David Parnas,[1] a pioneer in the field, emphasizes the “engineering” part and advocates a software engineering education firmly rooted in traditional engineering—including courses on materials and the like—and split from computer science the way electrical engineering is separate from physics.

Because this article presents a broad perspective on software education, I won't settle on any of these definitions; rather, I'd like to accept that they are all in some way valid and retain all the views of software they encompass. In fact, I am not just focusing on the “software engineering courses” traditionally offered in many universities but more generally on how to instill software engineering

in April 2000[2] that 850,000 IT jobs would go unfilled in the next 12 months. The dearth of qualified personnel is just as perceptible in Europe and Australia. Salaries are excellent. Project leaders wake up at night worrying about headhunters hiring away some of their best developers—or pondering the latest offers they received themselves.

Computer

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The course's working definition of Software Engineering

Software Engineering –

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(2) The study of approaches as in (1). **IEEE 610.12 (1990)**

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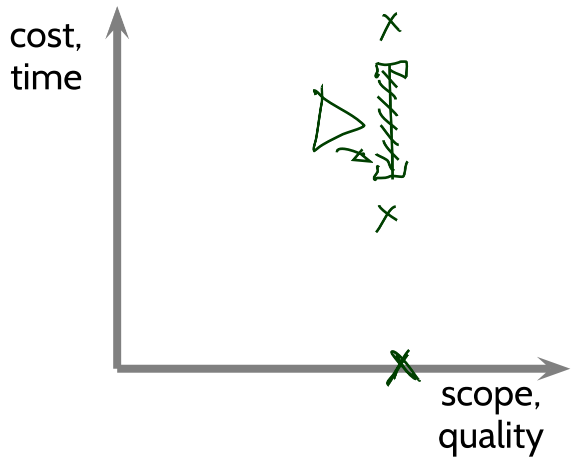
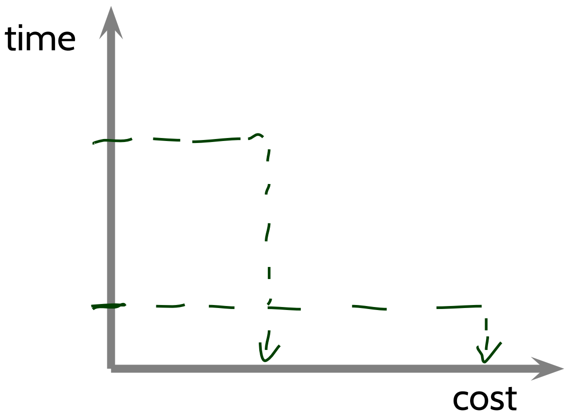
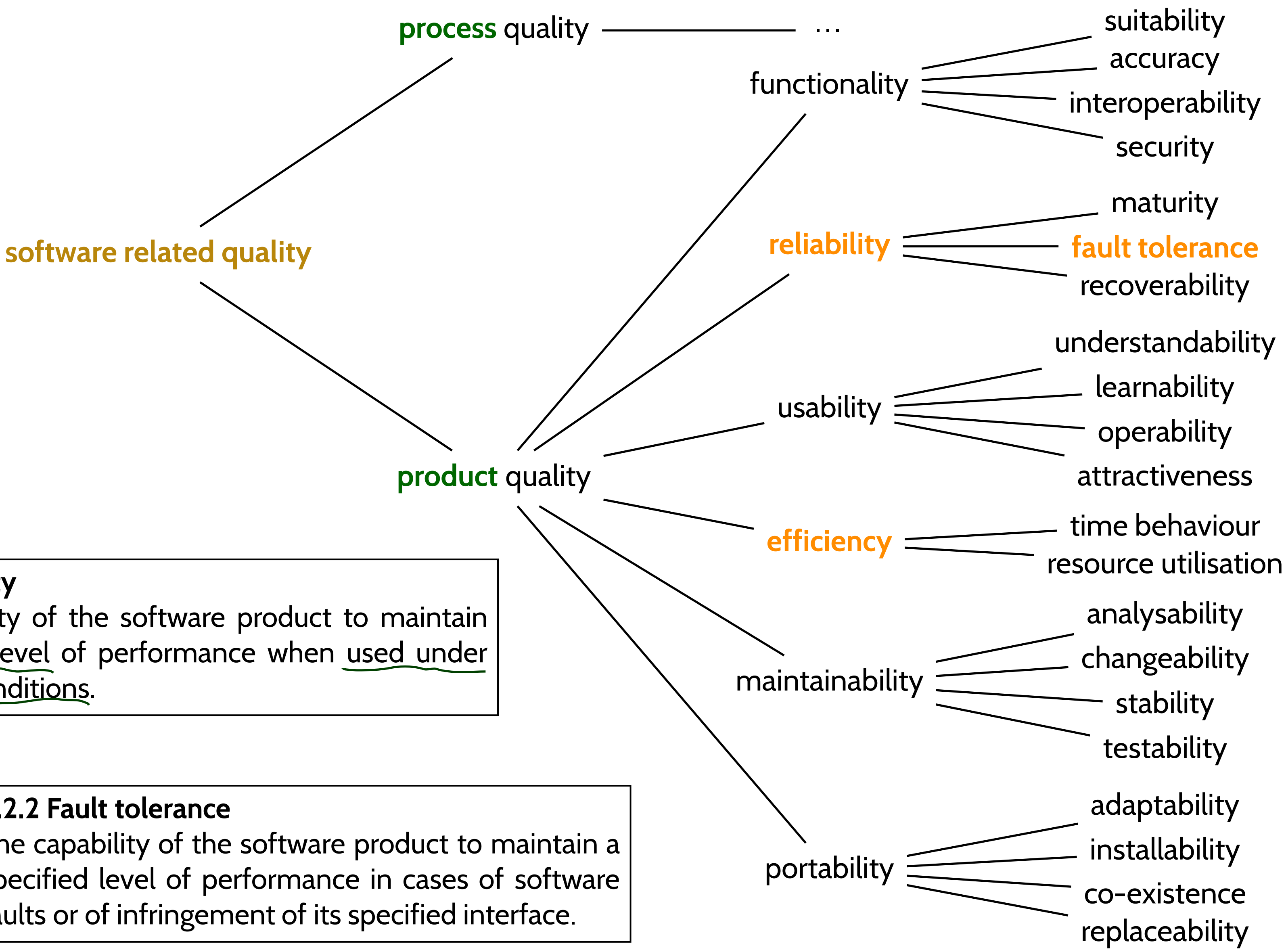




“software that is reliable and works efficiently” (Bauer, 1971)

More general: **software of (good) quality** (cf. ISO/IEC 9126-1:2000 (2000))



- software related quality
  - **process** quality — …
  - **product** quality
    - functionality
      - suitability
      - accuracy
      - interoperability
      - security
    - **reliability**
      - maturity
      - **fault tolerance**
      - recoverability
    - usability
      - understandability
      - learnability
      - operability
      - attractiveness
    - **efficiency**
      - time behaviour
      - resource utilisation
    - maintainability
      - analysability
      - changeability
      - stability
      - testability
    - portability
      - adaptability
      - installability
      - co-existence
      - replaceability

6.2 Reliability
The capability of the software product to maintain a specified level of performance when used under specified conditions.

6.2.2 Fault tolerance
The capability of the software product to maintain a specified level of performance in cases of software faults or of infringement of its specified interface.

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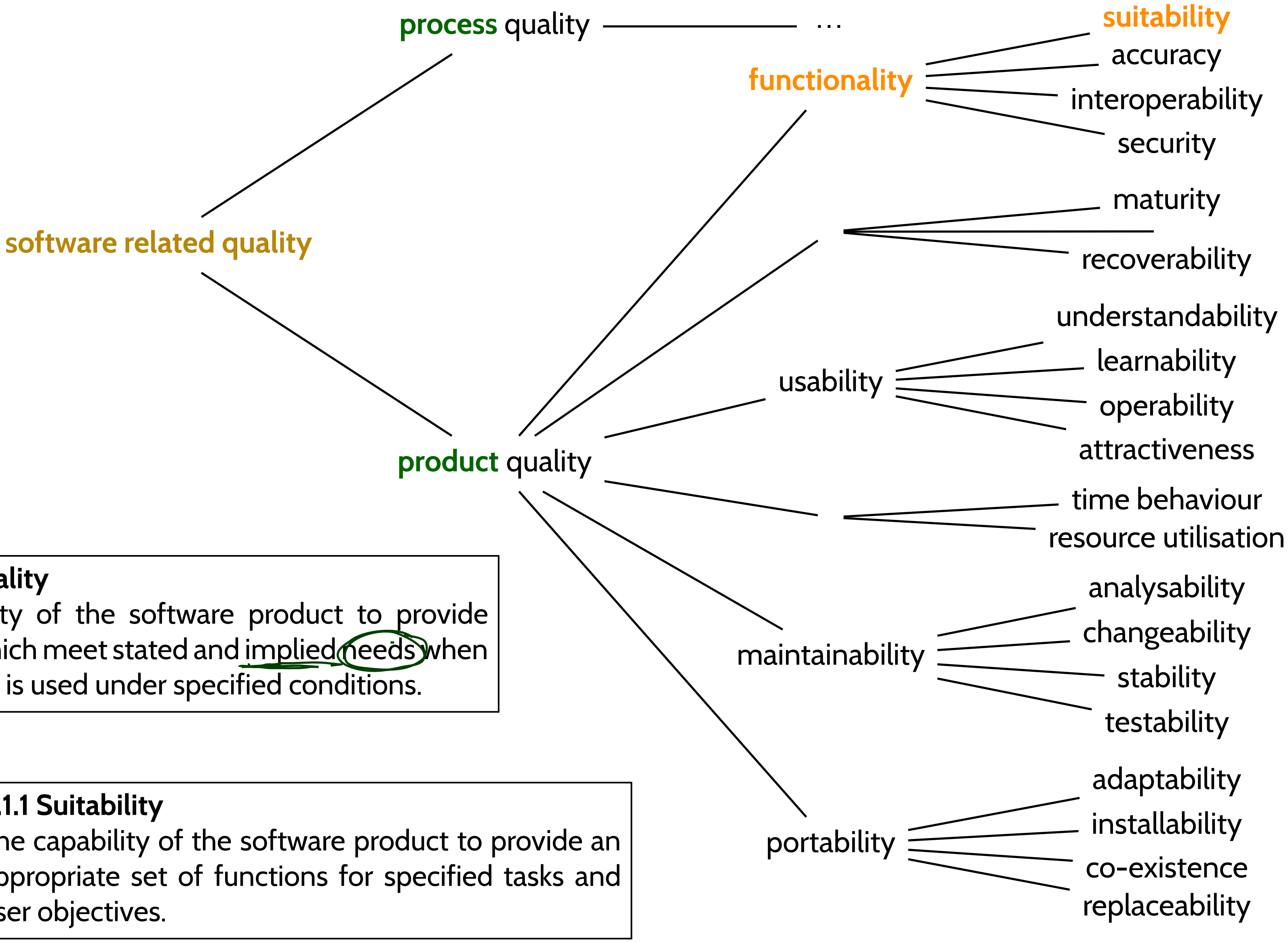

process quality …

software related quality

product quality

functionality: suitability, accuracy, interoperability, security

maturity, recoverability

usability: understandability, learnability, operability, attractiveness

time behaviour, resource utilisation

maintainability: analysability, changeability, stability, testability

portability: adaptability, installability, co-existence, replaceability

6.1 Functionality
The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions.

6.1.1 Suitability
The capability of the software product to provide an appropriate set of functions for specified tasks and user objectives.

The course's working definition of Software Engineering

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Successful Software Development

When is Software Development Successful?

A software development project is **successful**

if and only if

developer, customer, and user are happy with the result at the end of the project.

Is Software Development Always Successful?

success

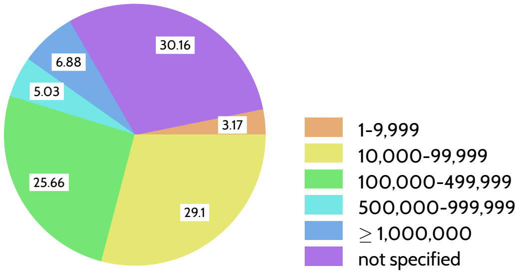
Erfolgs- und Misserfolgsfaktoren bei der Durchführung von Hard- und Softwareentwicklungsprojekten in Deutschland

2006

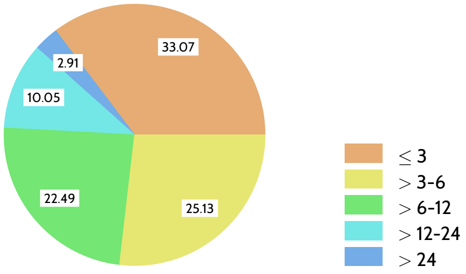
Autoren:
Ralf Buschermöhle
Heike Eekhoff
Bernhard Josko

Report:	VSEK/55/D
Version:	1.1
Datum:	28.09.2006

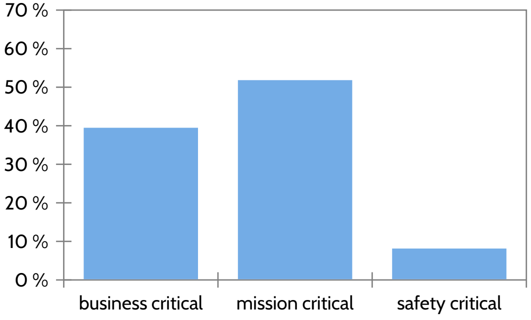
Some Empirical Findings (*Buschermöhle et al. (2006)*)



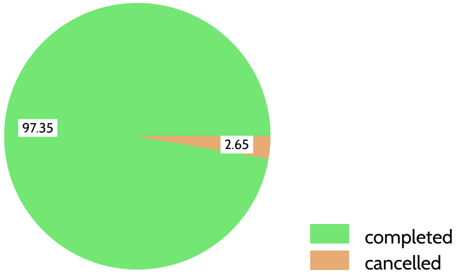
budget in € (378 responses)



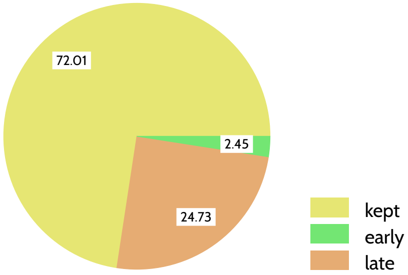
planned duration in months (378 responses)



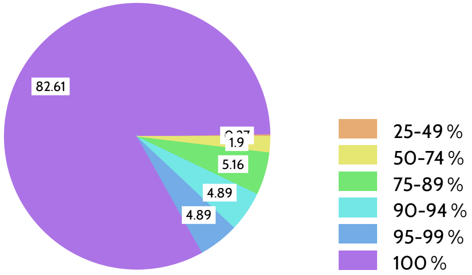
Criticality (378 responses, 30 'not spec.')



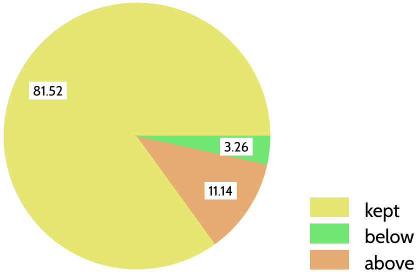
project completion (378 responses)



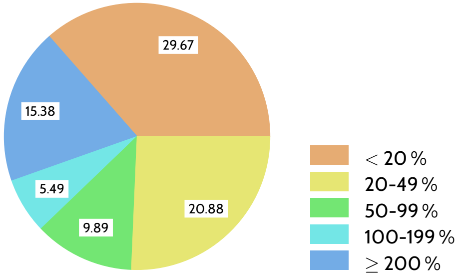
deadline (368 responses)



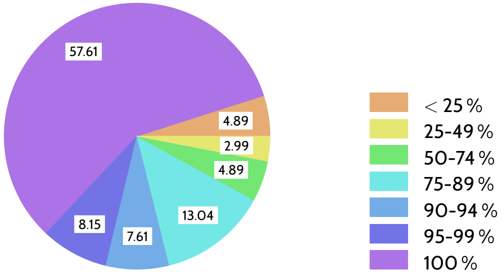
main functionality realised (368 responses)



budget (368 responses)



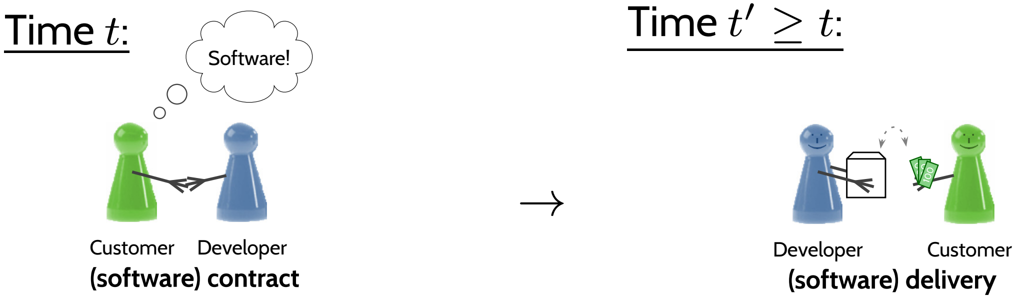
deadline missed by (91 responses)



secondary functionality realised (368 responses)

A Closer Look

- **Successful:**



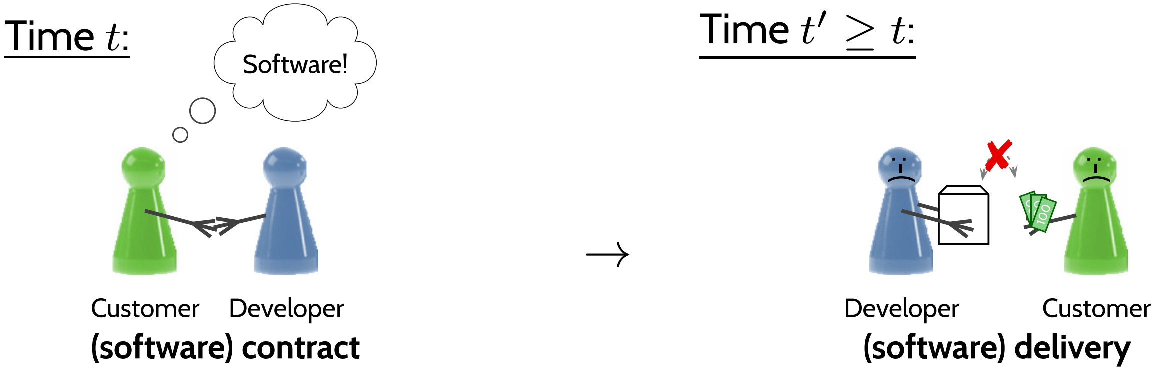
Time t:

(software) contract

Time $t' \geq t$:

(software) delivery

- **Unsuccessful**:



Time t:

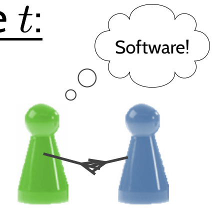
(software) contract

Time $t' \geq t$:

(software) delivery

What might've gone wrong?

Time t:

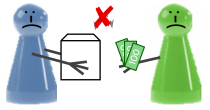


Customer Developer

(software) contract

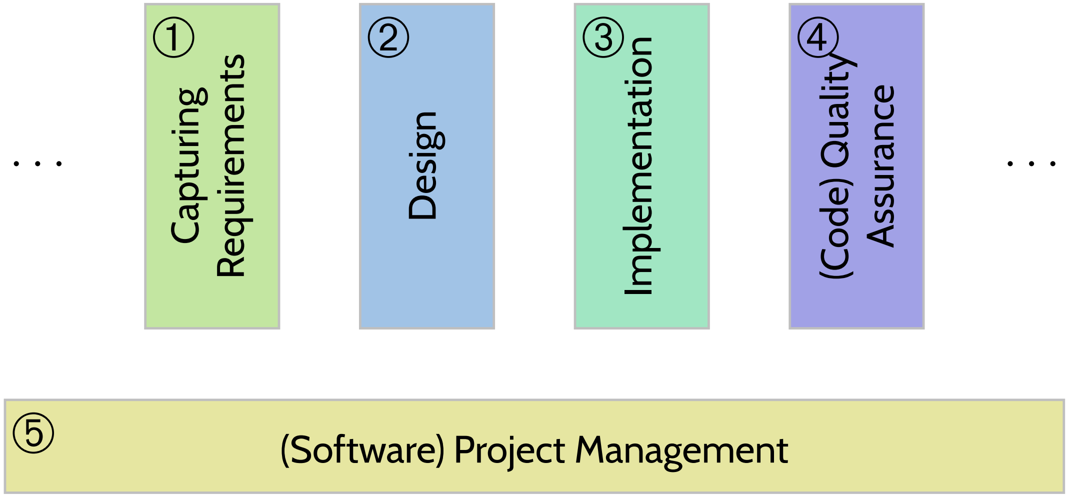
$\rightarrow$

Time $t' \geq t$:



Developer Customer

(software) delivery



. . . ① Capturing Requirements ② Design ③ Implementation ④ (Code) Quality Assurance . . .

⑤ (Software) Project Management

Some scenarios:

①	②	③	④	⑤	
✗	✓	✓	✓	✓	e.g. misunderstanding of requirements
✓	✗	✓	✓	✓	e.g. non-scalable design, feature forgotten
✓	✓	✗	✓	✓	e.g. programming mistake
✓	✓	✓	✗	✓	e.g. wrongly conducted test
✓	✓	✓	✓	✗	e.g. wrong estimates, bad scheduling

In Other Words

All engineering disciplines face the same questions:

- How to **describe requirements** / **avoid misunderstandings** with the customer?
- How to **describe design ideas** / **avoid misunderstandings** with the implementers?
- How to **ensure** that the **product is built right** / that the **right product is built**?
  (→ How to **measure** the quality of the product?)
- How to **schedule activities** properly?

At best: are there procedures which promise to **systematically** avoid certain mistakes or costs?

This course is about **Software Engineering**, so we should discuss:

- How to **describe requirements on software precisely**?
- How to **describe design ideas for software precisely**?
- How to **ensure** that **software** is built right?
  (→ How to **measure** the quality of **software**?)
- How to **schedule software development activities** properly?

What are procedures to **systematically** avoid certain mistakes or costs in **software development**?

Example: Nightly Builds

Scenario:

- Program P compiles successfully at time t.
- Programmers work for duration d on P, yielding program P' at time $t + d$.
- P' does not compile at time $t + d$.

→ **the reason** for not compiling any more **must be among** the changes during d.

Experience:

- If d is large, it can be very difficult (and time consuming) to identify the cause.

Proposal: "Nightly Builds"

- Set up a procedure, which (at best: automatically) tries to compile the current state of the development each day over night.
- **Promise**: with "nightly builds", d is **effectively limited** to be smaller or equal to one day, so the **number of possible causes** for not compiling should be **manageable**.

→ Software Engineering as a **defensive discipline** (measures against failures and "catastrophes"):

- **if program P always compiles**, the effort for "nightly builds" was strictly speaking **wasted**.
- **if a compilation issue occurs** during the project, the caused **damage is bounded**.

Same holds for documentation: if no maintenance is ever needed, documentation effort may be wasted.

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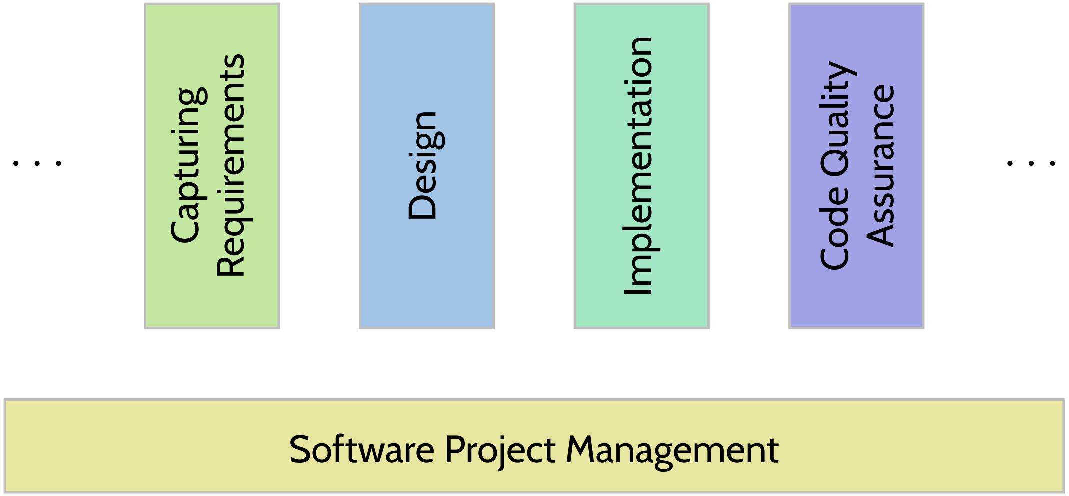
What are procedures to **systematically** avoid certain mistakes or costs in **software development**?

Software Engineering is a young discipline: **plenty of proposals** for each question.

So the course will **focus on the problems** and discuss **example proposals**.

Course: Content

Course Content (Tentative)



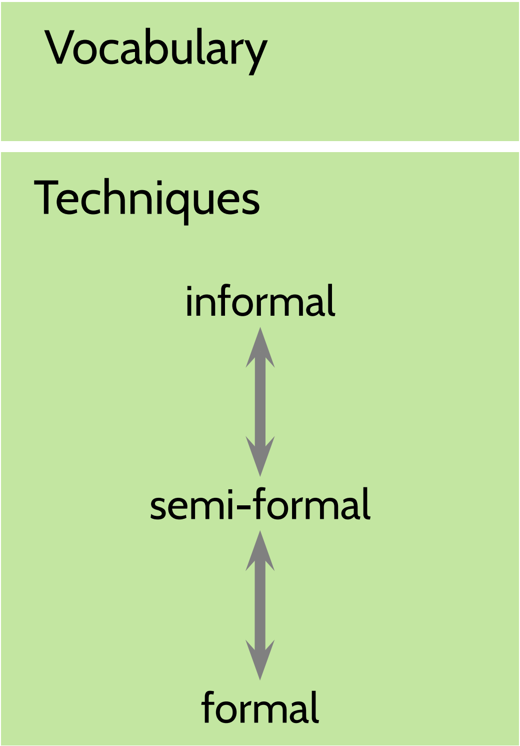
Ex0

Ex1

Introduction	L 1:	24.4., Mon
Scales, Metrics,	L 2:	27.4., Thu
	-	1.5., Mon
	T 1:	4.5., Thu
Costs, Development Process	L 3:	8.5., Mon
	L 4:	11.5., Thu
	L 5:	15.5., Mon
	T 2:	18.5., Thu
	L 6:	22.5., Mon
	-	25.5., Thu
Requirements Engineering	L 7:	29.5., Mon
	L 8:	1.6., Thu
	-	5.6., Mon
	-	8.6., Thu
	T 3:	12.6., Mon
	-	15.6., Thu
	L 9:	19.6., Mon
	L10:	22.6., Thu
Arch. & Design	L 11:	26.6., Mon
	T 4:	29.6., Thu
Software Modelling	L 12:	3.7., Mon
	L 13:	6.7., Thu
	L 14:	10.7., Mon
	T 5:	13.7., Thu
Patterns	L 15:	17.7., Mon
QA (Testing, Formal Verif.)	L 16:	20.7., Thu
	L 17:	24.7., Mon
Wrap-Up	~~L18:~~) Tu 6	27.7., Thu

Structure of Topic Areas

Example: Requirements Engineering



Vocabulary

e.g. consistent,
complete, tacit, etc.

Techniques

informal

semi-formal

formal

Excursion: Informal vs. Formal Techniques

Example: Requirements Engineering, Airbag Controller

DaimlerChrysler AG, CC BY-SA 3.0

Requirement:

Whenever a crash is detected, the airbag has to be fired within $300\,\mathrm{ms}$ $(\pm\varepsilon)$.

Developer A Developer B

vs.

- Fix observables: crashdetected : Time $\to \{0,1\}$ and fireairbag : Time $\to \{0,1\}$
- Formalise requirement:

$\leq$

$$\forall\, t, t' \in \mathrm{Time} \bullet \mathrm{crashdetected}(t) \wedge \mathrm{airbagfired}(t') \implies t' \in [t+300-\varepsilon, t+300+\varepsilon]$$

→ no more misunderstandings, sometimes **tools** can **objectively** decide: requirement satisfied yes/no.

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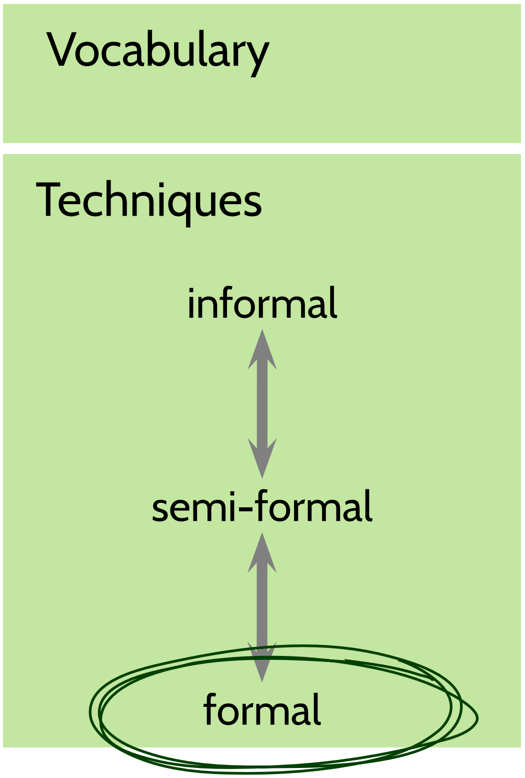
Structure of Topic Areas

Example: Requirements Engineering



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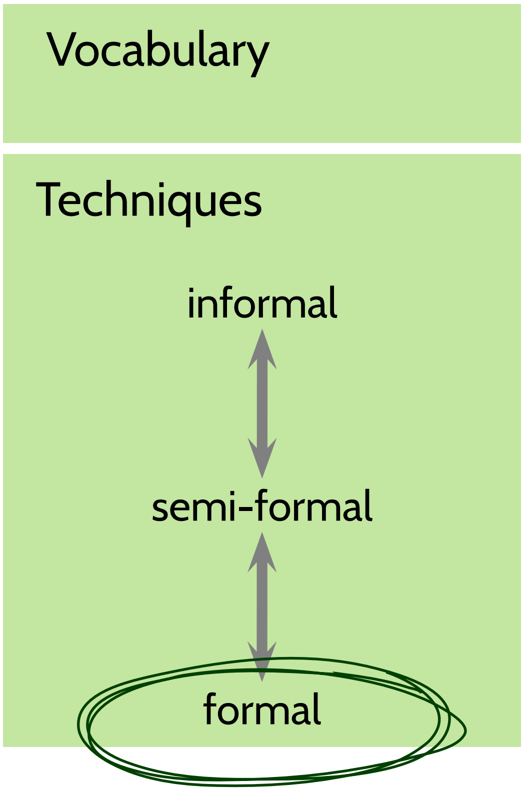


Vocabulary

e.g. consistent,
complete, tacit, etc.

In the course:

Techniques

Use Cases

informal

e.g. “Whenever a crash…”

Pattern Language

e.g. “Always, if ⟨**crash**⟩ at t…”

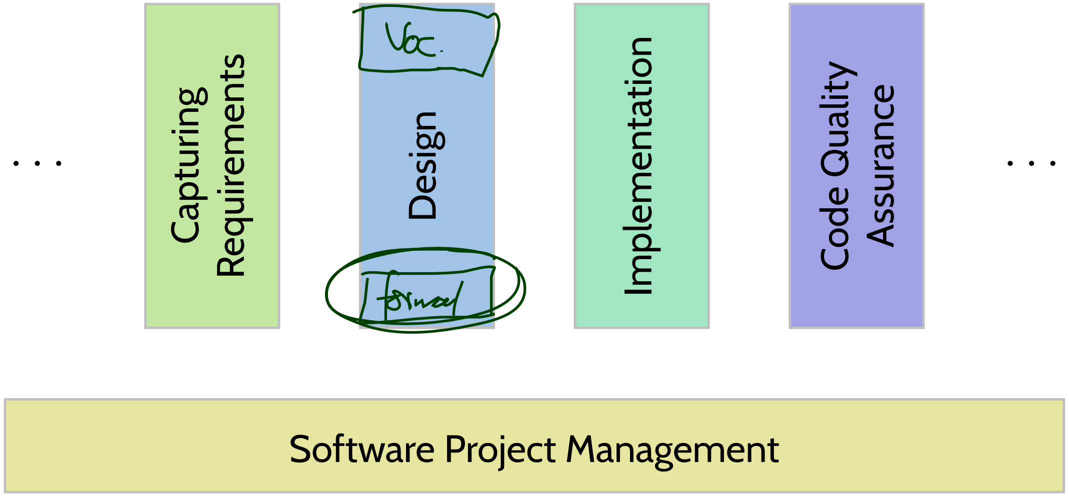
semi-formal

Decision Tables
Live Sequence Charts

formal

e.g. “$\forall\, t, t' \in$ Time $\bullet$ …”

Course Content (Tentative)



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Wrap-Up	L18:	27.7., Thu

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  - working definition: success
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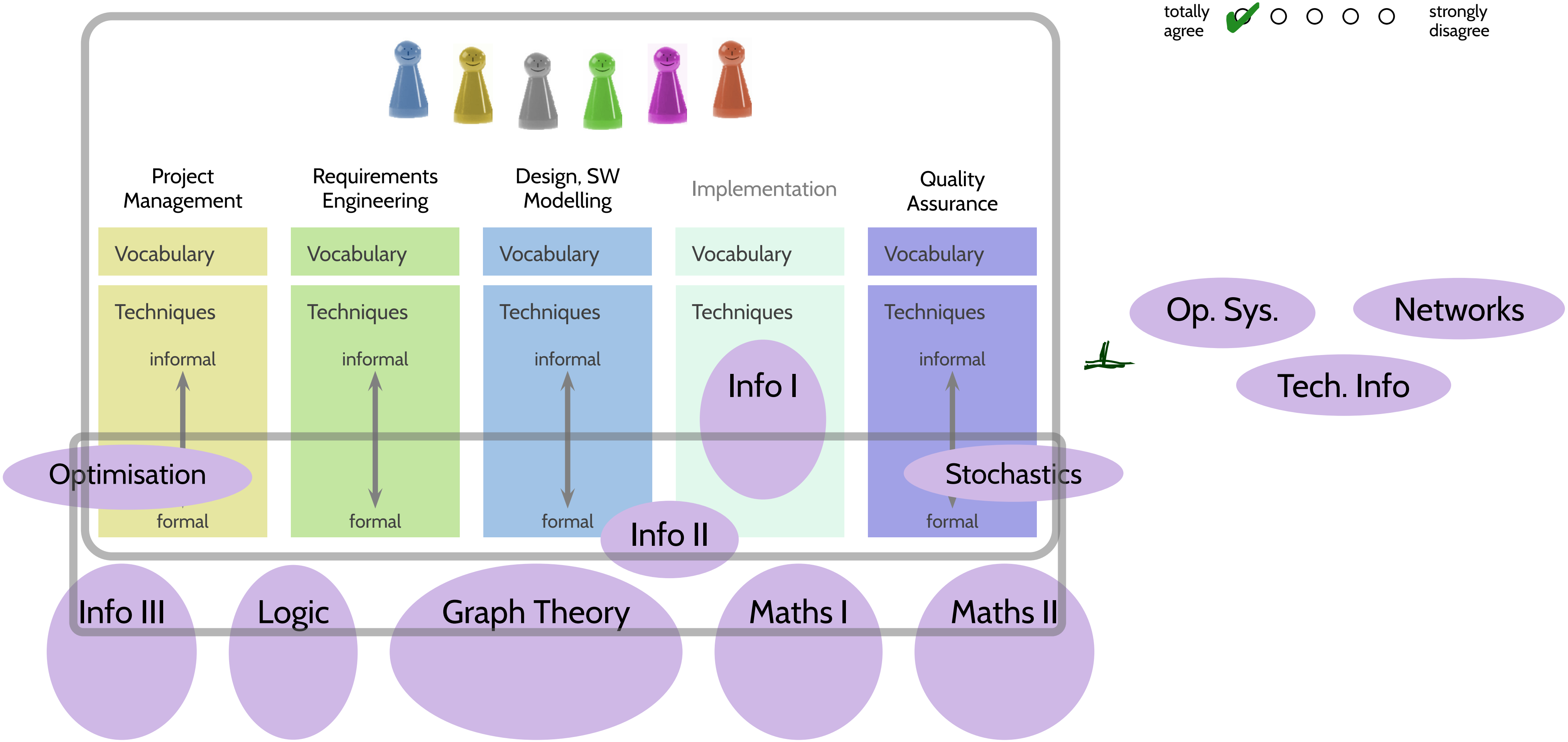
  - common reasons for non-success
- **Course**
  - Content
    - topic areas ✓
    - structure of topic areas ✓
    - emphasis: formal methods ✓
    - relation to other courses
    - literature
  - Organisation
    - lectures
    - tutorials
    - exam

Course Software-Engineering vs. Other Courses

The lecturer points out connections to other topics areas (e.g. research, praxis).

totally agree ☑ ○ ○ ○ ○ strongly disagree



Project Management

Requirements Engineering

Design, SW Modelling

Implementation

Quality Assurance

Vocabulary	Vocabulary	Vocabulary	Vocabulary	Vocabulary
Techniques informal formal	Techniques informal formal	Techniques informal formal	Techniques	Techniques informal formal

Optimisation

Info I

Info II

Stochastics

Info III

Logic

Graph Theory

Maths I

Maths II

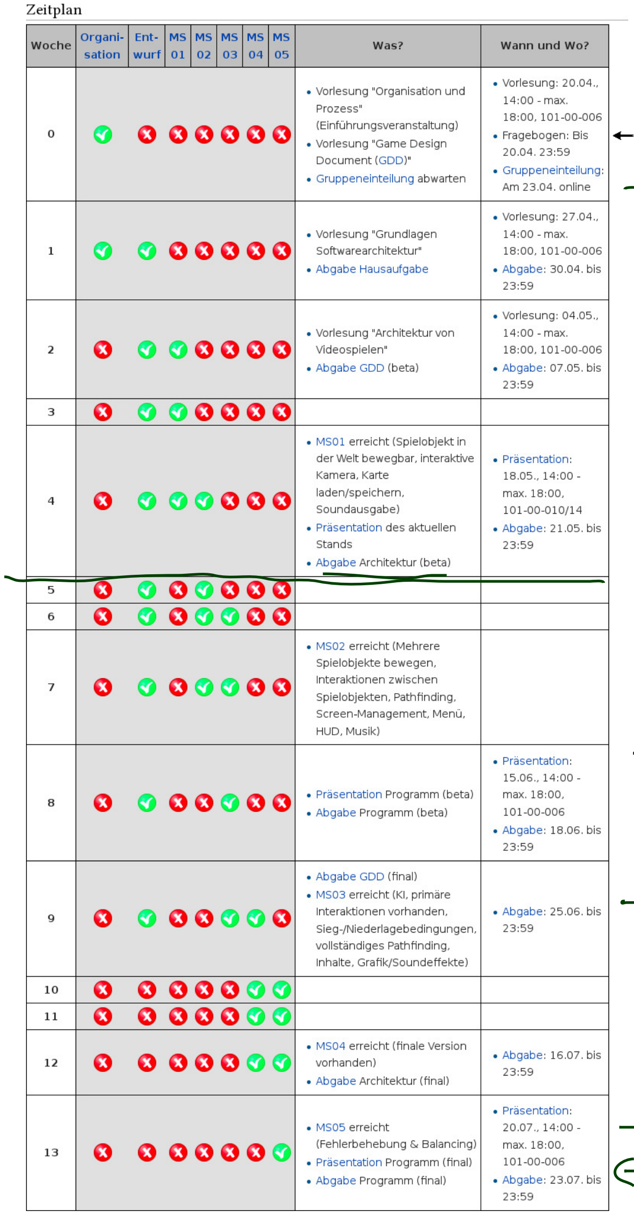
Op. Sys.

Networks

Tech. Info

Course Software-Engineering vs. Softwarepraktikum

Agreement between 'Fachschaft' and the chair for software engineering: strong(er) **coupling between both courses**.



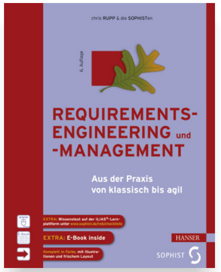
Zeitplan

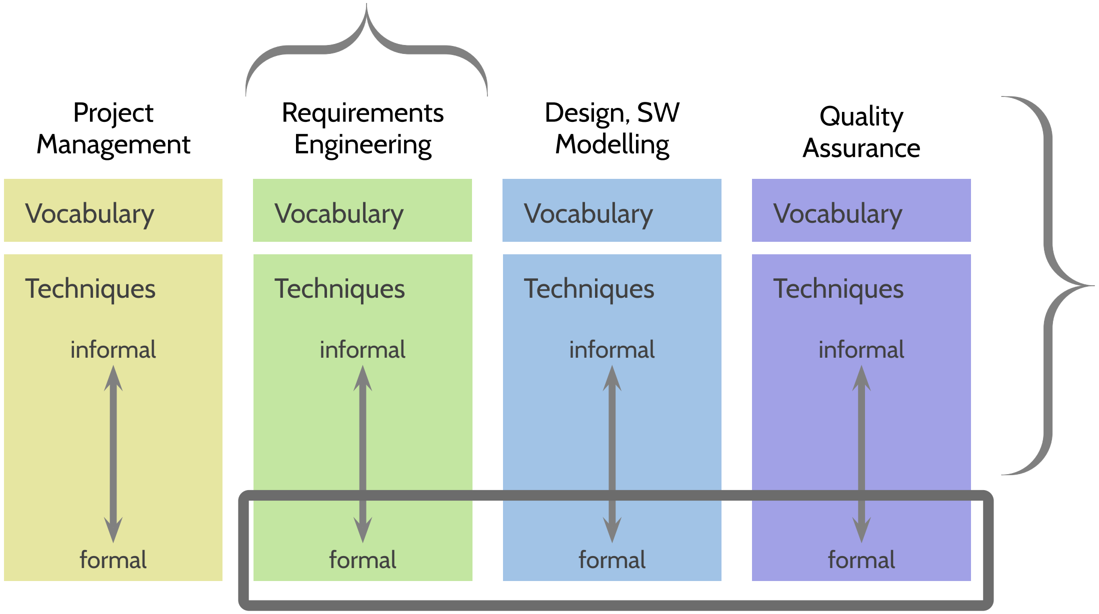
Woche	Organi-sation	Ent-wurf	MS 01	MS 02	MS 03	MS 04	MS 05	Was?	Wann und Wo?
0	✓	✗	✗	✗	✗	✗	✗	• Vorlesung "Organisation und Prozess" (Einführungsveranstaltung) • Vorlesung "Game Design Document (GDD)" • Gruppeneinteilung abwarten	• Vorlesung: 20.04., 14:00 - max. 18:00, 101-00-006 • Fragebogen: Bis 20.04. 23:59 • Gruppeneinteilung: Am 23.04. online
1	✓	✓	✗	✗	✗	✗	✗	• Vorlesung "Grundlagen Softwarearchitektur" • Abgabe Hausaufgabe	• Vorlesung: 27.04., 14:00 - max. 18:00, 101-00-006 • Abgabe: 30.04. bis 23:59
2	✗	✓	✓	✗	✗	✗	✗	• Vorlesung "Architektur von Videospielen" • Abgabe GDD (beta)	• Vorlesung: 04.05., 14:00 - max. 18:00, 101-00-006 • Abgabe: 07.05. bis 23:59
3	✗	✓	✓	✗	✗	✗	✗		
4	✗	✓	✓	✓	✗	✗	✗	• MS01 erreicht (Spielobjekt in der Welt bewegbar, interaktive Kamera, Karte laden/speichern, Soundausgabe) • Präsentation des aktuellen Stands • Abgabe Architektur (beta)	• Präsentation: 18.05., 14:00 - max. 18:00, 101-00-010/14 • Abgabe: 21.05. bis 23:59
5	✗	✓	✗	✓	✗	✗	✗		
6	✗	✓	✗	✓	✓	✗	✗		
7	✗	✓	✗	✓	✓	✗	✗	• MS02 erreicht (Mehrere Spielobjekte bewegen, Interaktionen zwischen Spielobjekten, Pathfinding, Screen-Management, Menü, HUD, Musik)	
8	✗	✓	✗	✗	✓	✗	✗	• Präsentation Programm (beta) • Abgabe Programm (beta)	• Präsentation: 15.06., 14:00 - max. 18:00, 101-00-006 • Abgabe: 18.06. bis 23:59
9	✗	✓	✗	✗	✓	✓	✗	• Abgabe GDD (final) • MS03 erreicht (KI, primäre Interaktionen vorhanden, Sieg-/Niederlagebedingungen, vollständiges Pathfinding, Inhalte, Grafik/Soundeffekte)	• Abgabe: 25.06. bis 23:59
10	✗	✗	✗	✗	✗	✓	✓		
11	✗	✗	✗	✗	✗	✓	✓		
12	✗	✗	✗	✗	✗	✓	✓	• MS04 erreicht (finale Version vorhanden) • Abgabe Architektur (final)	• Abgabe: 16.07. bis 23:59
13	✗	✗	✗	✗	✗	✗	✓	• MS05 erreicht (Fehlerbehebung & Balancing) • Präsentation Programm (final) • Abgabe Programm (final)	• Präsentation: 20.07., 14:00 - max. 18:00, 101-00-006 • Abgabe: 23.07. bis 23:59

Bsp.

Introduction	L 1:	24.4., Mon
Scales, Metrics,	L 2:	27.4., Thu
	-	1.5., Mon
	T 1:	4.5., Thu
Costs,	L 3:	8.5., Mon
Development	L 4:	11.5., Thu
Process	L 5:	15.5., Mon
	T 2:	18.5., Thu
	L 6:	22.5., Mon
	-	25.5., Thu
Requirements	L 7:	29.5., Mon
Engineering	L 8:	1.6., Thu
	-	5.6., Mon
	-	8.6., Thu
	T 3:	12.6., Mon
	-	15.6., Thu
	L 9:	19.6., Mon
	L10:	22.6., Thu
Arch. & Design	L 11:	26.6., Mon
	T 4:	29.6., Thu
	L12:	3.7., Mon
Software	L13:	6.7., Thu
Modelling	L14:	10.7., Mon
	T 5:	13.7., Thu
Patterns	L15:	17.7., Mon
QA (Testing,	L16:	20.7., Thu
Formal Verif.)	L 17:	24.7., Mon
Wrap-Up	L18:	27.7., Thu

Literature





Project Management	Requirements Engineering	Design, SW Modelling	Quality Assurance
Vocabulary	Vocabulary	Vocabulary	Vocabulary
Techniques informal formal	Techniques informal formal	Techniques informal formal	Techniques informal formal

…more on the course homepage.

Any Questions So Far?

Course: Organisation

Content

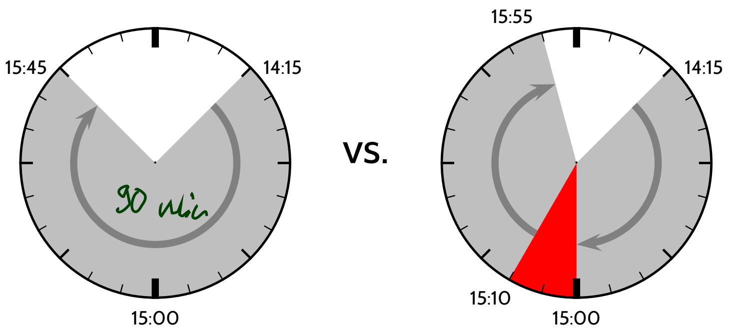
- **Software, Engineering, Software Engineering**
- **Successful Software Development**
  - working definition: success
  - unsuccessful software development exists
  - common reasons for non-success
- **Course**
  - Content
    - topic areas
    - structure of topic areas
    - emphasis: formal methods
    - relation to other courses
    - literature
  - Organisation
    - lectures
    - tutorials
    - exam

Organisation: Lectures

- **Homepage:** `http://swt.informatik.uni-freiburg.de/teaching/SS2017/swtvl`
- **Course language:** **German** (since we are in an odd year)
- **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. 2 days delay (cf. link on **homepage**)
- **Schedule:** topic areas à three 90 min. lectures, one 90 min. tutorial (with exceptions)

- **Interaction:** absence often moaned; but **it takes two**, so please ask/comment immediately.
- **Questions/comments:**
  - **“online”**: ask immediately or in the break
  - **“offline”**: (i) try to solve yourself
    (ii) discuss with colleagues
    (iii) a) **Exercises**: ILIAS (group) forum, contact tutor
    b) **Everything else**: contact lecturer (cf. homepage)
    or just drop by: Building 52, Room 00-020

- **Break:** we'll have a **5-10 min. break** in the middle of each lecture (from now on), unless a majority objects now.



Organisation: Exercises & Tutorials

- **Schedule/Submission:**
  - exercises **online** (**homepage** and **ILIAS**) with first lecture of a block,
  - **early submission** 24h before tutorial (usually Wednesday, 12:00, local time),
  - **regular submission** right before tutorial (usually Thursday, 12:00, local time).
  - please submit **electronically** via **ILIAS**; paper submissions are **tolerated**
  - should work in teams of **approx. 3**, clearly give **names** on submission

20%

- **Grading system:** "**most complicated grading system ever**"
  - **Admission points** (good-will rating, upper bound)
    ("reasonable grading given student's knowledge **before** tutorial")
  - **Exam-like points** (evil rating, lower bound)
    ("reasonable grading given student's knowledge **after** tutorial")

20% **bonus** for **early** submission.

- **Tutorial:** **Three groups** (central assignment), hosted by tutor.
  - Starting from discussion of the early submissions (anonymous), develop **one** good proposal together,
  - tutorial notes provided via **ILIAS**.

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Requirements Engineering	L 7:	29.5., Mon
	L 8:	1.6., Thu
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	-	8.6., Thu
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	L 17:	24.7., Mon
Wrap-Up	L18:	27.7., Thu

Organisation: Exam

- **Exam Admission:**

  Achieving 50% of the **regular admission points** in total
  is sufficient for admission to exam.

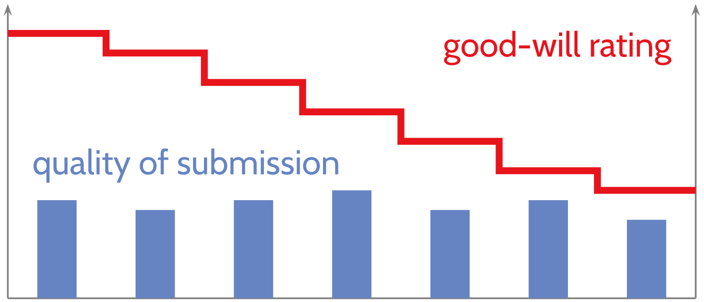
  10 regular admission points on sheets 0 and 1, and
  20 regular admission points on exercise sheets 2–6

  → 120 **regular** admission points for 100%.

  ↳ 50% - 60

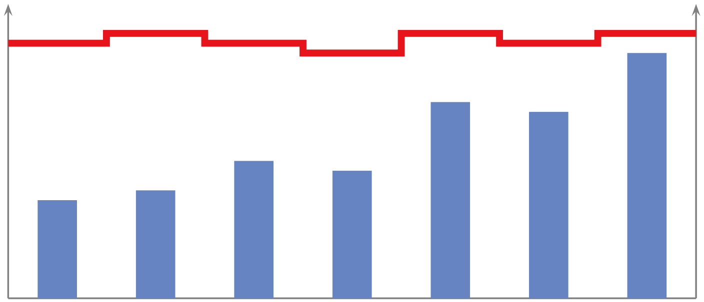
- **Exam Form:**
  - **written** exam
  - date, time, place: tba
  - permitted exam aids: one A4 paper (max. 21 x 29.7 x 1 mm) of notes, max. two sides inscribed
  - scores from the exercises **do not** contribute to the final grade.
  - example exam available on **ILIAS**

One Last Word on The Exercises…



I have improved my skills in scientific problem solving.

totally agree ○ ○ ○ ○ ☒ strongly disagree



I have improved my skills in scientific problem solving.

totally agree ☑ ○ ○ ○ ○ strongly disagree

- Every exercise task is **a tiny little scientific work**!
- Basic rule for high quality submissions:
  - **rephrase** the task in your own words,
  - **state** your solution,
  - **convince** your tutor of (at best: prove) the correctness of your solution.

Tell Them What You've Told Them. . .

- **Basic vocabulary**:
  - software, engineering, software engineering,
  - customer, developer, user,
  - successful software development

  → **note:** some definitions are neither formal nor universally agreed
- **(Fun) fact**: software development is not always successful
- **Basic activities of (software) engineering**:
  - gather requirements,
  - design,
  - implementation,
  - quality assurance,
  - project management

  → motivates content of the course – for the case of software
- **Formal (vs. informal) methods**
  - avoid misunderstandings,
  - enable objective, tool-based assessment

→ **note:** still, humans are at the heart of software engineering.

- **Course content and organisation**

Any (More) Questions?

References

References

Bauer, F. L. (1971). Software engineering. In *IFIP Congress (1)*, pages 530–538.

Buschermöhle, R., Eekhoff, H., and Josko, B. (2006). success – Erfolgs- und Misserfolgsfaktoren bei der Durchführung von Hard- und Softwareentwicklungsprojekten in Deutschland. Technical Report VSEK/55/D.

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Parnas, D. L. (2011). Software engineering: Multi-person development of multi-version programs. In Jones, C. B. et al., editors, *Dependable and Historic Computing*, volume 6875 of *LNCS*, pages 413–427. Springer.