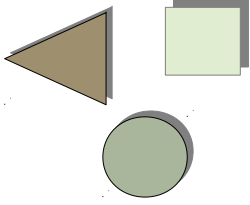


11. The OI*SDR Research Process - From the Idea to the Text of a Paper or Bachelor/Master/PhD Thesis

1

Prof. Dr. Uwe Aßmann
Softwaretechnologie
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Technische Universität Dresden
2013-1.1, 27.11.13
<http://st.inf.tu-dresden.de/acse>

Speak OI*SDR as Oyster



- 1) The OI*SDR Research Processes
- 2) Orientation: From the idea to the research question
- 3) Information Gathering
- 4) Diffusion
 - 1) Structuring
 - 2) Drafting and Revising for Textification, Talkification and Demos



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Literature

2

- ▶ [Krumbiegel] Helga Esselborn-Krumbiegel. Von der Idee zum Text. Eine Anleitung zum Know-how-schaftlichen Schreiben:
 - 3. überarbeitete Auflage, 2008
 - Leiterin des Schreibzentrums in Köln <http://schreibzentrum-koeln.de/>
 - Angegliedert am Studentenwerk Köln
- ▶ Matti Tedre. Know your discipline: Teaching the philosophy of computer science. Journal of Information Technology Education (JITE), 6:105-122, 2007.
- ▶ Prof. Mary Shaw from CMU has a lot of good material on Software Engineering Research. <http://spoke.compose.cs.cmu.edu/serO4/>
- ▶ The English portal for students <http://www.studentastic.co.uk/>
- ▶ <http://www.studentastic.co.uk/ten-steps-for-better-research-university.html>

In this sense, computer scientists are expected to be bricoleurs, sort of academic jacks-of-all-trades. [Tedre]





3

Other Literature

- ▶ [Ashby] Mark Ashby. How to Write a Paper. Engineering Department, University of Cambridge, Cambridge 6rd Edition, April 2005 <http://www-mech.eng.cam.ac.uk/mmd/ashby-paper.pdf>
- ▶ [deBono] Edward de Bono. de Bono's neue Denkschule. Kreativer denken, effektiver arbeiten, mehr erreichen. mvg-Verlag, München.
- ▶ [Heimes] Silke Heimes. Schreiben im Studium: Das PiIP-Prinzip. Vandenhoeck und Ruprecht. UTB 3457
- ▶ Marc E. Tischler. Scientific Writing Booklet. Dept. of Biochemistry and Molecular Biophysics. University of Arizona. <http://www.biochem.arizona.edu/marc/Sci-Writing.pdf>



4

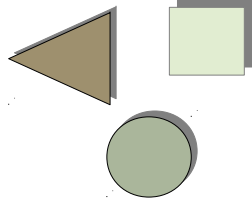
Goals of this Chapter

- ▶ Give you an overview of the research process, e.g., of a Master's thesis
- ▶ Understand how the steps are written up into a coherent Thesis Report
- ▶ Illustrate the process with some example methods.



11.1. The OI*SDR Research Processes

Inspired from [Esselborn-Krummbiegel]



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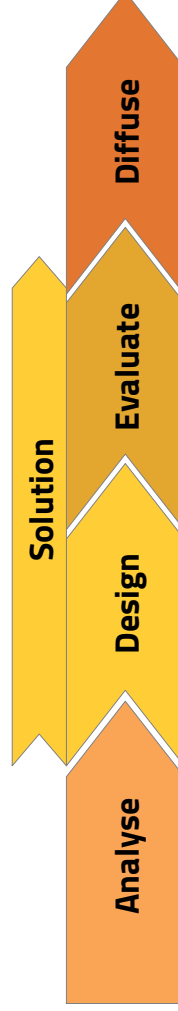
5



Standard Research Process ADED [Österle/Otto]

- ▶ [Hubert Österle, Boris Otto. A Method For Consortial Research. Report No. BE HSG/ CC CDQ/ 6, University of St. Gallen http://works.bepress.com/hubert_oesterle/196/]
- ▶ **Analyse** existing technologies, literature, background, problems
- ▶ **Design** new technologies (new solution)
 - Think
 - Research and develop
- ▶ **Evaluate** technologies (new solution)
 - Show why the new technology is superior; use success criteria
- ▶ **Diffuse**
 - Demonstration for creating vision
 - Popularize (position) your research results
 - „visible scientist“

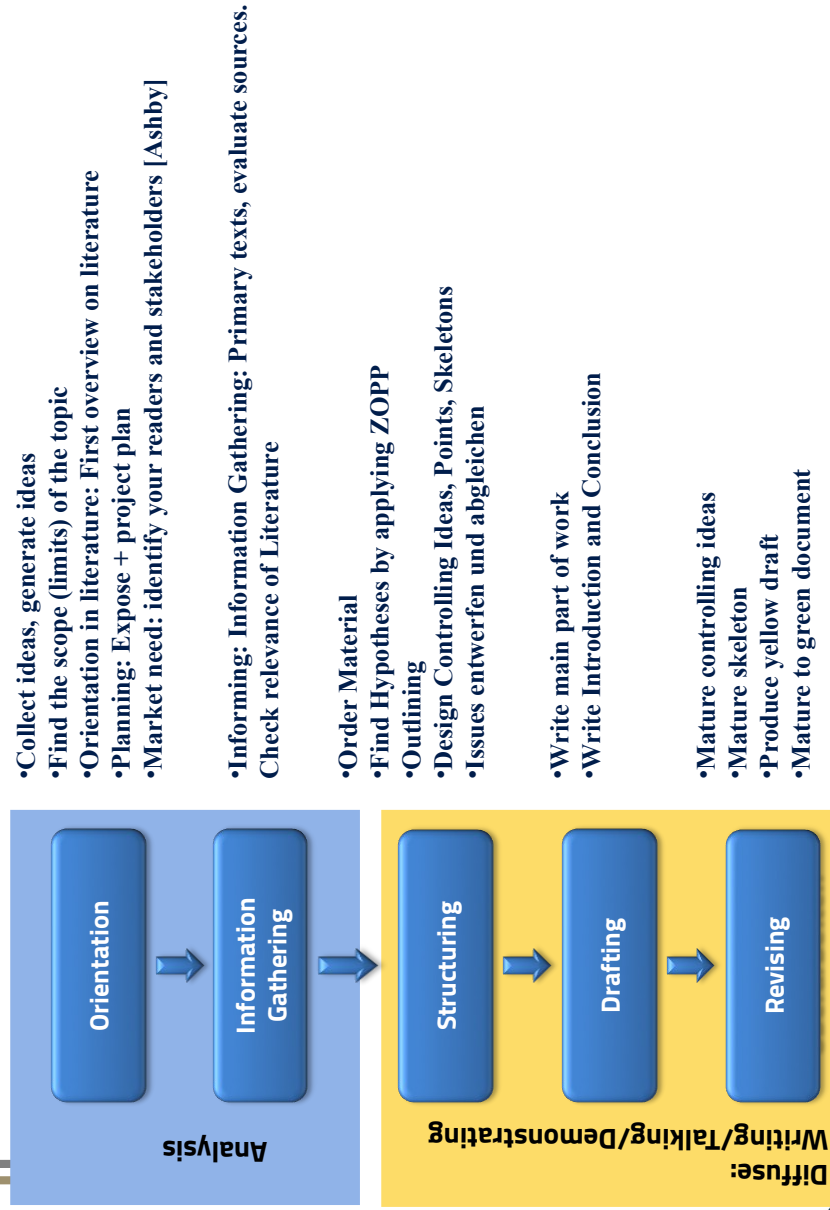
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The OI-SDR Research Process for General Scientific Topics and Overviews

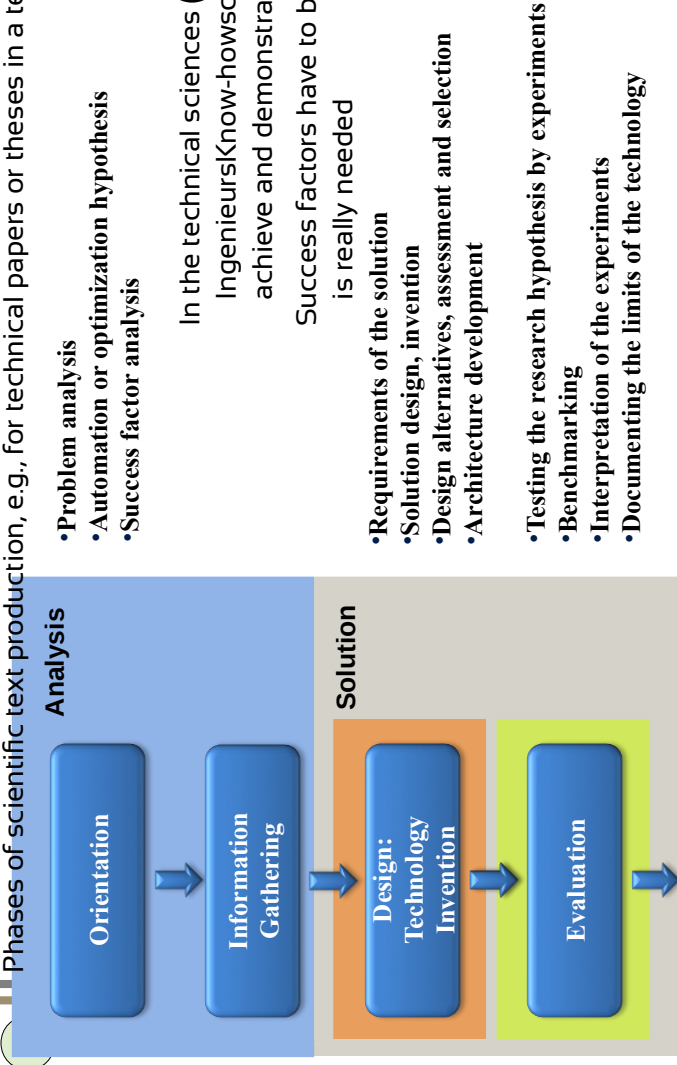
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Phases of scientific text production, e.g., for overview papers on a subject or essays



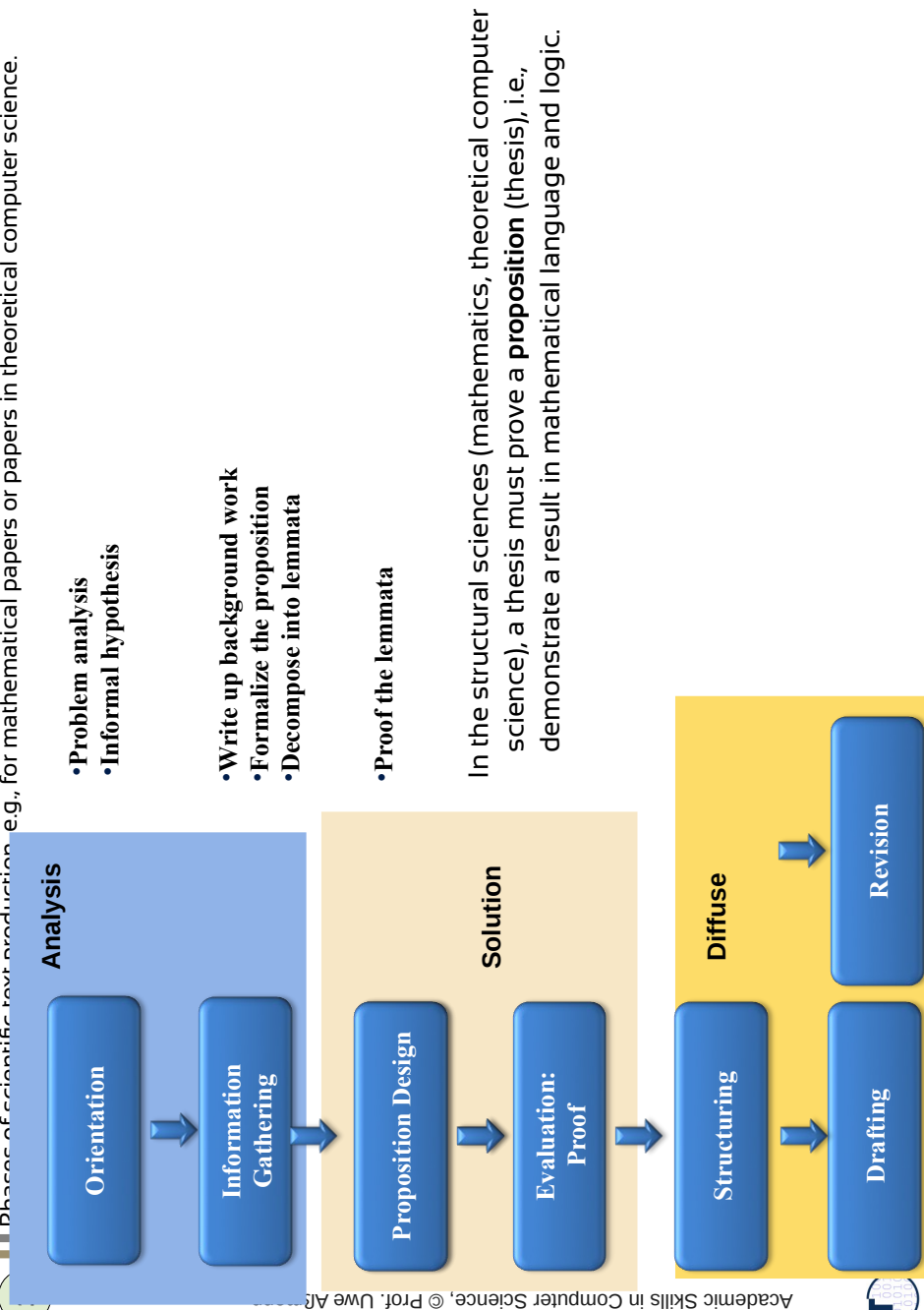
The OI-DE-SDR Research Process for Technical Science Thesis

Phases of scientific text production, e.g., for technical papers or theses in a technical science.

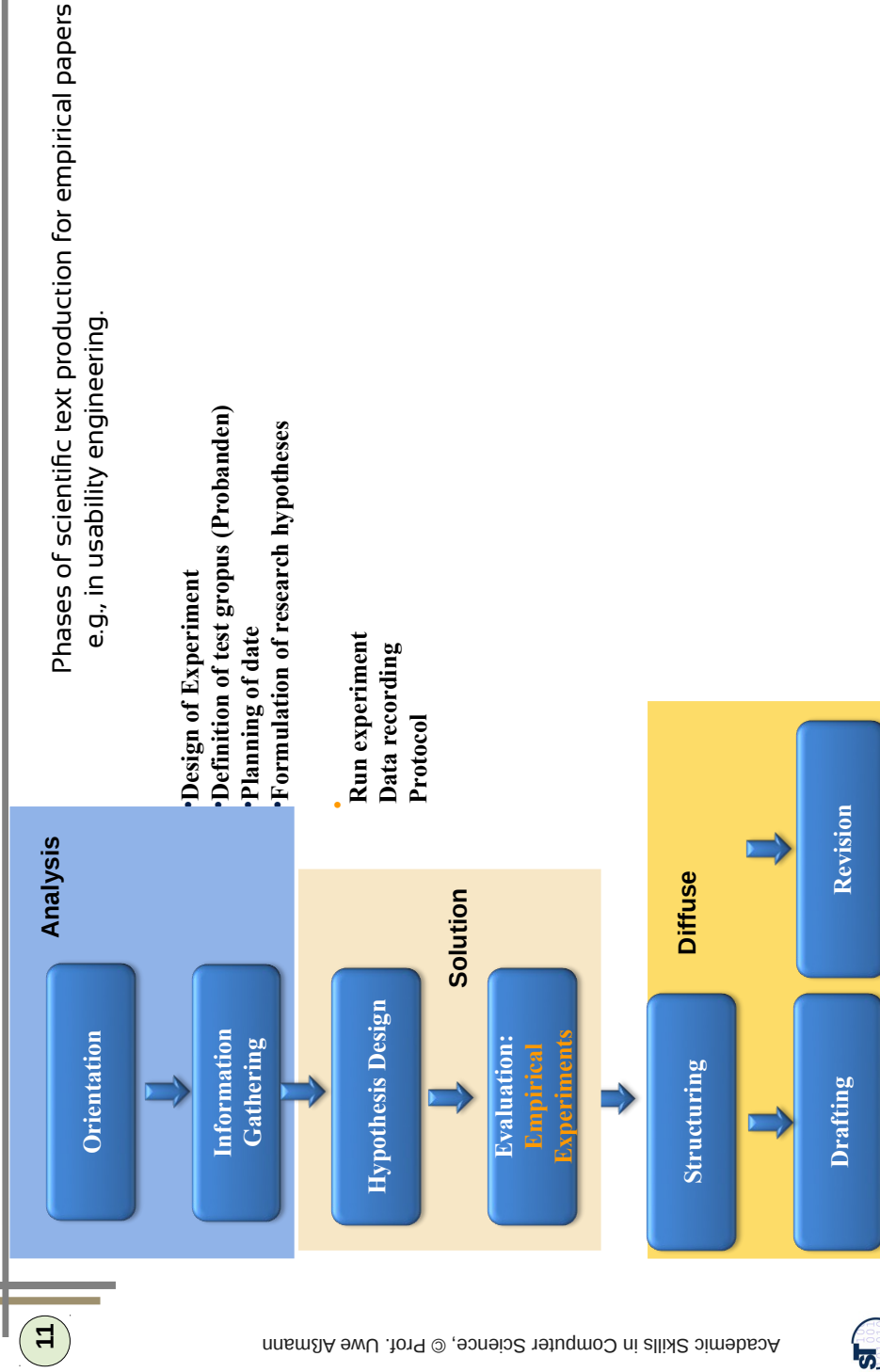


The OI-PP-SDR Research Process for Mathematical/Structural Science Thesis

Phases of scientific text production, e.g., for mathematical papers or papers in theoretical computer science.



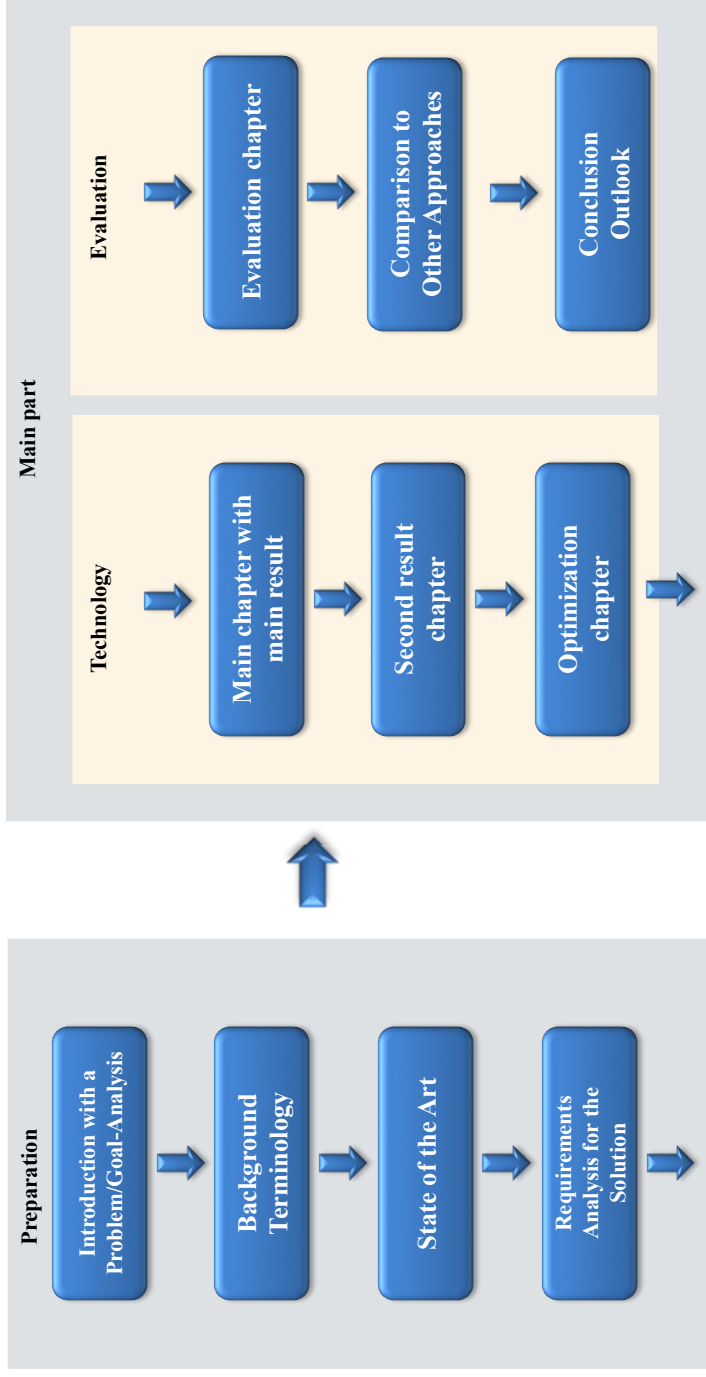
The OI-HE-SDR Research Process for Empirical Science Thesis



Standard Structure of a Technical Science Thesis

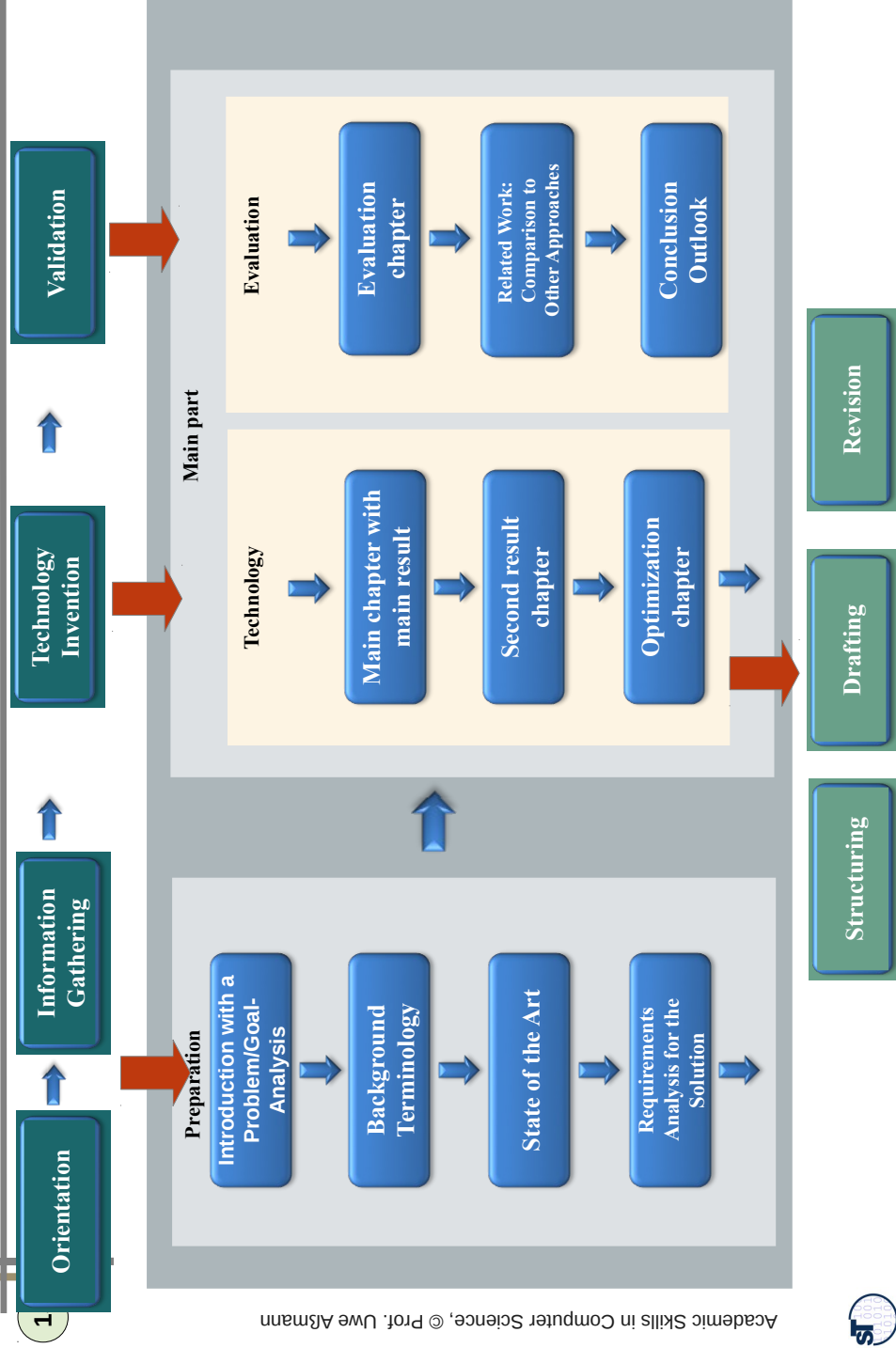
12

- ▶ A scientific thesis work should clear demarcate the part that is from you from the part that is not from you (background).
- ▶ The main part is divided in technology and evaluation part.
 - Some chapters can be folded or distributed.



The Standard Structure of a Master Thesis in Technical Science is Related to the OIS-SDR Research Process

1



Chapters and Process

14

- ▶ Because the structure of a scientific thesis is related to the chapters, write chapter by chapter
 - Start with (a draft of) the “background” and “literature state of the art” chapters from the orientation phase
 - Then develop the technical solution and write it up in a main technical contribution chapter
 - Validate with an evaluation (experimental, proof, empiric) in parallel.
 - Draft, revise, revise,...
- ▶ If you clearly put your technical contributions into 3-4 main chapters, your main slide at your defense will be:

Scientific Results / Contributions:

1. Result of Main Chapter 1
2. Result of Main Chapter 2
3. Result of Main Chapter 3



- ▶ And this will also form your introduction of your thesis.

Practical Hints

15

- ▶ Reserve 1/3 of your time for writing
 - 3 months Bachelor → 1 month writing
 - 6 months Masters → 8 weeks, at least 7 weeks, writing
 - 4 years PhD thesis → 1 year writing PhD thesis, 0.5 year writing papers
- ▶ Meet your supervisor biweekly or weekly.
 - Produce protocols of the meetings
- ▶ Write up everything in scratchpads. Material can be used in the end, and you don't forget important discussions or decisions
 - Starting to write after 2/3 of the time is a fatal error
- ▶ If your writing is not so good, do this course much more intensively than others. Read the original literature.
 - Become a “dressed writer” or “question-based writer” and it will go much better for you
- ▶ In a Bachelor thesis, reading of English research papers is not yet required, however, in a Master's thesis, it is.
- ▶ PhD thesis and Master's thesis may be written in English or German.
 - English gets a broader, world-wide audience.



Training Unit

16

- ▶ Analyze the following tables of contents from the web site of the course how they fit into this generic outline.
 - Why did the author follow or deviate from the outline?
- ▶ Diplomarbeiten:
 - [Seidel-DA] Christoph Seidl. Evolution in Feature-Oriented Model-Based Software Product Line Engineering. Diplomarbeit 2011. TU Dresden. <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa-81200>
 - [Wilke-DA] Claas Wilke. Model-Based Run-time Verification of Software Components by Integrating OCL into Treaty. Diplomarbeit. TU Dresden. <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa-27365>
- ▶ Doktorarbeiten:
 - [Röttger-Diss] Simone Röttger. Systematische Prozessunterstützung für die Entwicklung laufezeitkritischer Softwaresysteme - PROKRIS-Methodik und -Framework. PhD thesis, Dresden University of Technology, 2009. <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa-25206>
 - [Johannes-Diss] Jendrik Johannes. Component-Based Model-Driven Software Development. PhD thesis, Dresden University of Technology, December 2011. <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa-63986>
 - [Seifert-Diss] Mirko Seifert. Designing Round-Trip Systems by Model Partitioning and Change Propagation. PhD thesis, Dresden University of Technology, June 2011. <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa-71098>
 - [Hartmann-Diss] Falk Hartmann. Safe Template Processing of XML Documents. PhD thesis, Dresden University of Technology, July 2011. <http://nbn-resolving.de/urn:nbn:de:bsz:14-qucosa-75342>



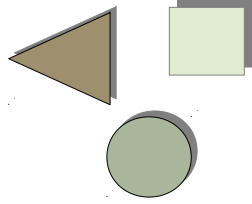
Homework

17

- ▶ Take the outline of Seidl and Wilke and produce one slide each for the defense – as if you had to defend their master's thesis.
- ▶ Look for *research results (research contributions)*
 - What is the main result?
 - What are secondary results?
 - How did the author
- ▶ Look for *demarkation to other related work*
 - How is the progress over the state of the art shown?



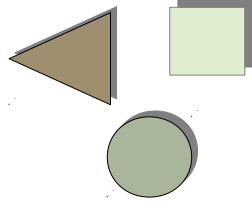
11.2. Orientation – From the Idea to the Thesis Question



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18

11.2.1 Analysis and Idea Generation Clustering with Mindmaps and other Techniques



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Clustering Helps to Develop Logical Structures of Your Work

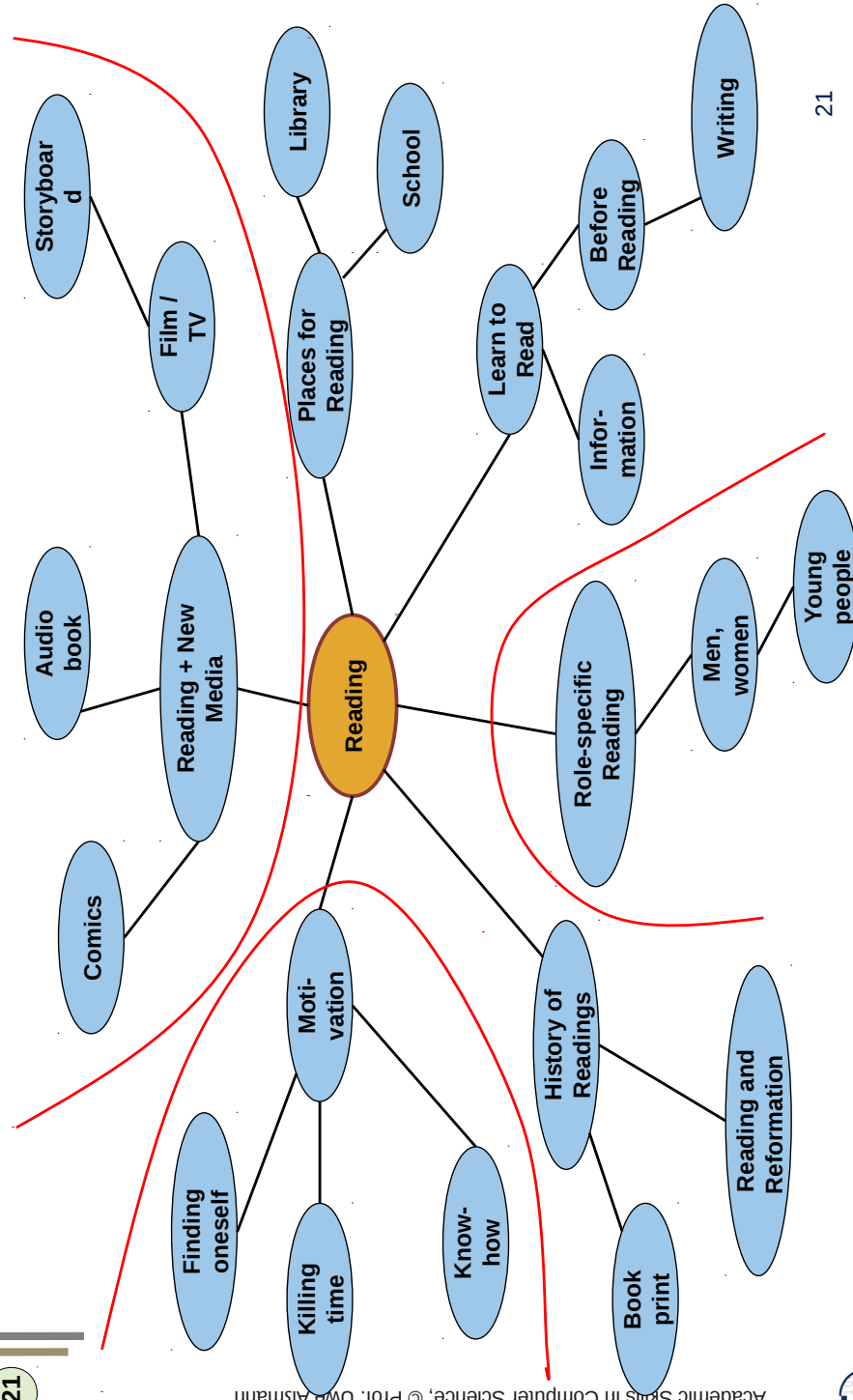
20

- ▶ Objective:
 - Develop ideas by association
 - Use the blackboard's space to find association
- ▶ Procedure:
 - Note the central concept in the middle
 - Start to note associated terms or relations
 - Iterate
- ▶ Clustering is a method for analysis, idea generation and structuring

20

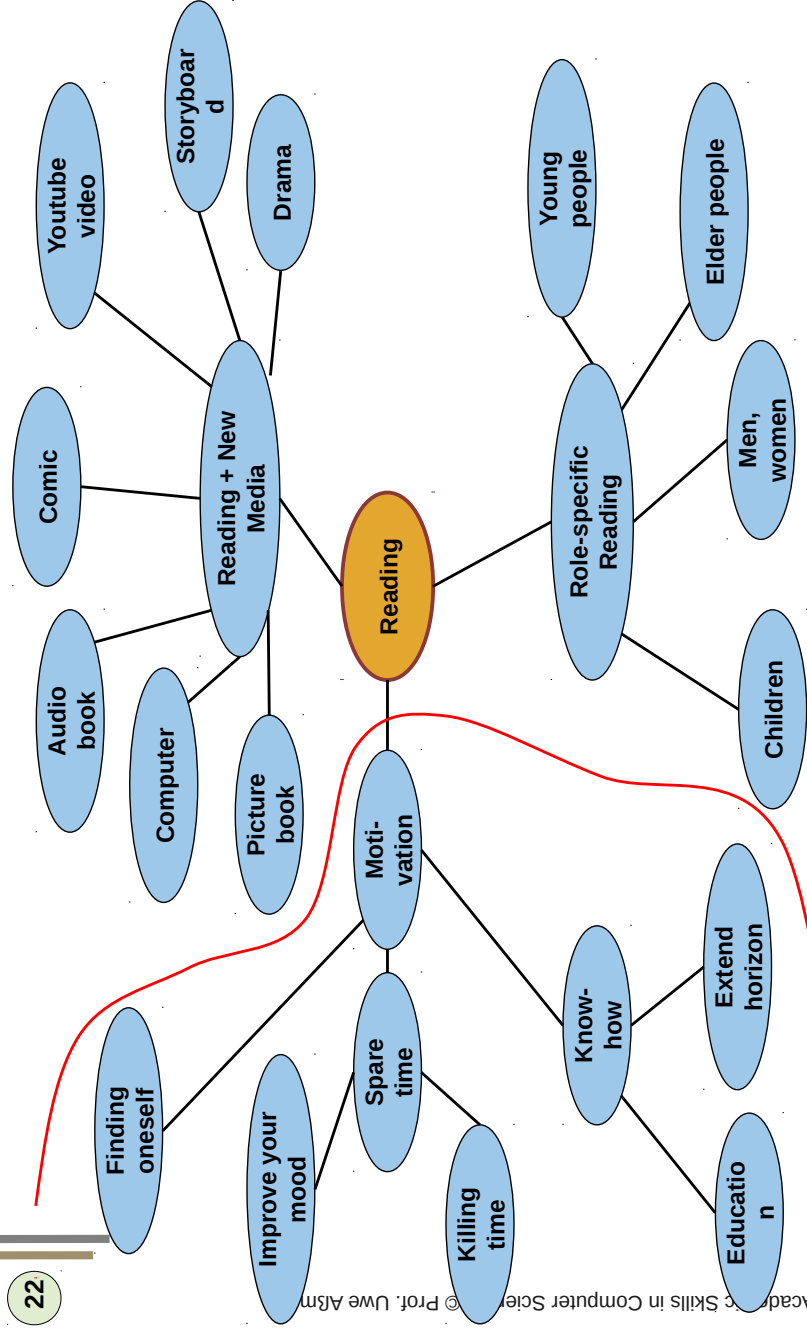
Ex.: Initial Version Multi-Level Cluster „Reading“

21



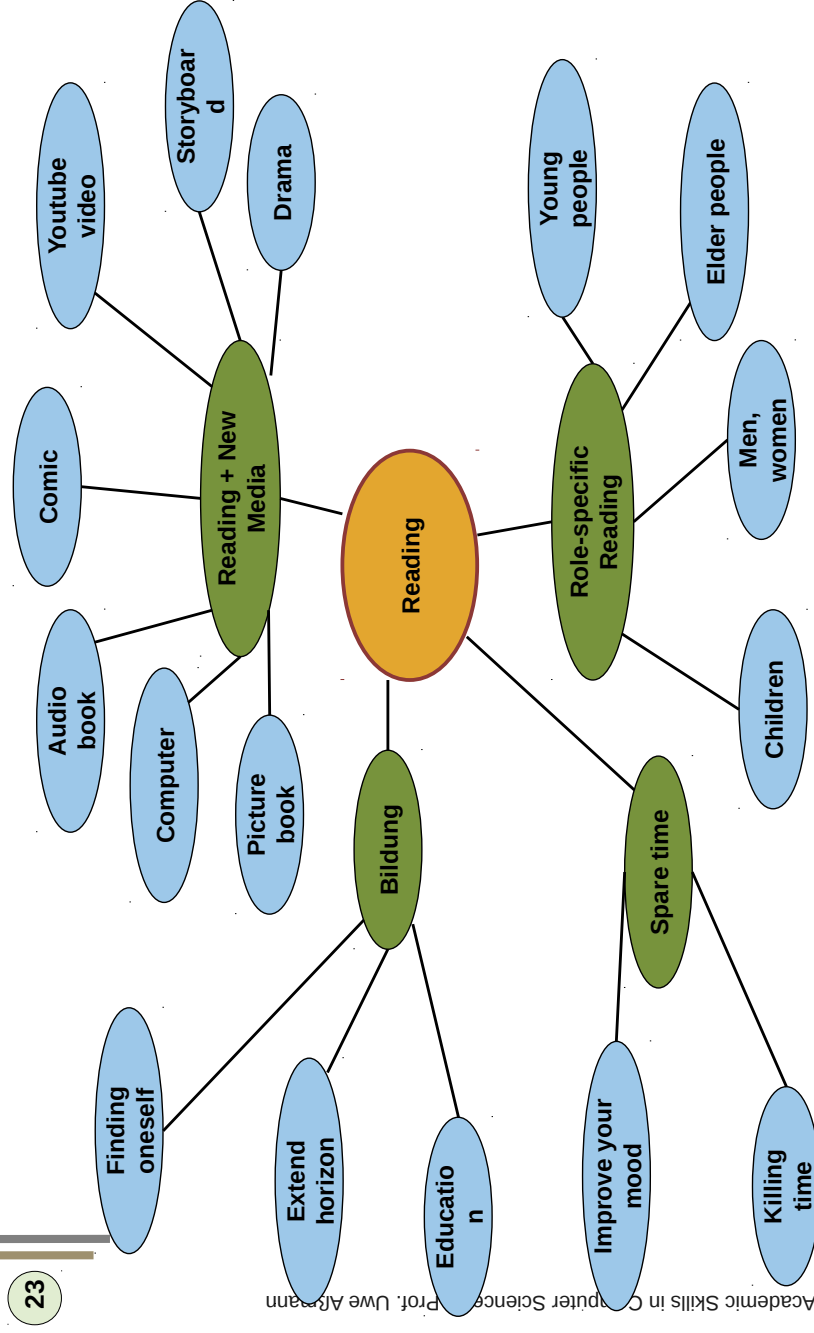
21

Ex.: Refined 4-Level-Cluster "Reading"



22

Ex.: Well-Balanced, 3-Level Cluster "Reading"



23



24

Normalized Clusters should have up to 3, at most 4 Levels

- ▶ The logical structure of arguments, blocks, paragraphs, and sections is called a **cluster, flat** or **deep**.
- ▶ Usually, clusters fall into the following categories:
 - **Flat**
 - A **comb (Kamm)** is a 2-level cluster with central point and arguments. An **n-comb** has n arguments.
 - A **5-step (5-Schritt)** is a 5-comb with overlaid linear ordering.
 - **Deep**
 - A **bush (Busch)** is a 3-level cluster with central point, first level of arguments (*primary arguments*), and a second level of *secondary arguments*.
 - An **Xmas tree (Weihnachtsbaum)** is a 4-level cluster
- ▶ **Clustering (cluster normalization)** starts with wild, unordered clusters, mindmaps, and rearranges them.
- ▶ Clusters will also be applied to problems, goals, causes and effects, a.m.m.



25

Text Blocks should have up to 3 Levels

- ▶ A **comb text (Kammtext)** is a text block stemming from a comb (2-level cluster).
- ▶ A **bush text (Buschtext)** is a text block stemming from a bush cluster.
- ▶ An **Xmas text (Weihnachtstext)** is a text block stemming from an Xmas tree cluster.
- ▶ If more than 3 levels are used, paragraphs become hard to read.

The fourth level of an Xmas treecluster must be folded away into a bush text.





Homework

26

- ▶ Which technique does Schmidt use? Combs? Bushes?



11.2.1.1 Structure Trees

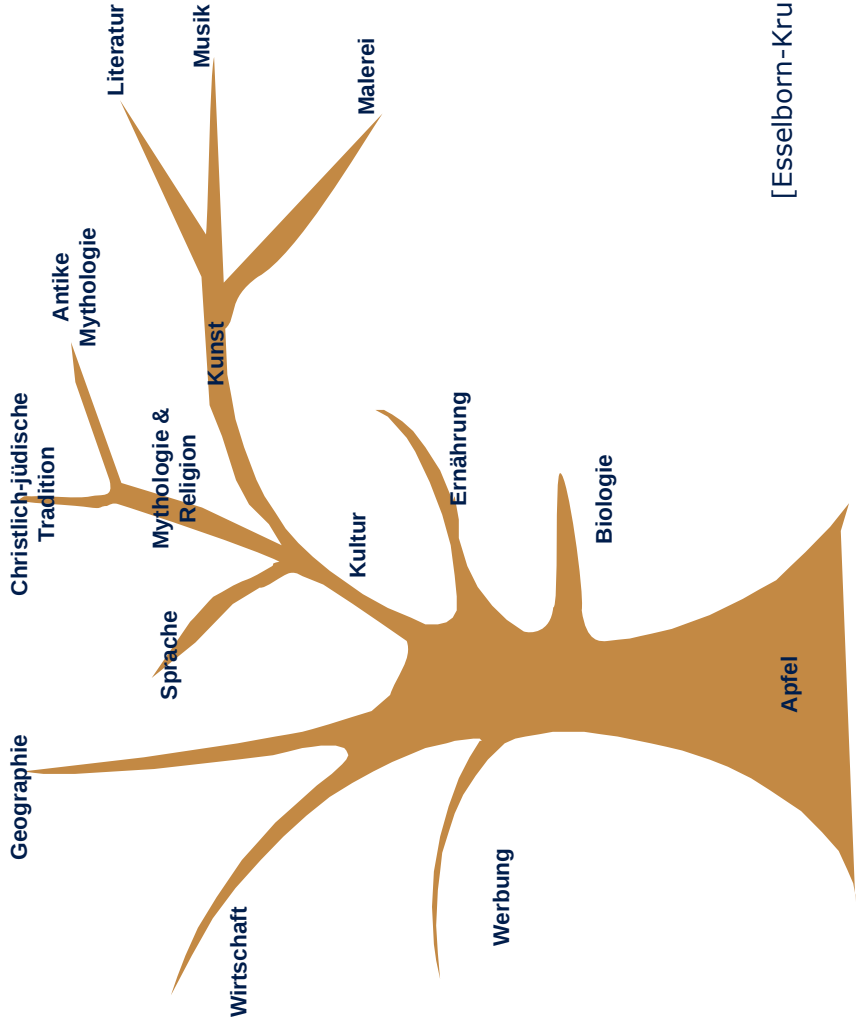
27

- ▶ Mindmaps are similar to structure trees
- ▶ A **Structure Tree** is a tree with differently deep branches.
 - Structure trees can be drawn as trees
 - Line hierarchies
 - Widget trees
- ▶ The metaphor of a tree helps some people to brainstorm.
- ▶ Structure Trees serve to decompose a concept in *one dimension (no-aspects)*
 - Association Trees → hierarchical decomposition of associated concepts
 - Functions → function trees
 - Actions → action trees
 - Concepts → taxonomies, classifications
 - Concepts → part-of hierarchies (mereologies)



Ex.: Association Tree "Apple"; Decomposition with Associated Terms

28



[Esselborn-Krummbiegel]



The Law of Questions for Problem Solving

29

<http://de.wikipedia.org/wiki/Sesamstra%C3%9F>

Musik: Ingfried Hoffmann, Text: Volker Ludwig, 1. Version gesungen vom Hamburger Kinderchor Vineta unter der Leitung von Dietrich Czirmiook. Ab Oktober 2012 wird das Lied von Lena Meyer-Landrut interpretiert.



Law of Questioning for Problem Solving:

Der, die, das - wer, wie, was – wieso, weshalb, warum – wer nicht fragt, bleibt dumm!

11.2.1.4 The 7 Basic Questions (7 W-Fragen)

30

The 6 honest serving men (R. Kipling, Just So Stories)

I keep six honest serving-men:
(They taught me all I knew)

Their names are What and Where and When
And How and Why and Who.

I send them over land and sea,

I send them east and west;

But after they have worked for me,

I give them all a rest.

I let them rest from nine till five.

For I am busy then,

As well as breakfast, lunch, and tea,

For they are hungry men:

But different folk have different views:

I know a person small--

She keeps ten million serving-men,

Who get no rest at all!

She sends 'em abroad on her own affairs,

From the second she opens her eyes--

One million Hows, two million Wheres,

And seven million Whys!



The 7 Basic Questions (7 W-Fragen) used for Topical Questions

31

For finding topics of research, a text or talk, the 6 honest men (7-W-Questions) should be attempted to expand into a checklist.

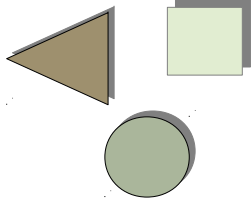
This checklist can be used to create alternatives for the topic (idea generation for topic).

| | Ideas for Topic; Limits and Implications |
|-------------------------|--|
| Who? | Who is interested in the topic? Who benefits? |
| What? | What do I want to find out? What may change in my topic, problem or question? What is fix? |
| How? | How similar is my topic to another work? How different is it? What is its research advance? research contribution? |
| Where? | Where is my research located in the research landscape? |
| When? | When did somebody else research on something similar? |
| Why? | Why do we need the topic? |
| For what? To which end? | What will happen if we don't solve the problem? |



11.4. Solution Invention – How Do I Find a Solution for my Problem?

Please, consult the lectures of “Software management (SWM)” to improve your knowledge on management. Runs in Summer.



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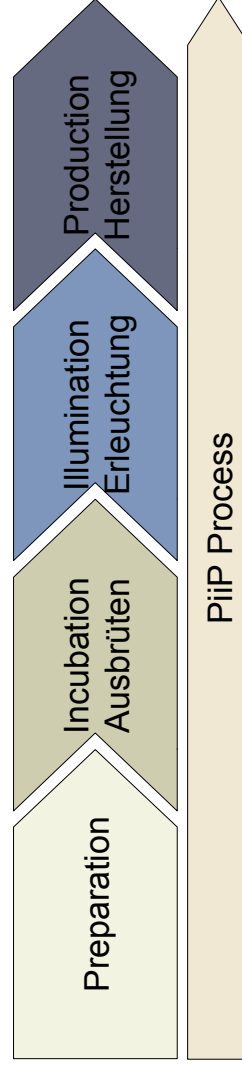


Solution Invention with the PiIP Process

- ▶ If we want to solve a research problem, we must be enduring and patient. A lot of thinking (“incubation”) is needed. [Heimes]
- ▶ **Don't give up** if the incubation takes some time, and the illumination does not want to appear.
 - Consider, that this is always like this. Edison made more than 10000 experiments before the lightbulb worked.

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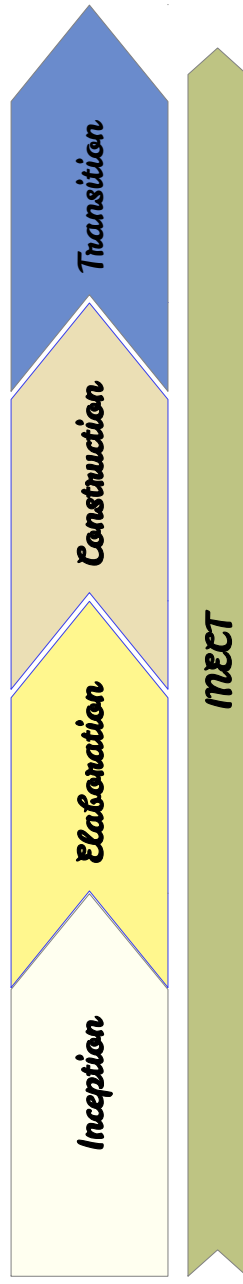


Solution Invention with the Process InECT

34

The Rational Unified Process (RUP) contains a phase-structured microprocess INECT for general structuring the invention of solutions:

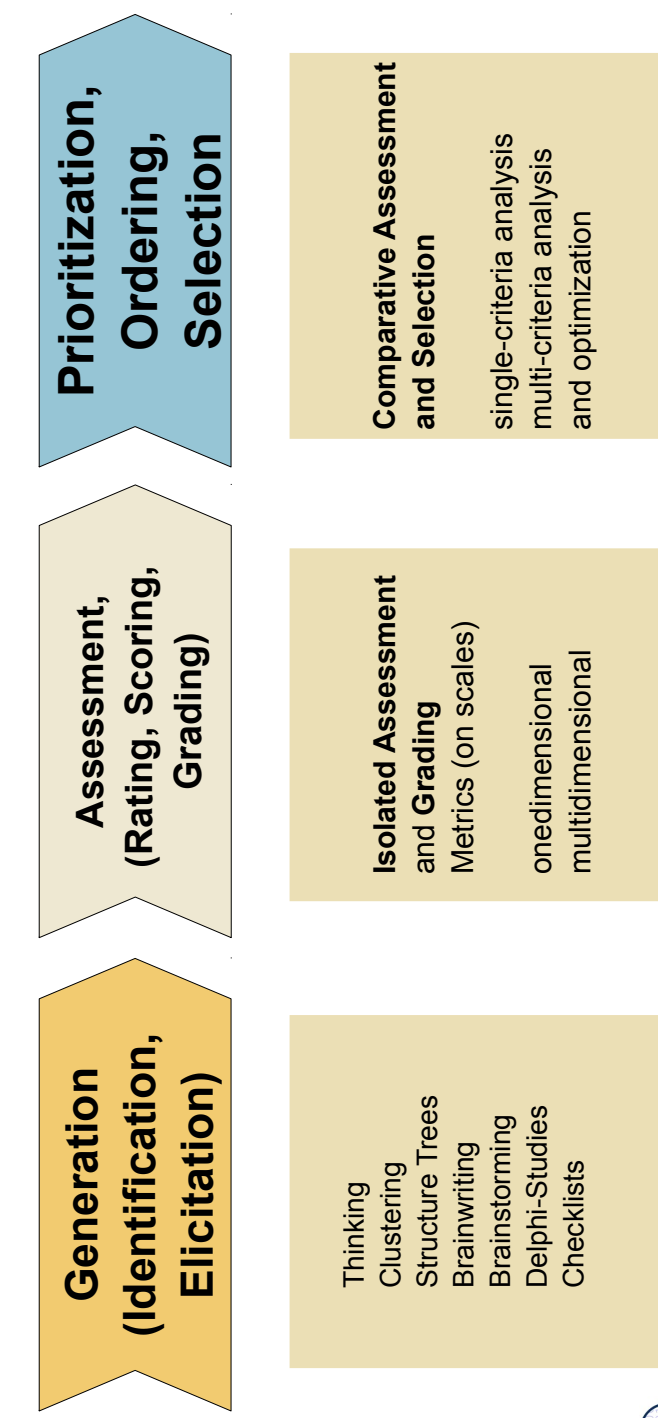
- ▶ **Inception:** Fix the problem. Fix all project requirements and conditions. Fix environment.
- ▶ **Elaboration:** Analysis, fix use cases, fix interfaces and fix preliminary structural architecture (skeleton)
- ▶ **Construction:** Realize the interfaces and the architecture with an implementation
- ▶ **Transition:** Prepare next phases; deploy solution; after-math study (Nachstudie); Process improvement for future projects

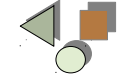


Generation of Design Alternatives with GAP

35

- ▶ For assessments and analyses of *several designs*
- ▶ For alternatives if difficult decisions have to be taken





A Simple Form of GAP: de Bono's Alternatives-Possibilities-Choices (APC)

36

| Alternatives | Possibilities | Choices |
|--------------|---------------|---------|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

- ▶ [DeBono] introduced a very simple 3-step for thinking about alternatives. Process:
- ▶ Find an alternative.
- ▶ Once you fixed this, think about other "possibilities". Is this alternative the only one?
- ▶ The third category "Choices" should fix remarks and reasons for the final choice.
- ▶ APC can be used for variant generation of problems, solutions, ideas, topics, arguments



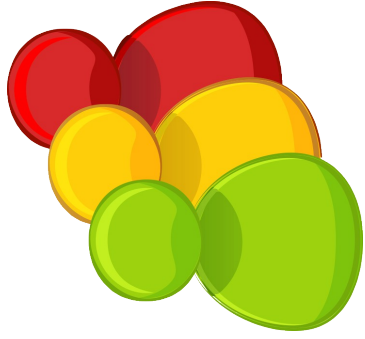
A Simple Form of Assessment and Binary Prioritization: de Bono's PMI (Plus-Minus-Interesting)

37

| Plus | Minus | Interesting |
|------|-------|-------------|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

- ▶ [DeBono] introduced a very simple 3-step for thinking about decisions
- ▶ Do this really sequentially, i.e., do not add Plusses if you are working on Minuses or Interesting
- ▶ The third category "interesting" helps to find out whether the arguments on Plus or Minus are really important
- ▶ PMI can be used for Discussion parts, Idea, topic, argument generation

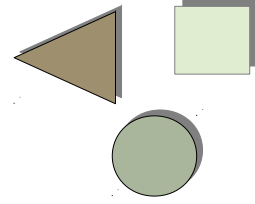




- ▶ **Traffic lights:** Valuate with red, green, blue
- ▶ **School grades:** Assessment with 5 points
- ▶ **“American Women” Method:** Assessment with 10 points
 - Advantage: multiply school grades by 2 => American Women Method
- ▶ **“Abi-grading“:** Assessment with 15 points
 - Advantage: multiply school grades by 3 => Abi-grading



11.5. Diffusion of Research: Structuring





Structuring of Ideas, Problems, Solutions

40

- ▶ Use 7-W and other techniques for idea generation
 - ▶ Clusters and Structure Trees are the main instruments to bring wild the unsorted ideas into structured, hierarchical form.
- Decomposition of structures is along different criteria:
- ▶ Categorise into taxonomies
 - Find super and subconcepts
 - Find similarities, differences, relations
 - ▶ Segmenting and partitioning
 - Validate superconcepts by identification of separating/segmenting features
 - Partition a superconcept into subconcepts
 - ▶ Part-of Hierarchies
 - ▶ Argumentation hierarchies for Claims
 - ▶ There are special chapters on structuring



Structuring is Dealt with in a Specific Part of the Course

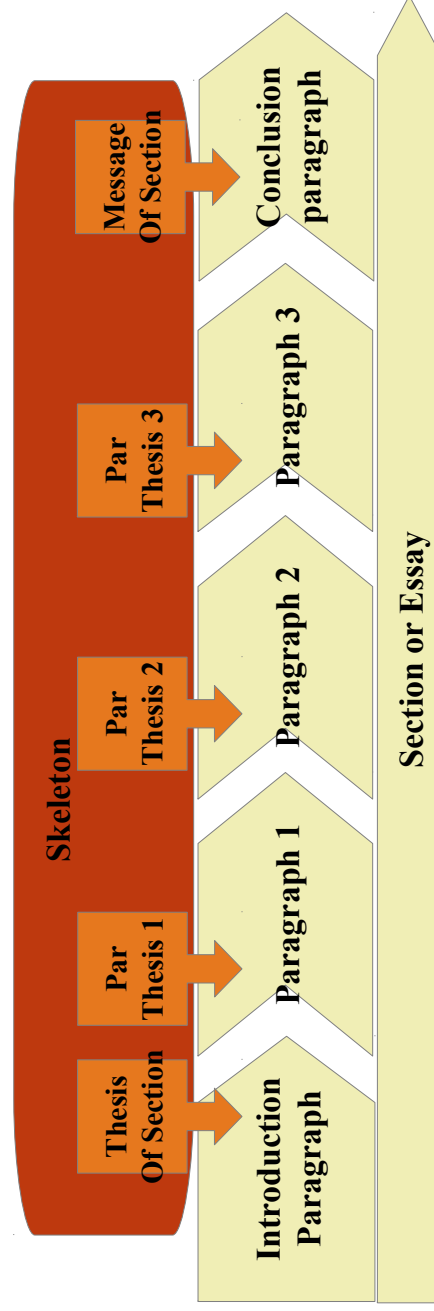
41

- ▶ This course has several special chapters on how to organize logical clusters with *Thesis statements*
- ▶ For all texts and talks, thesis statements are **structural contracts** between the author and the reader/listener
- ▶ **Thesis: Topic + Controlling idea + Development Scheme**

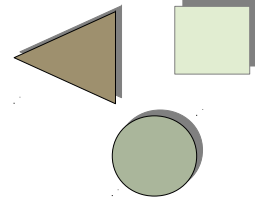




- ▶ The **skeleton** of a section is the sequence of all thesis statements of all paragraphs.
- The skeleton is an abstraction of the text
- ▶ The skeleton results from Point maturation, Support analysis, and Skeleton maturation
- ▶ A section (or essay) has **unity** if all points of the paragraphs support its thesis.

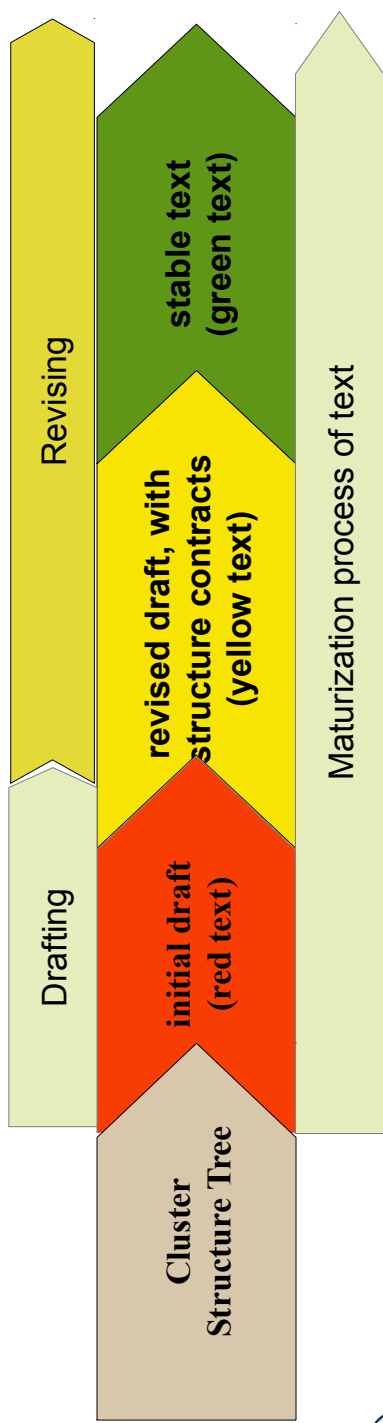


11.5.2. Drafting and Revising for Diffusion: Textification, Talkification and Demonstrating

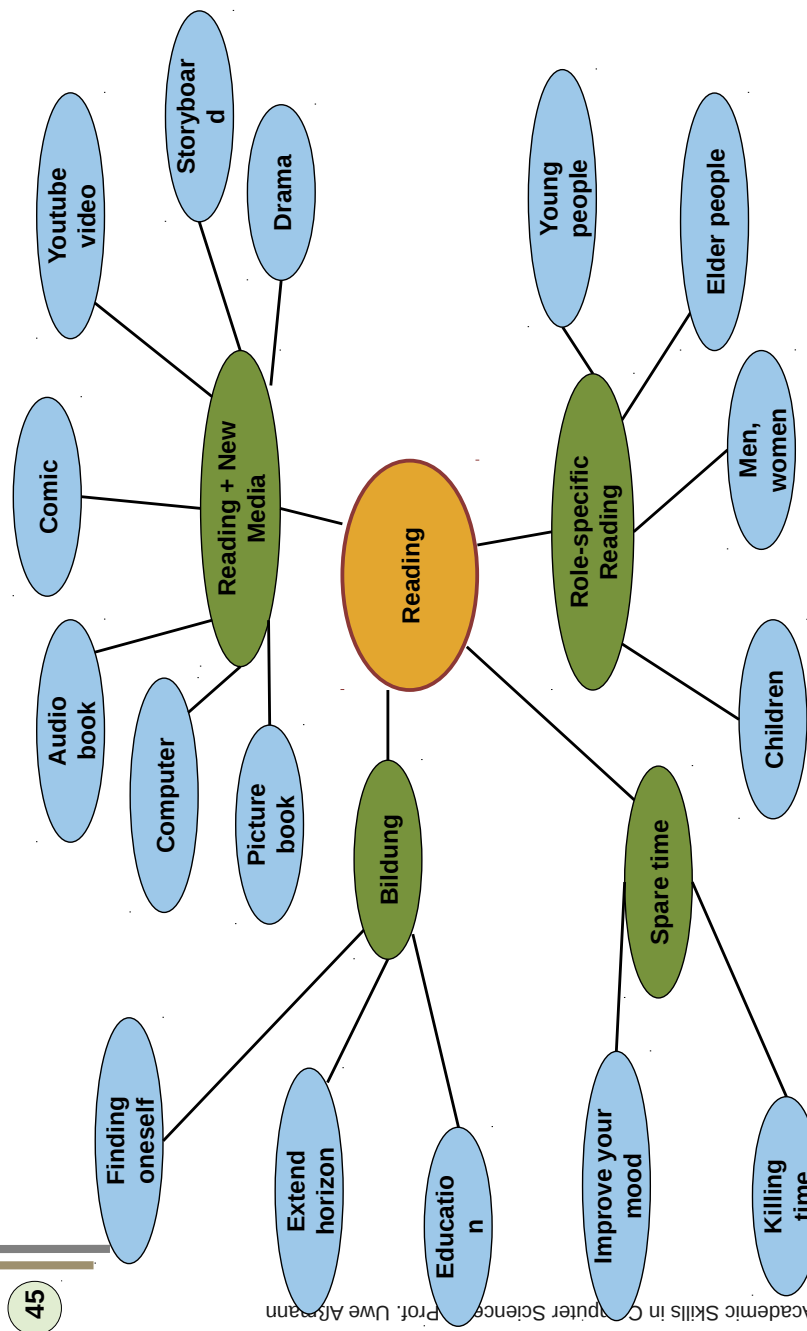


Textification and Talkification of Clusters

- ▶ **Textification** is the process of putting Clusters, Structure Trees, Points and Development Schemes into beautiful texts, like Fishbones, Whalebones, Pivot paragraphs a.m.m.
- ▶ **Talkification** is the similar process of producing talks, and it is very similar.
- ▶ Both processes start with a **draft (red version)**, revise it twice into a **yellow** and a **green version**, the final text or document.
 - Under three versions, don't believe a text is mature.

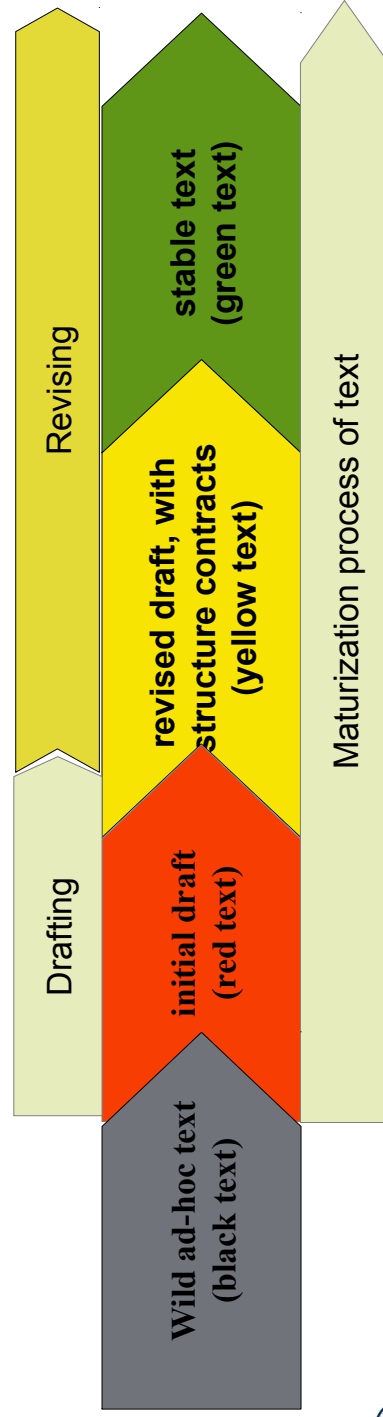


Exercise: Textify the Bush "Reading"



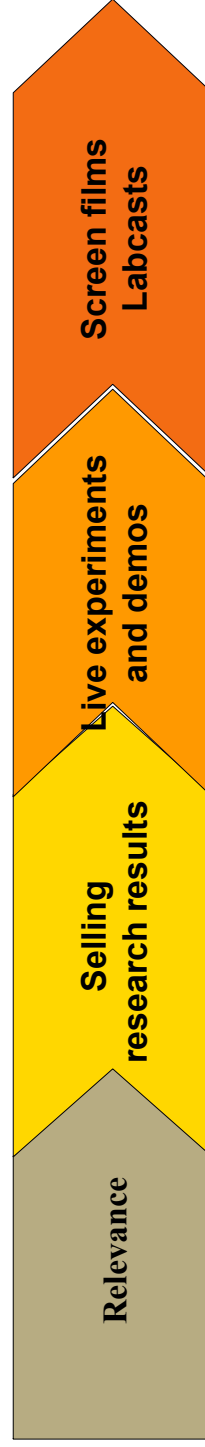
Revision for ... Unity and Coherence with Controlling Ideas

- ▶ Most people start to write ad-hoc text (black text). Then, the texts wander around, more and more associated ideas disturb unity and coherence.
- ▶ **Unity:** a sentence contributes, reminds on or supports the central idea of the text (the controlling idea)
- ▶ **Coherence:** all sentences relate to each other, being threaded by common words, subjects, thematic strings.
- ▶ Do not start with black text! Always start with a controlling idea and try to write red text, drafts which are already roughly unity and coherence.

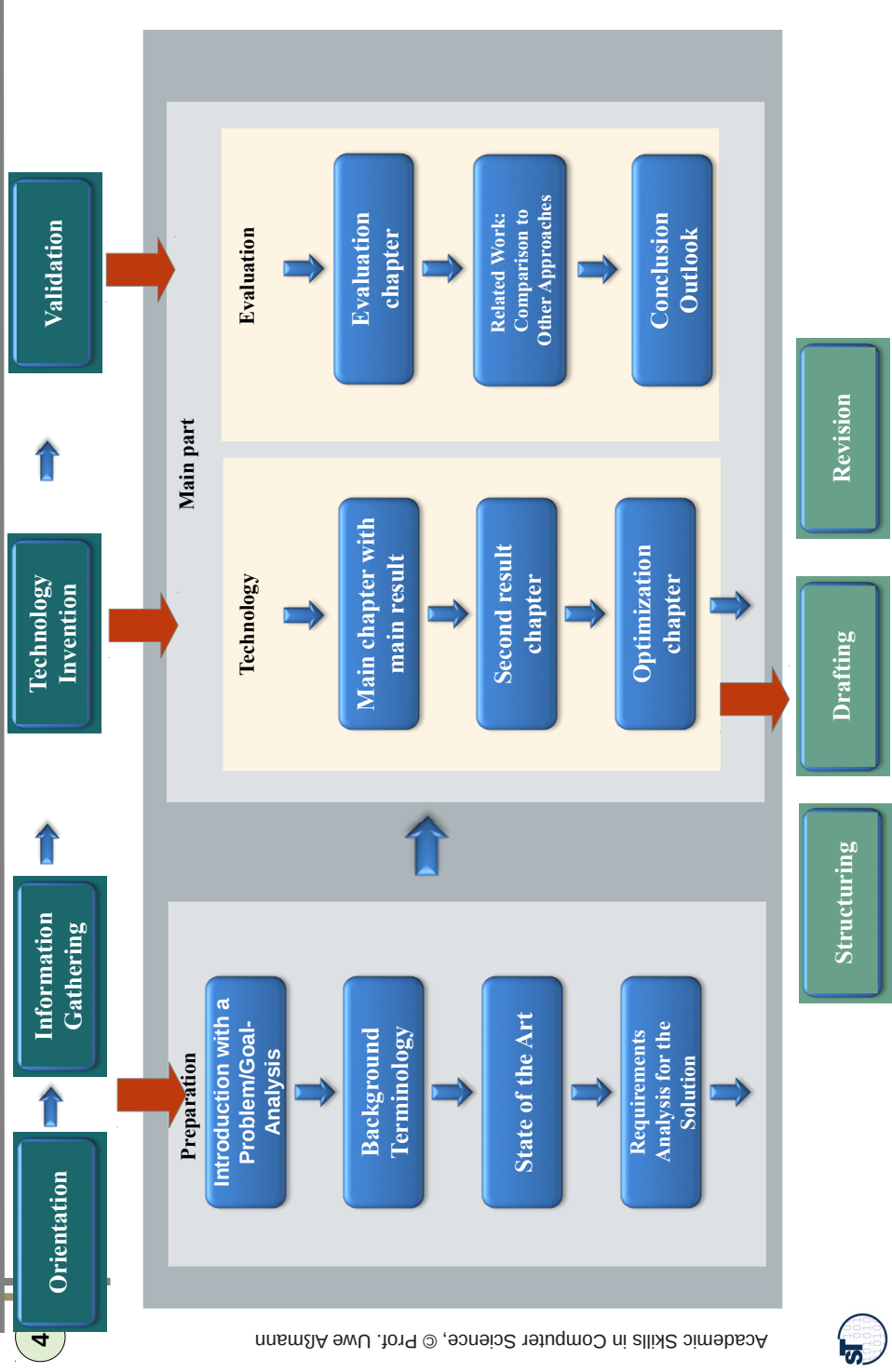


Demonstrating

- ▶ In technical science, experiments and demonstrations are very important.
- ▶ Scientists and PhD students need to *sell their results*, because results should be *relevant*
- ▶ On the way to a thesis the student has to *demonstrate* or *sell* his ideas in many ways:
 - A paper, report, and talk should contain an experiment or demo.
 - Screen films and lab videos (labcasts) can be made to illustrate and document



The Standard Structure of a Master Thesis in Technical Science is Related to the OIS-SDR Research Process



Exercises



Bed-Time Schmidt Reading (for German Speakers)

50

- ▶ Helmut Schmidt is a good read, isn't he? This week, read:
- ▶ Helmut Schmidt. Zivilisiert den Kapitalismus! (zum 100. Geburtstag von Marion Gräfin Dönhoff), in "Einmischungen", Goldmann-Verlag
- ▶ From the paper, construct a mindmap bush out of the concept "Raubtierkapitalismus"
 - Start with a cluster
 - Trim it to a bush
- ▶ Use the Metaphor "Raubtier" to develop a structure tree.
 - Develop the metaphor by associations: Meat, Death, Fressen und Gefressen werden, etc.
- ▶ Create a new cluster and bush around what you found out about the metaphor.
- ▶ Outline a new article around the metaphor "Raubtier" about "Zivilisiert den Raubtierkapitalismus".



Bed-Time Churchill Reading (for English Speakers)

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- ▶ Winston Churchill is also a good read? This week, read:
- ▶ Winston Churchill. "Their finest hour". Speech in the House of Commons. June 18, 1940. <https://www.winstonchurchill.org/learn/speeches/speeches-of-winston-churchill/1940-finest-hour/122-their-finest-hour>
- ▶ Look at the last paragraph. Construct a mindmap bush out of the concept "Survival of Christian civilization" and another one of the contrasting concept "Sinking into the abyss of a new Dark Age".
 - Start with a cluster
 - Trim it to a bush
- ▶ Use both concepts "Survival of Christian civilization" and "Sinking into the abyss of a new Dark Age" to develop a structure tree.
 - Develop the metaphor by associations: Abyss, Ocean, Dark, Age, Survival in the Ocean, Civilization, Barbarians, ...
- ▶ Create a new cluster(s) and bush(es) around what you found out about the metaphor.
- ▶ Outline a new article around what you clustered.
- ▶ Why was Churchill's speech so powerful?





Analyzing Overview Papers (Homework)

- ▶ An **overview paper** is a paper analyzing the state of the art in a field, or the literature. Every thesis has to have at least one overview chapter.
- ▶ To prepare unit 3, you should analyze several overview papers:
 - Steve Vinoski. An overview of middleware. In Albert Llamosí and Alfred Strohmeier, editors, *Reliable Software Technologies - Ada-Europe 2004*, volume 3063 of *Lecture Notes in Computer Science*, pages 35-51. Springer. Berlin / Heidelberg, 2004. 11.1007/978-3-540-24841-5_3.
 - Tim Sheard. Accomplishments and research challenges in meta-programming. In Walid Taha, editor, *Semantics, Applications, and Implementation of Program Generation*, volume 2196 of *Lecture Notes in Computer Science*, pages 2-44. Springer Berlin / Heidelberg, 2001. 11.1007/3-540-44806-3_2.
 - Mazeiar Salehie and Ladan Tahvildari. Self-adaptive software: Landscape and research challenges. *ACM Trans. Auton. Adapt. Syst.*, 4(2):14:1-14:42, May 2009.
- ▶ Questions to answer:
 - Find the papers on the web
 - Compare their table of contents
 - Can you find a pattern for a structure of an overview paper?
 - Read the paper with the most important structure with the RIK process (see next chapter)



Vinoski's Paper Follows a "Historic Development Scheme"

- ▶ Introduction
- ▶ Middleware Origins → Early History
- ▶ Middleware Fundamentals → Basic concepts, Purpose, Rationale, Reference Architecture
 - Communication support → Concepts
 - Messaging → Concepts, classification
 - Concurrency Support
 - Common middleware services
- ▶ Middleware evolution → history
 - Early influences
 - Distributed objects and components
 - Enterprise application integration
 - Component models and web services
- ▶ Future of middleware





Appendix

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- ▶ Several slides are courtesy to Sebastian Cech

