Softwaretechnik / Software-Engineering

Lecture 1: Introduction

2019-04-25

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Albert-Ludwigs-Universität Freiburg, Germany

Engineering, Software, Software Engineering

Engineering

Engineering – The **application** of a **systematic**, **disciplined**, **quantifiable** approach to structures, machines, products, systems, or processes. **IEEE 610.12** (1990)

Engineering – is the **application of** knowledge in the form of **science**, **mathematics**, and **empirical evidence**,

to the innovation, design, construction, operation and maintenance

of structures, machines, materials, software, devices, systems, processes, and organizations. **Wikipedia**

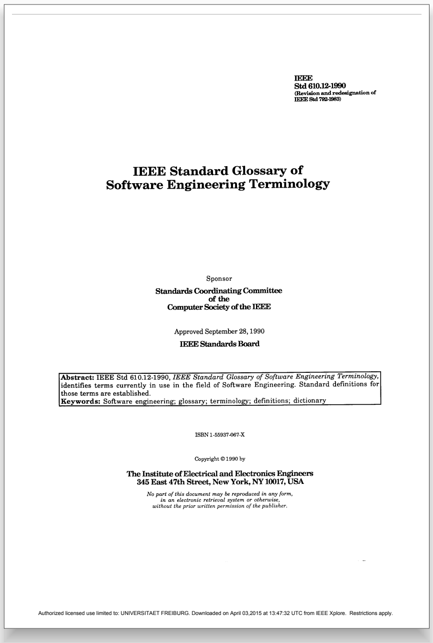
Non-Engineering vs. Engineering

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

(Ludewig and Lichter, 2013)

Content

- **Terminology** ✓
  - **Engineering**, **Software**, **Software Engineering**
- **Motivation: 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



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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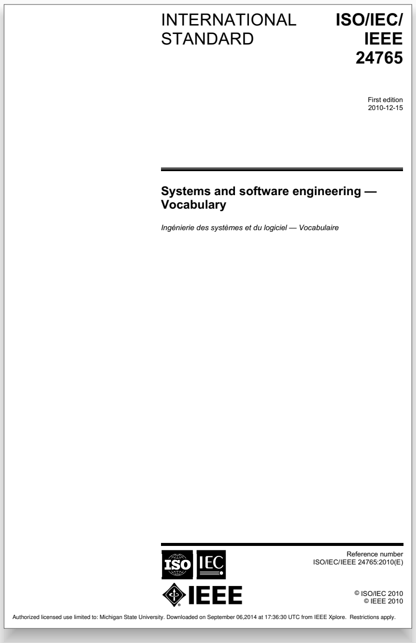

INTERNATIONAL
STANDARD

ISO/IEC/
IEEE
24765

First edition
2010-12-15

Systems and software engineering —
Vocabulary

Ingénierie des systèmes et du logiciel — Vocabulaire

ISO IEC
IEEE

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. [...]

cf. **application software**

NOTE: includes firmware, documentation, data, and execution control statements. **IEEE 24765** (2010)

Software Engineering — This Course's Working Definition

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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Successful Software Development

When is Software Development Successful?

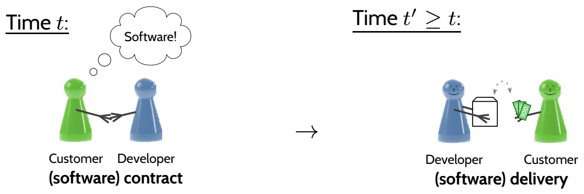
A software development project is **successful**

if and only if

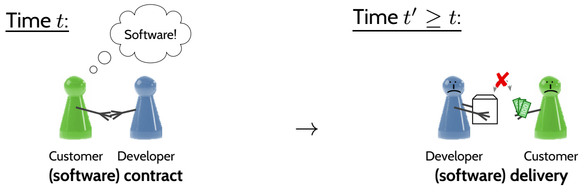
developer, customer, and user are happy with the result at the end of the project.

Which Result? Which Project?

- **Successful:**



- **Unsuccessful**:



Does 'uncussessful' happen? **If yes: How can we avoid it?**

Is Software Development Always Successful?

success

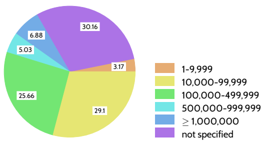
Erfolgs- und Misserfolgsfaktoren bei der Durchführung von Hard- und Softwareentwicklungsprojekten in Deutschland

2006

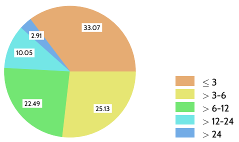
Autoren:
Ralf Buschermöhle
Heike Eekhoff
Bernhard Josko

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

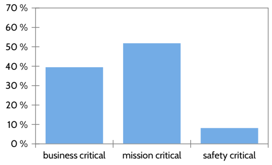
Some Empirical Findings (*Buschermöhle et al. (2006)*)



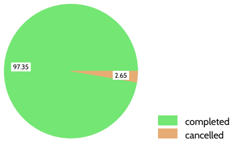
budget in € (378 responses)



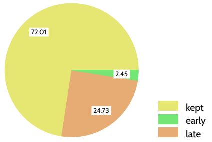
planned duration in months (378 responses)



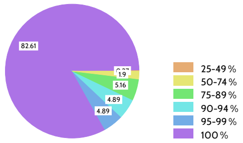
Criticality (378 responses, 30 'not spec.')



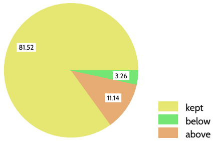
project completion (378 responses)



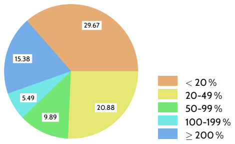
deadline (368 responses)



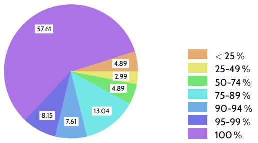
main functionality realised (368 responses)



budget (368 responses)

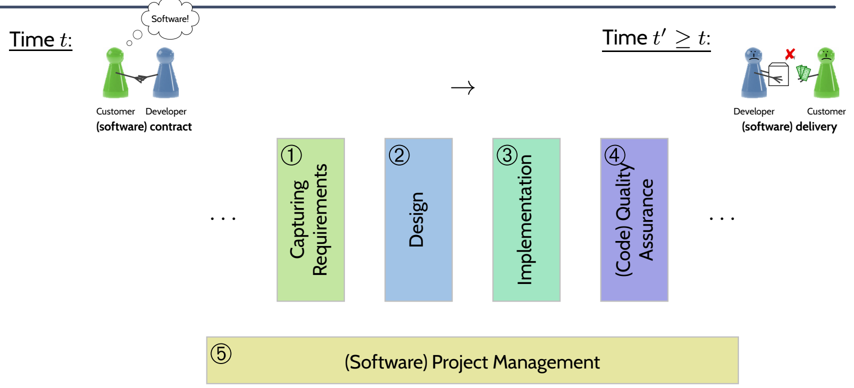


deadline missed by (91 responses)



secondary functionality realised (368 responses)

Causes for Unsuccessful Projects: First Approximation


Time t:

(software) contract

→

Time $t' \geq t$:

(software) delivery

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

⑤ (Software) Project Management

Possible causes (by phase):

①	②	③	④	⑤	
✗	✓	✓	✓	✓	e.g. misunderstanding of requirements; contradicting requirements
✓	✗	✓	✓	✓	e.g. non-scalable design; feature forgotten; designer misunderstood requirement
✓	✓	✗	✓	✓	e.g. programmer misread design specification; simple programming mistake
✓	✓	✓	✗	✓	e.g. wrongly conducted test; tester misunderstood requirement
✓	✓	✓	✓	✗	e.g. wrong cost estimation; bad scheduling; team member was not aware of responsibilities

Causes for Unsuccessful Projects: Once Again

①	②	③	④	⑤	
✗	✓	✓	✓	✓	e.g. misunderstanding of requirements; contradicting requirements
✓	✗	✓	✓	✓	e.g. non-scalable design; feature forgotten; designer misunderstood requirement
✓	✓	✗	✓	✓	e.g. programmer misread design specification; simple programming mistake
✓	✓	✓	✗	✓	e.g. wrongly conducted test; tester misunderstood requirement
✓	✓	✓	✓	✗	e.g. wrong cost estimation; bad scheduling; team member was not aware of responsibilities

And that's this course:

- Discuss typical Software-Engineering problems,
  - like communication, misunderstandings, etc.
  - like technical errors, quality issues, etc.
- and (state-of-the-art) generic mitigation approaches
  - like precise description languages (e.g. for requirements),
  - like analysis techniques (e.g. for program correctness),

  by development phase (Requirements, Design, etc.).

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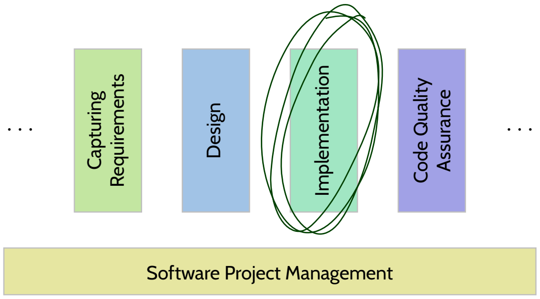
Course: Content

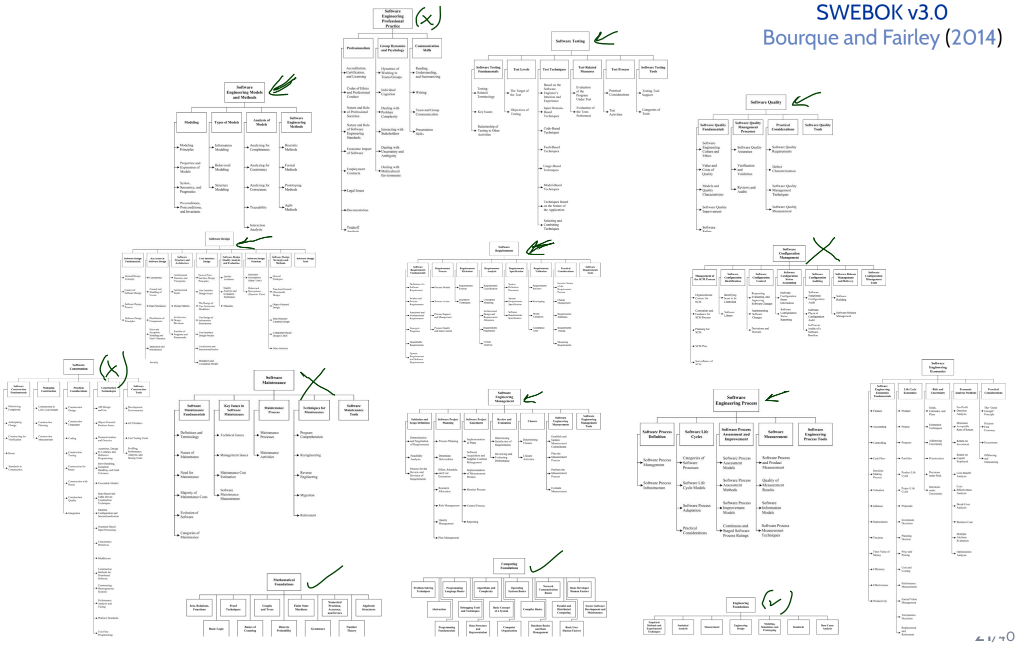
Course Content (Tentative)



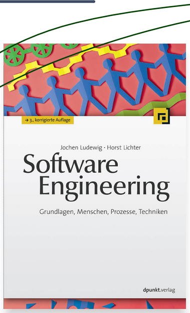
	-	22.4., Mon
Introduction	L 1:	25.4., Thu
Metrics, Costs,	L 2:	29.4., Mon
Development	L 3:	2.5., Thu
Process	L 4:	6.5., Mon
	T 1:	9.5., Thu
Requirements Engineering	L 5:	13.5., Mon
	L 6:	16.5., Thu
	L 7:	20.5., Mon
	T 2:	23.5., Thu
	L 8:	27.5., Mon
	-	30.5., Thu
	L 9:	3.6., Mon
	T 3:	6.6., Thu
	-	10.6., Mon
	-	13.6., Thu
Arch. & Design,	L10:	17.6., Mon
	-	20.6., Thu
Software-	L 11:	24.6., Mon
	T 4:	27.6., Thu
Modelling,	L12:	1.7., Mon
Patterns	L13:	4.6., Thu
QA	L14:	8.7., Mon
	T 5:	11.7., Thu
(Testing, Formal	L15:	15.7., Mon
Verification)	L16:	18.7., Thu
Wrap-Up	L 17:	22.7., Mon
	T 6:	25.7., Thu

http://www.antarctica.gov.au (Janet Shelley)

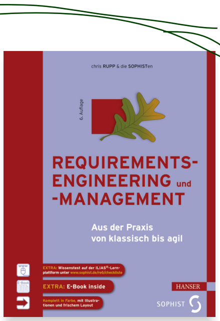
SWEBOK v3.0
Bourque and Fairley (2014)


Software Engineering Professional Practice
Software Testing
Software Engineering Models and Methods
Software Quality
Software Design
Software Requirements
Software Configuration Management
Software Construction
Software Maintenance
Software Engineering Management
Software Engineering Process
Software Engineering Economics
Mathematical Foundations
Computing Foundations
Engineering Foundations

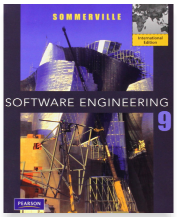
Literature (Preview)



+ 3., korrigierte Auflage
Jochen Ludewig · Horst Lichter
Software Engineering
Grundlagen, Menschen, Prozesse, Techniken
dpunkt.verlag



chris RUPP & die SOPHISTen
6. Auflage
REQUIREMENTS-ENGINEERING und -MANAGEMENT
Aus der Praxis von klassisch bis agil
EXTRA: Wissenstest auf der ILIAS®-Lernplattform unter www.sophist.de/re6/checkliste
EXTRA: E-Book inside
Komplett in Farbe, mit Illustrationen und frischem Layout
HANSER
SOPHIST



SOMMERVILLE
International Edition
SOFTWARE ENGINEERING 9
PEARSON

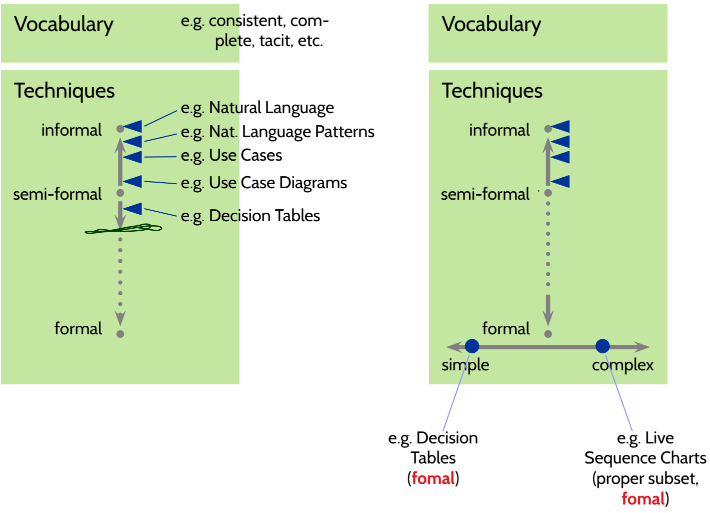
Helmut Balzert
Lehrbuch der Softwaretechnik
Basiskonzepte und Requirements Engineering
3. Auflage
Lehrbücher der Informatik
Spektrum

Helmut Balzert
Lehrbuch der Softwaretechnik
Entwurf, Implementierung, Installation und Betrieb
3. Auflage
Lehrbücher der Informatik
Spektrum

Structure of Topic Areas *(Example: Requirements Eng.)*

Sommerville (2010), Balzert (2009), Ludewig and Lichter (2013), etc.:

This course:



Vocabulary

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

Techniques

informal

semi-formal

formal

e.g. Natural Language

e.g. Nat. Language Patterns

e.g. Use Cases

e.g. Use Case Diagrams

e.g. Decision Tables

Vocabulary

Techniques

informal

semi-formal

formal

simple

complex

e.g. Decision Tables (fomal)

e.g. Live Sequence Charts (proper subset, fomal)

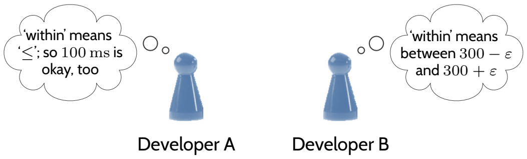
Excursion: Informal vs. Formal Techniques

Example: Requirements Engineering, Airbag Controller

DaimlerChrysler AG, CC BY-SA 3.0

Requirement specification, informal:

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


'within' means '$\leq$'; so $100\,\mathrm{ms}$ is okay, too
'within' means between $300-\varepsilon$ and $300+\varepsilon$
Developer A
Developer B

Requirement specification, formal:

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

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

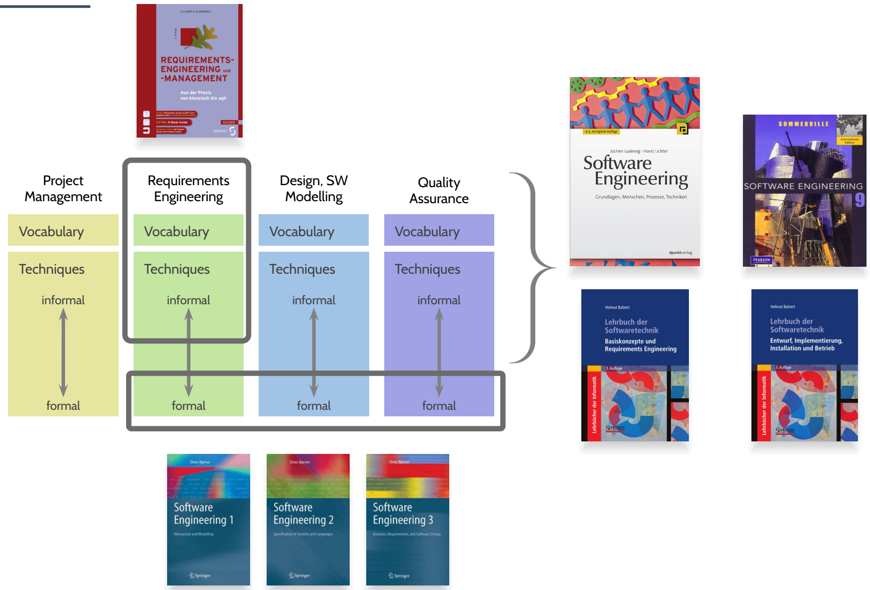
$\to$ no more misunderstandings, sometimes **tools** can **objectively** decide: requirement satisfied yes/no.

Sign says:

Welcome to **formal methods paradise**:

- No more **misunderstandings**!
- Let **tools** decide things **objectively**!

Literature



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

REQUIREMENTS-ENGINEERING und -MANAGEMENT
Software Engineering
SOMMERVILLE
SOFTWARE ENGINEERING 9
Lehrbuch der Softwaretechnik
Basiskonzepte und Requirements Engineering
Lehrbuch der Softwaretechnik
Entwurf, Implementierung, Installation und Betrieb
Software Engineering 1
Software Engineering 2
Software Engineering 3

…more on the course homepage.

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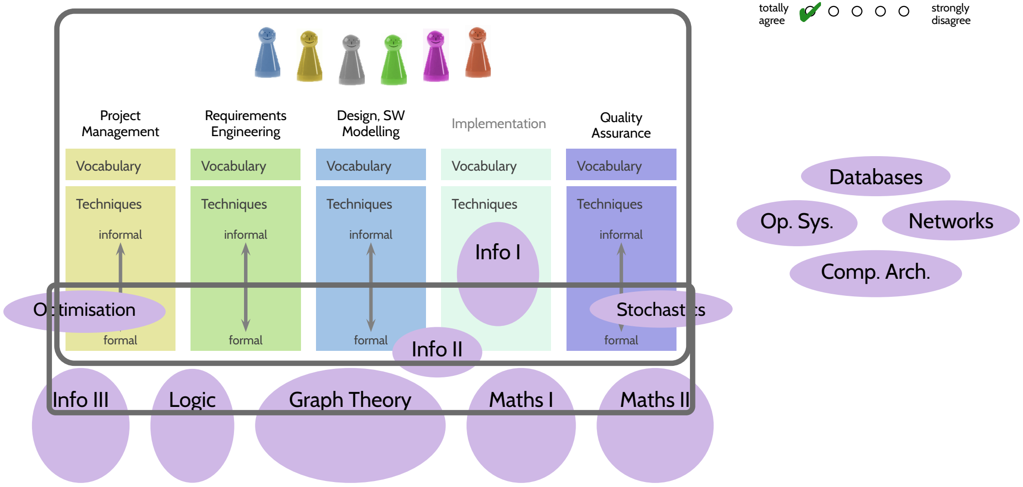
Course Software-Engineering vs. Other Courses

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



Project Management | Requirements Engineering | Design, SW Modelling | Implementation | Quality Assurance

Vocabulary | Vocabulary | Vocabulary | Vocabulary | Vocabulary

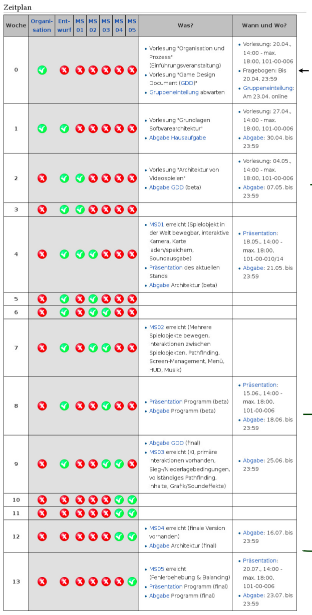
Techniques | Techniques | Techniques | Techniques | Techniques

informal | informal | informal | informal

formal | formal | formal | formal

Course Software-Engineering vs. Softwarepraktikum

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



Zeitplan

Woche	Organisation	Entwurf	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.

Bsp.

Bsp.

	-	22.4.,	Mon
Introduction	L 1:	25.4.,	Thu
Metrics, Costs, Development Process	L 2:	29.4.,	Mon
	L 3:	2.5.,	Thu
	L 4:	6.5.,	Mon
	T 1:	9.5.,	Thu
Requirements Engineering	L 5:	13.5.,	Mon
	L 6:	16.5.,	Thu
	L 7:	20.5.,	Mon
	T 2:	23.5.,	Thu
	L 8:	27.5.,	Mon
	-	30.5.,	Thu
	L 9:	3.6.,	Mon
	T 3:	6.6.,	Thu
	-	10.6.,	Mon
	-	13.6.,	Thu
Arch. & Design,	L10:	17.6.,	Mon
	-	20.6.,	Thu
Software-	L 11:	24.6.,	Mon
	T 4:	27.6.,	Thu
Modelling, Patterns	L 12:	1.7.,	Mon
	L 13:	4.6.,	Thu
QA	L 14:	8.7.,	Mon
	T 5:	11.7.,	Thu
(Testing, Formal Verification)	L 15:	15.7.,	Mon
	L 16:	18.7.,	Thu
Wrap-Up	L 17:	22.7.,	Mon
	T 6:	25.7.,	Thu

Any Questions So Far?

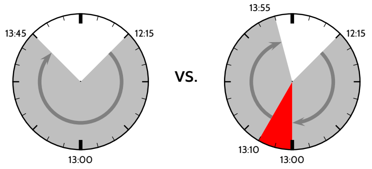
Content

- **Terminology**
  - **Engineering**, **Software**, **Software Engineering**
- **Motivation: 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: Organisation

Organisation: Lectures

- **Homepage:** `http://swt.informatik.uni-freiburg.de/teaching/SS2019/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
  - should work in teams of 2–3 people, clearly give names on submission

	-	22.4., Mon
Introduction	L 1:	25.4., Thu
Metrics, Costs, Development Process	L 2:	29.4., Mon
	L 3:	2.5., Thu
	L 4:	6.5., Mon
	T 1:	9.5., Thu
Requirements Engineering	L 5:	13.5., Mon
	L 6:	16.5., Thu
	L 7:	20.5., Mon
	T 2:	23.5., Thu
	L 8:	27.5., Mon
	-	30.5., Thu
	L 9:	3.6., Mon
	T 3:	6.6., Thu
	-	10.6., Mon
	-	13.6., Thu
Arch. & Design,	L10:	17.6., Mon
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Organisation: Exercises & Tutorials

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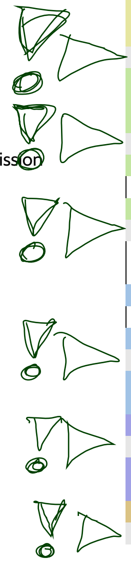
  - exercises **online** (**homepage** and **ILIAS**) with first lecture of a block,
  - **early submission** 24h before tutorial (usually Wednesday, 12:00, local time),
  - **regular submission** right before tutorial (usually Thursday, 12:00, local time).
  - please submit **electronically** via **ILIAS**
  - should work in teams of **2–3 people**, 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")

  10% **bonus** for **early** submission.
- **Tutorial:** **Four groups** (central assignment), hosted by tutor.
  - Starting from discussion of the early submissions (anonymous), develop **one** good proposal together,
  - tutorial notes provided via **ILIAS**.



	-	22.4., Mon
Introduction	L 1:	25.4., Thu
Metrics, Costs,	L 2:	29.4., Mon
Development	L 3:	2.5., Thu
Process	L 4:	6.5., Mon
	T 1:	9.5., Thu
	L 5:	13.5., Mon
Requirements	L 6:	16.5., Thu
Engineering	L 7:	20.5., Mon
	T 2:	23.5., Thu
	L 8:	27.5., Mon
	-	30.5., Thu
	L 9:	3.6., Mon
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Verification)	L16:	18.7., Thu
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– 1 – 2019-04-25 – Sorgatut –

Organisation: Exam

- **Exam Admission:**

  Achieving **50%** of the **regular admission points** of Exercise Sheets 0–3 and **50%** of the **regular admission points** of Exercise Sheets 4–6 is sufficient for admission to exam.

  5 + 15 regular admission points on sheets 0 and 1, and 20 regular admission points on exercise sheets 2–6

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

  (plus plenty of **admission bonus points** in both blocks, 0–3 and 4–6)
- **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**

– 1 – 2019-04-25 – Sorgexam –

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** yourself and your tutor of the correctness of your solution (at best: prove it).

Example:

Task: What is the length of the longest line inside the square with side length $a = 19.1$?

Submission A:

27

Submission B:

The length of the longest straight line fully inside the square with side length $a = 19.1$ is 27.01 (rounded).

The longest straight line inside the square is the diagonal. By Pythagoras, its length is $\sqrt{a^2 + a^2}$. Inserting $a = 19.1$ yields 27.01 (rounded).

One Last Word on The Exercises...

- Every exercise task is **a tiny little scientific work**!
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Example:

Task: What is the length of the longest line inside the square with side length $a = 19.1$?

Submission A:

✗

Submission B: ✓

The length of the longest straight line fully inside the square with side length $a = 19.1$ is 27.01 (rounded).

The longest straight line inside the square is the diagonal. By Pythagoras, its length is $\sqrt{a^2 + a^2}$. Inserting $a = 19.1$ yields 27.01 (rounded).

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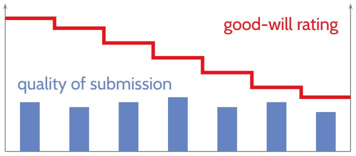
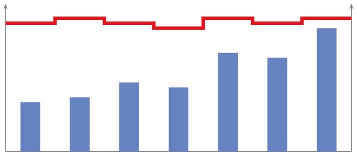


I have improved my skills in scientific problem solving.

totally agree ○ ○ ○ ○ ☒ strongly disagree



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totally agree ✓ ○ ○ ○ ○ strongly disagree

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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