# *Softwaretechnik / Software-Engineering*

# *Lecture 1: Introduction*

*2017-04-24*

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Albert-Ludwigs-Universität Freiburg, Germany

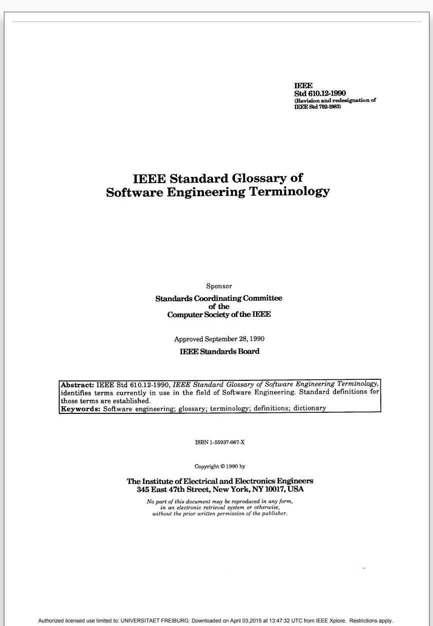


## *Content*

- **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

# 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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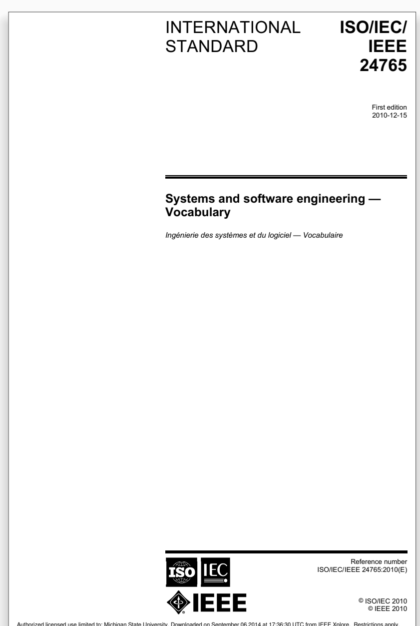

INTERNATIONAL STANDARD

**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)

© ISO/IEC 2010
© IEEE 2010

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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**. **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** –

(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)**

fff.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… ing to soft…

(2) The stu…

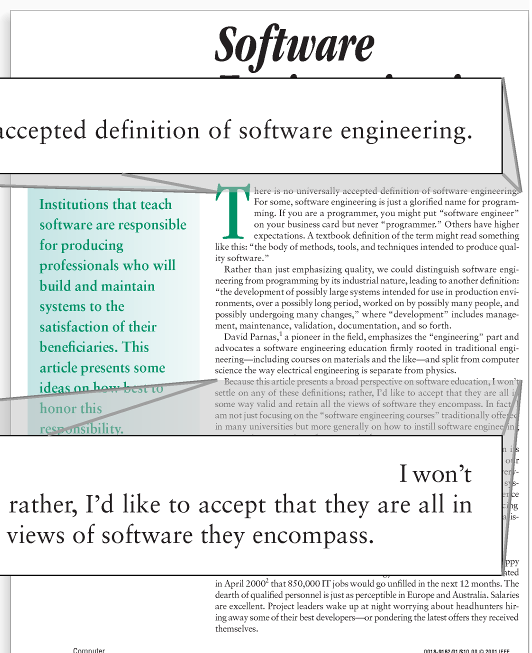
**Software Engineering** – **1.** the systematic application of scientific and technological knowledge, methods, and experience to the design, implementation, testing, and documentation of software.

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

**Software** … version Pr…

**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)**

There is no universally accepted definition of software engineering.



*Software Engineering*

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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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.

# The course's working definition of 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)

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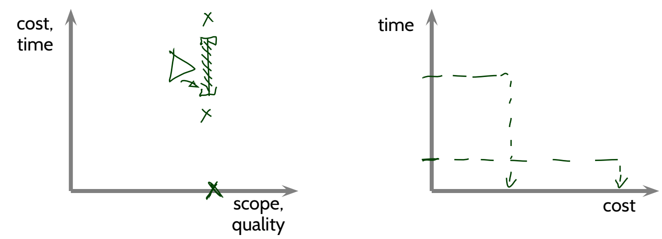
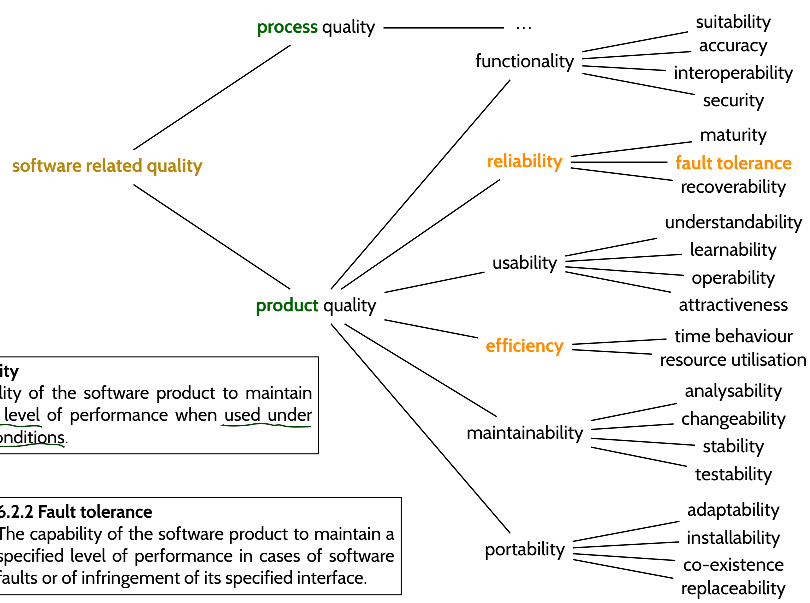







# "software that is reliable and works efficiently" (Bauer, 1971)

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




**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.

# “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
    - 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

**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.
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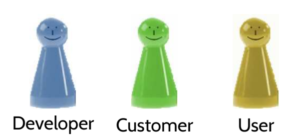
# *Successful Software Development*



## *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

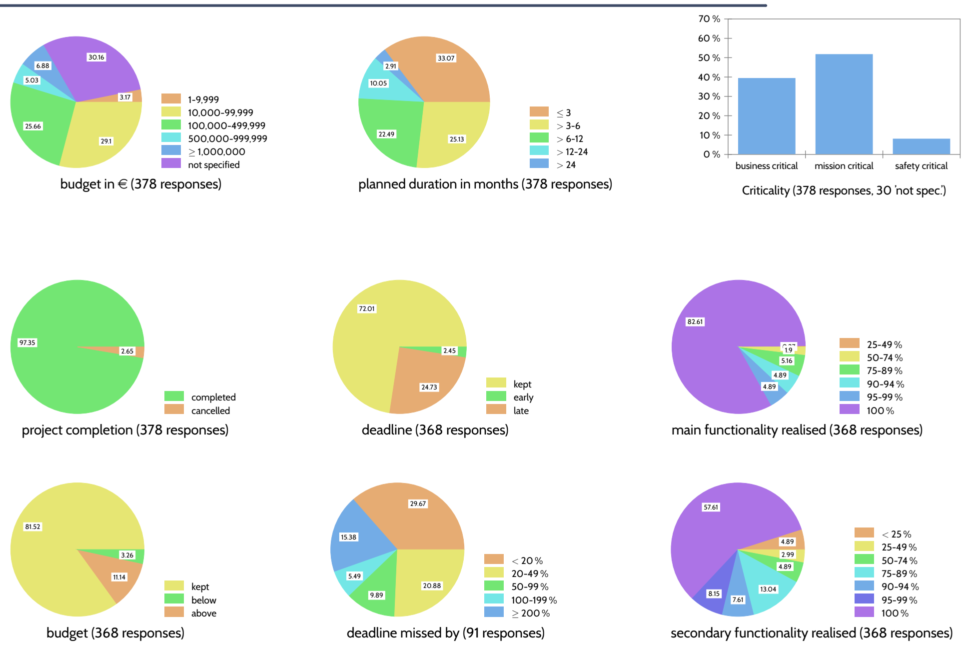
2006

**Autoren:**
Ralf Buschermöhle
Heike Eekhoff
Bernhard Josko

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

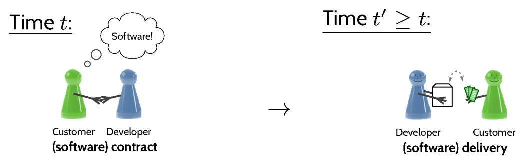


# *Some Empirical Findings* (*Buschermöhle et al.* (*2006*))

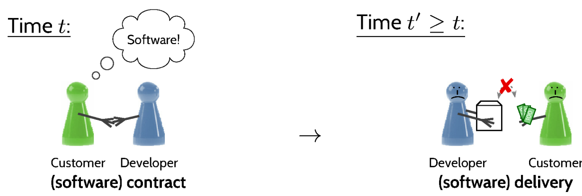


# *A Closer Look*

- **Successful:**

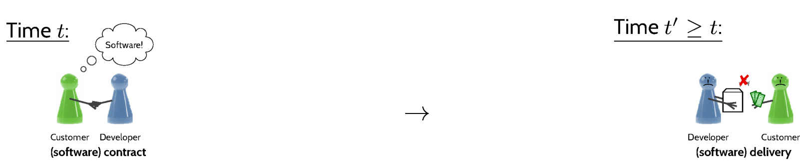



- **Unsuccessful**:




**What might've gone wrong?**






... 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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- How to **schedule software development activities** properly?

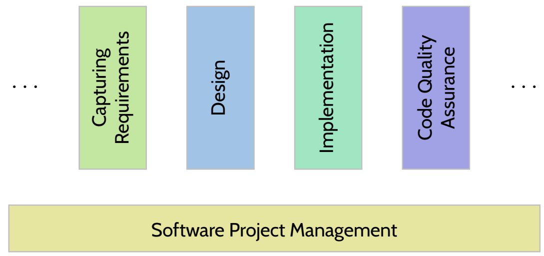
What are procedures to **systematically** avoid certain mistakes or costs in **software development**?

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 |
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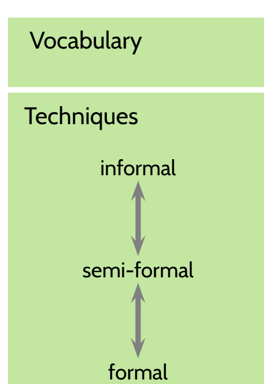
| | T 4: | 29.6., Thu |
| Software Modelling | L 12: | 3.7., Mon |
| | L 13: | 6.7., Thu |
| | L 14: | 10.7., Mon |
| | T 5: | 13.7., Thu |
| Patterns | L 15: | 17.7., Mon |
| QA (Testing, Formal Verif.) | L 16: | 20.7., Thu |
| | L 17: | 24.7., Mon |
| Wrap-Up | ~~L18:~~ Tut 6 | 27.7., Thu |



# Structure of Topic Areas

**Example**: Requirements Engineering



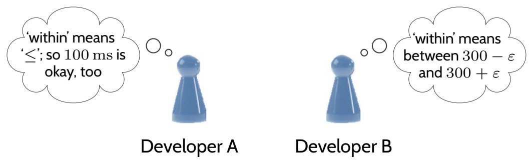

e.g. consistent, complete, tacit, etc.

**Example**: Requirements Engineering, Airbag Controller



**Requirement**:

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




vs.

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

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

$\leq$

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





## *Structure of Topic Areas*

**Example**: Requirements Engineering

| | | |
|---|---|---|
| | **Vocabulary** | e.g. consistent, complete, tacit, etc. |
| | **Techniques** | |
| | informal | |
| | ↕ | |
| | semi-formal | |
| | ↕ | |
| | formal | |

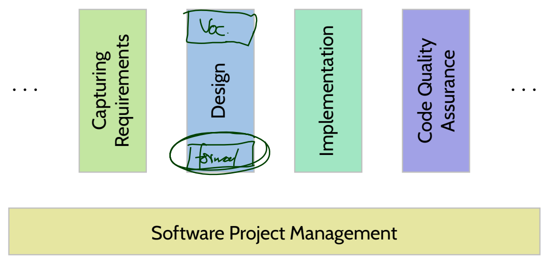


## *Structure of Topic Areas*

**Example**: Requirements Engineering

| | | |
|---|---|---|
| | **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 $\langle$**crash**$\rangle$ at $t$…" |
| | semi-formal | |
| | ↕ | |
| **Decision Tables**<br>**Live Sequence Charts** | formal | e.g. "$\forall\, t, t' \in \mathit{Time} \bullet \ldots$" |

# Course Content (Tentative)

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# Content

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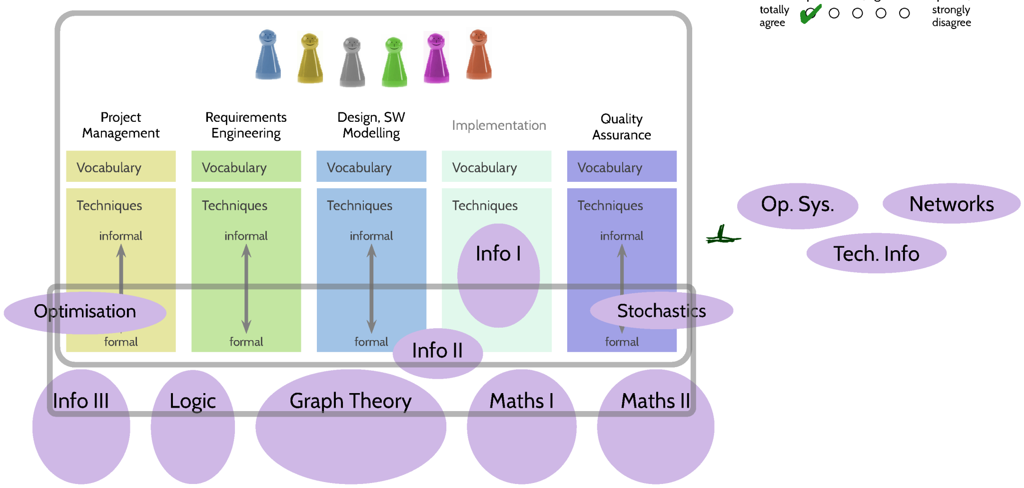
- **Successful Software Development**
  - working definition: success
  - unsuccessful software development exists
  - common reasons for non-success
- **Course**
  - Content
    - topic areas ✓
    - structure of topic areas ✓
    - emphasis: formal methods ✓
    - relation to other courses
    - literature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

# Course Software-Engineering vs. Other Courses

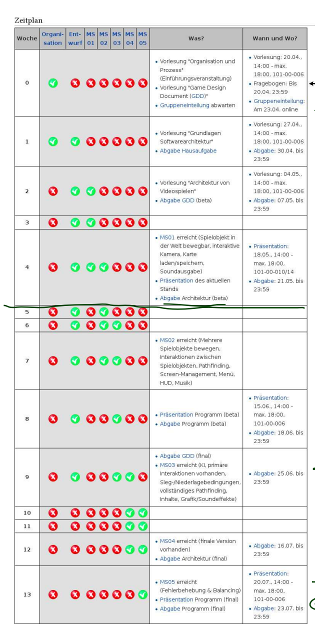
The lecturer points out connections to other topics areas (e.g. research, praxis).
totally agree ○ ○ ○ ○ ○ strongly disagree






# Course Software-Engineering vs. Softwarepraktikum

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



Bsp.

| | | |
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| Wrap-Up | L18: | 27.7., Thu |

# *Literature*


…more on the course homepage.



## *Any Questions So Far?*

## *Course: Organisation*





## *Content*

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    - lectures
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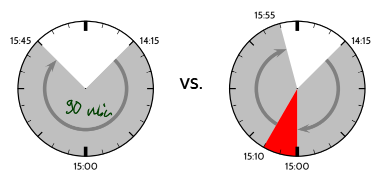
    - exam

# 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), 20%
  - 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
- **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.

| | | |
|---|---|---|
| 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.) | L17: | 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...*


- 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

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IEEE (1990). *IEEE Standard Glossary of Software Engineering Terminology*. Std 610.12-1990.

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