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

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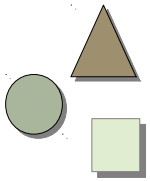
1) The OI*SDR Research Processes
2) Orientation: From the idea to the research question
3) Information Gathering
4) Diffusion
   1) Structuring
   2) Drafting and Revising for Textification, Talkification and Demos



Speak OI*SDR as Oyster

Literature

- [Krumbiegel] Helga Esselborn-Krumbiegel. Von der Idee zum Text. Eine Anleitung zum Know-howschaftlichen Schreiben:
  - 3. überarbeitetete 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/ser04/
- 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]

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. Vandenhoek 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

Goals of this Chapter

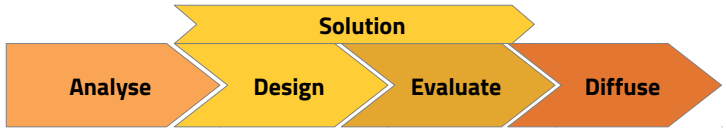
- Give you an overview of the research process, e.g., of a Master's thesis
- Understand how the steps are written up into a coherent Thesis Report
- Illustrate the process with some example methods.

11.1. The OI*SDR Research Processes

Inspired from [Esselborn-Krummbiegel]

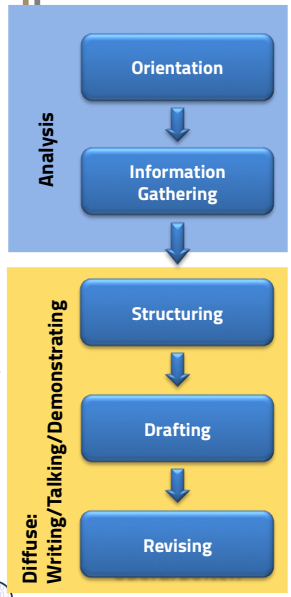
Standard Research Process ADED [Österle/Otto]

- [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“



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

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



- Collect ideas, generate ideas
- Find the scope (limits) of the topic
- Orientation in literature: First overview on literature
- Planning: Expose + project plan
- Market need: identify your readers and stakeholders [Ashby]

- Informing: Information Gathering: Primary texts, evaluate sources. Check relevance of Literature

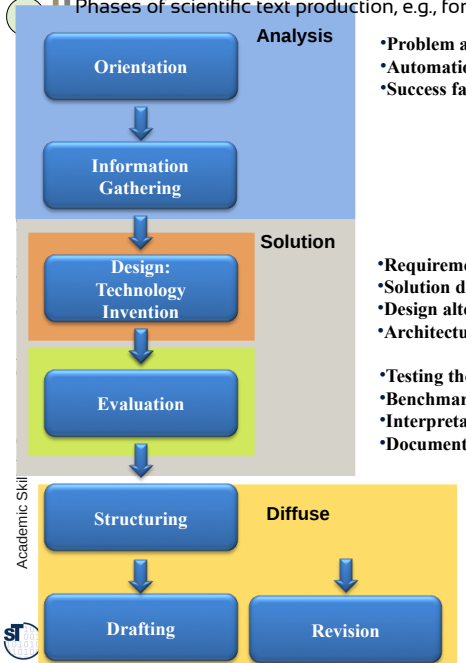
- Order Material
- Find Hypotheses by applying ZOPP
- Outlining
- Design Controlling Ideas, Points, Skeletons
- Issues entwerfen und abgleichen

- Write main part of work
- Write Introduction and Conclusion

- Mature controlling ideas
- Mature skeleton
- Produce yellow draft
- Mature to green document

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.



- Problem analysis
- Automation or optimization hypothesis
- Success factor analysis

In the technical sciences (engineering science, IngenieursKnow-howschaft), a thesis must be technical, achieve and demonstrate a technical result.

Success factors have to be analyzed to know whether a re is really needed

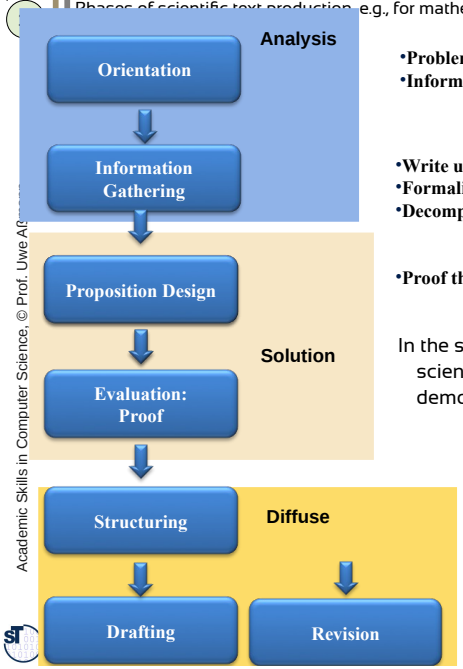
- Requirements of the solution
- Solution design, invention
- Design alternatives, assessment and selection
- Architecture development

- Testing the research hypothesis by experiments
- Benchmarking
- Interpretation of the experiments
- Documenting the limits of the technology

Diffusion of the technology by writing: a design pattern, a report

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.



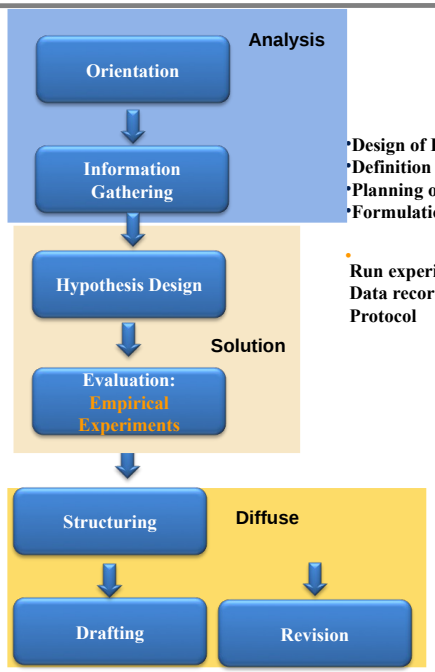
- Problem analysis
- Informal hypothesis

- Write up background work
- Formalize the proposition
- Decompose into lemmata

- Proof the lemmata

In the structural sciences (mathematics, theoretical computer science), a thesis must prove a **proposition** (thesis), i.e., demonstrate a result in mathematical language and logic.

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



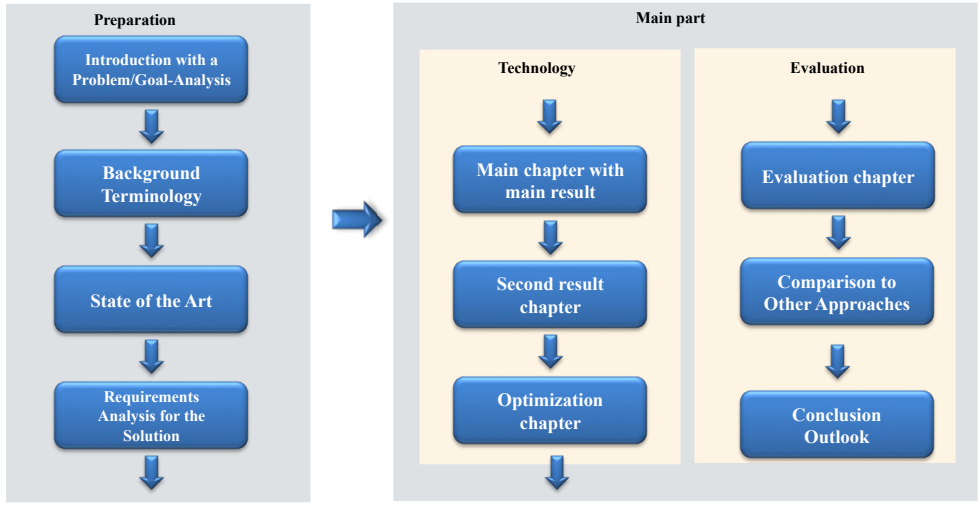
Phases of scientific text production for empirical papers e.g., in usability engineering.

- Design of Experiment
- Definition of test gropus (Probanden)
- Planning of date
- Formulation of research hypotheses

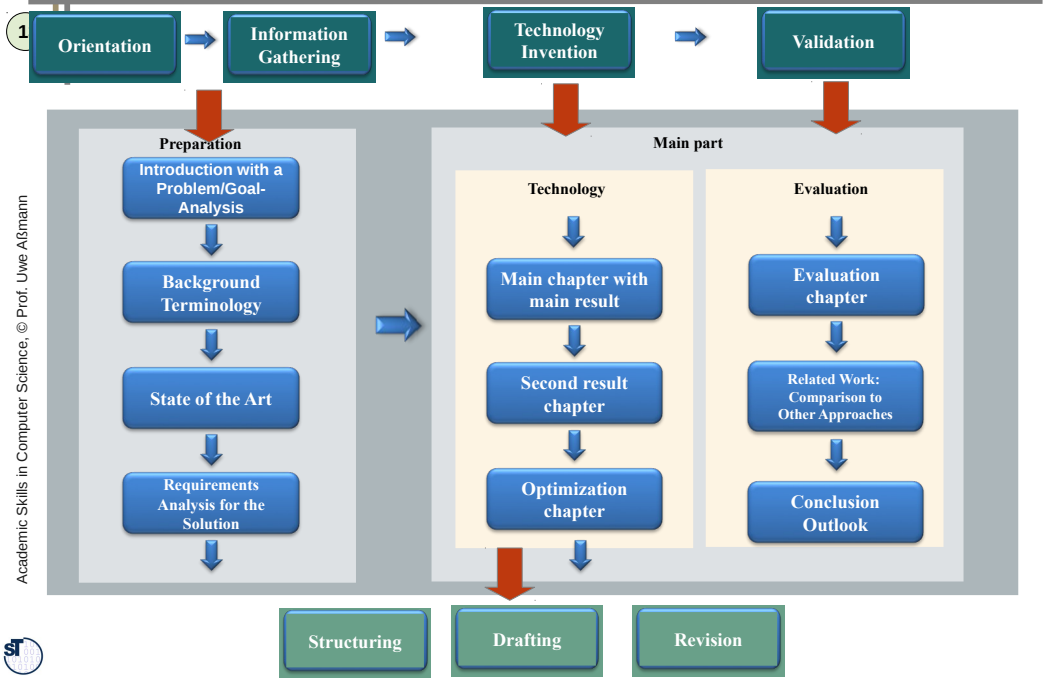
Run experiment
Data recording
Protocol

Standard Structure of a Technical Science Thesis

- 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



Chapters and Process

- 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

- 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

- 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 laufzeitkritischer 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

- 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 *demarcation 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

11.2.1 Analysis and Idea Generation Clustering with Mindmaps and other Techniques

Clustering Helps to Develop Logical Structures of Your Work

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- 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

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

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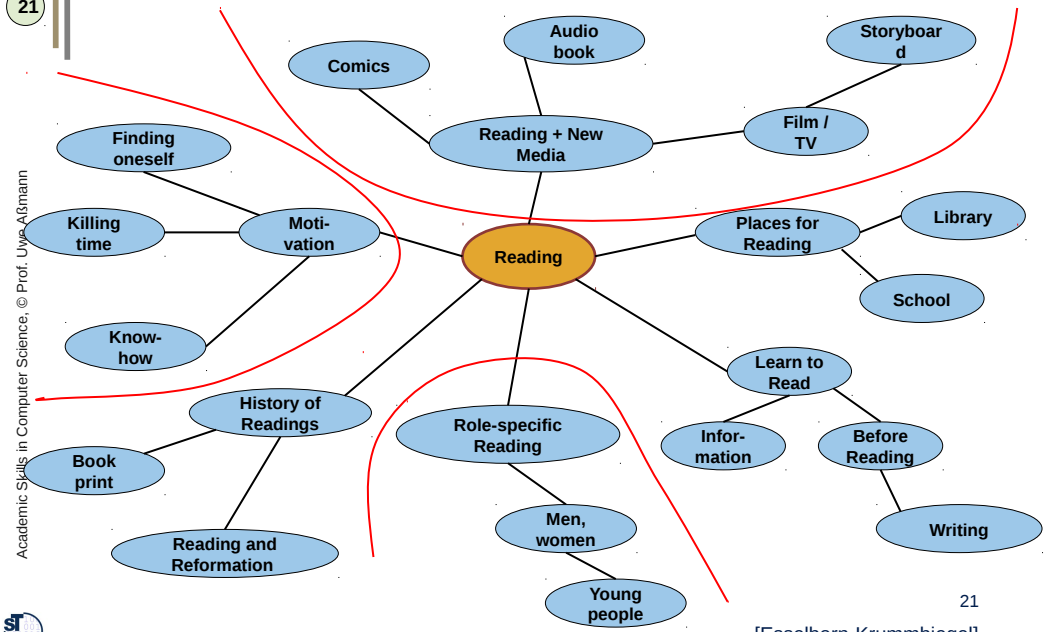
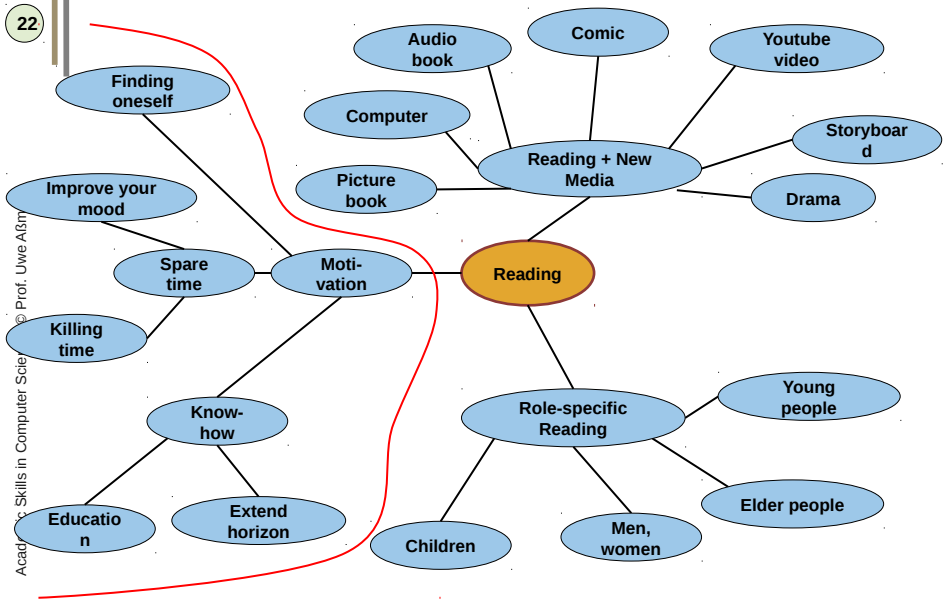
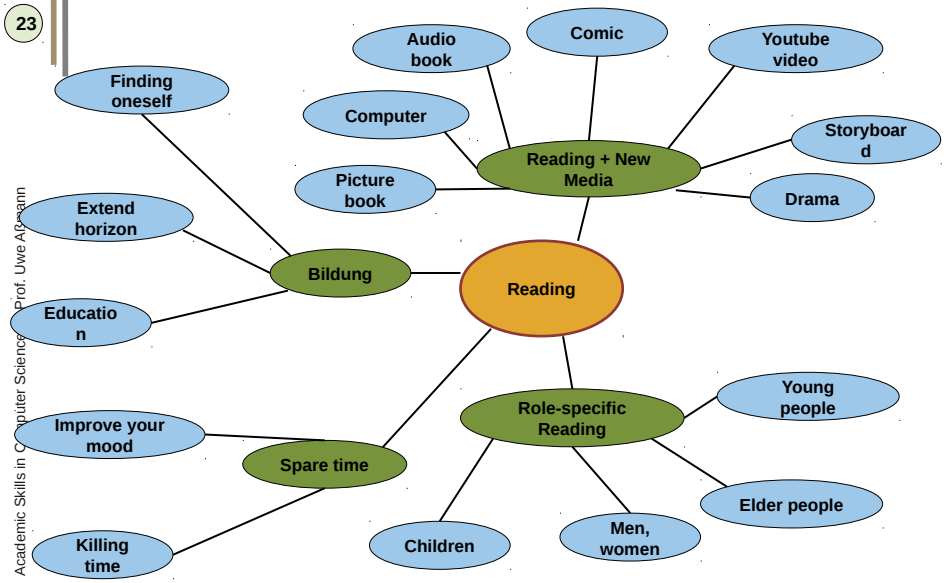


[Esselborn-Krummbiegel]

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



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



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 overlayed 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.

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

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- Which technique does Schmidt use? Combs? Bushes?

11.2.1.1 Structure Trees

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- 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

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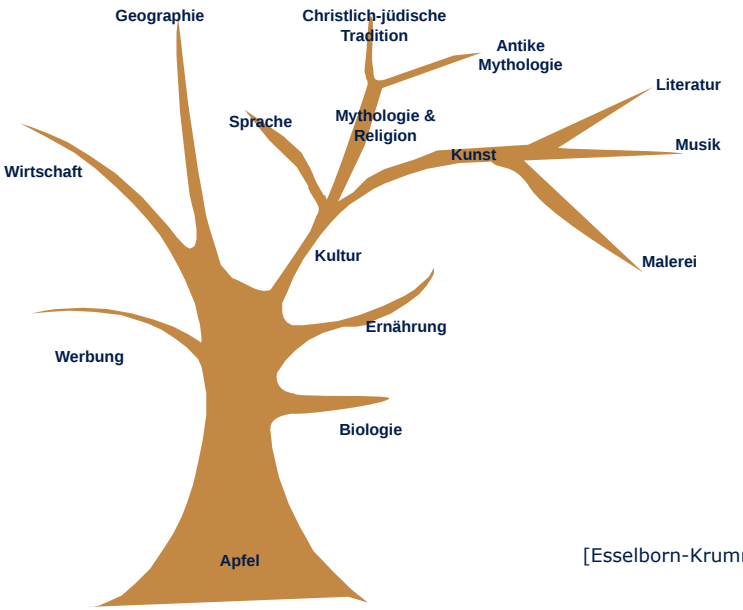

[Esselborn-Krummbiegel]

The Law of Questions for Problem Solving

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- http://de.wikipedia.org/wiki/Sesamstra%C3%9Fe
- **Musik: Ingfried Hoffmann, Text: Volker Ludwig, 1. Version gesungen vom Hamburger Kinderchor Vineta unter der Leitung von Dietrich Czirniok. 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)

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

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).

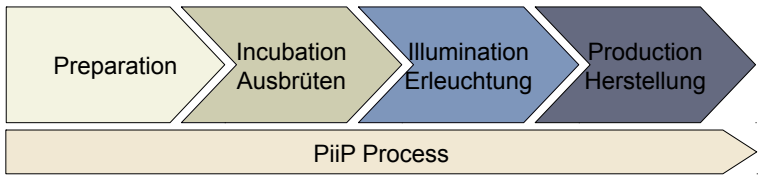
	Ideas for Topic; Limits and Implications
Who?	Who is interested in the topic? Who benefits?
What?	What do I want to find out? What may change in my topic, problem or question? What is fix?
How?	How similar is my topic to another work? How different is it? What is its research advance? research contribution?
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 mangement (SWM)" to improve your knowledge on management. Runs in Summer.

Solution Invention with the PiiP Process

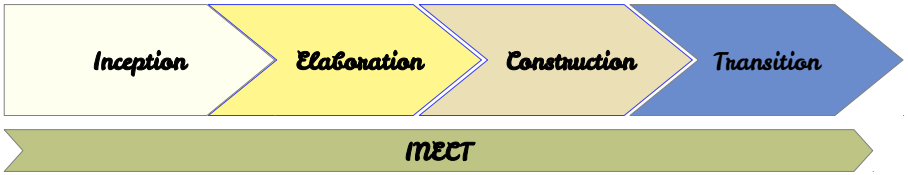
- If we want to solve a research problem, we must be enduring and patient. A lot of thinking ("incubation") is needed. [Heimes]
- **Don't give up** if the incubation takes some time, and the illumination does not want to appear:
  - Consider, that this is always like this. Edision made more than 10000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



Solution Invention with the Process InECT

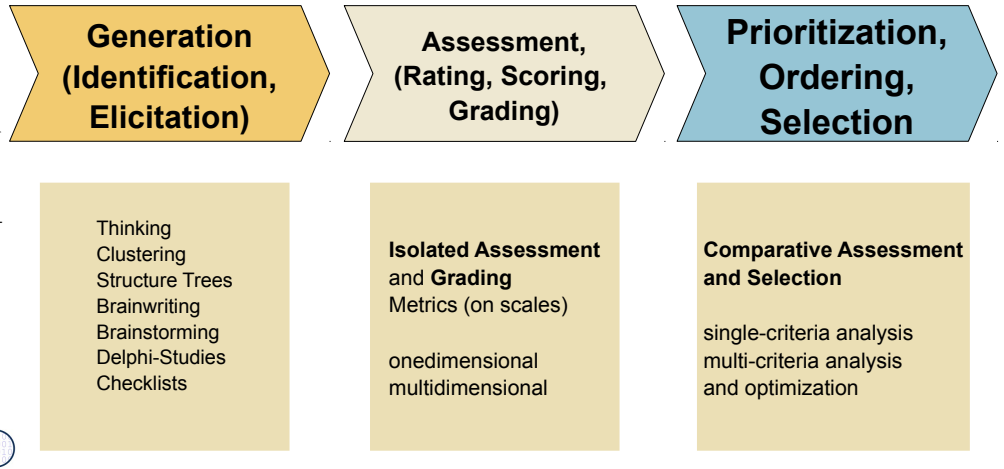
The Rational Unified Process (RUP) contains a phase-structured microprocess INECT for general structuring the invention of solutions:

- **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

- 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)

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)

Plus	Minus	Interesting

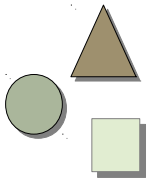
- [DeBono] introduced a very simple 3-step for thinking about decisions
- Do this really sequentially, i.e., do not add Plusses if you are working on Minusses or Interesting
- The third category "interesting" helps to find out whether the arguments on Plus or Minus are really important
- PMI can be used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

Prioritization with Simple Numeric Grading (Ordinal Scales)

- **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

[Hill]

11.5. Diffusion of Research: Structuring



Structuring of Ideas, Problems, Solutions

- 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:

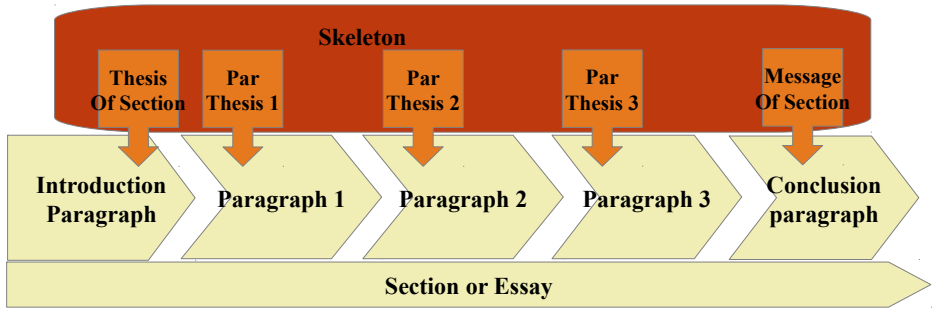
- Categorise into taxonomies
  - Find super and subconcepts
  - Find similarities, differences, relations
- Segmenting and partitioning
  - Validate superconcepts by identification of separating/segmenting features
  - Partition a superconcept into subconcepts
- Part-of Hierarchies
- Argumentation hierarchies for Claims
- There are special chapters on structuring

Structuring is Dealt with in a Specific Part of the Course

- 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**

Skeletons

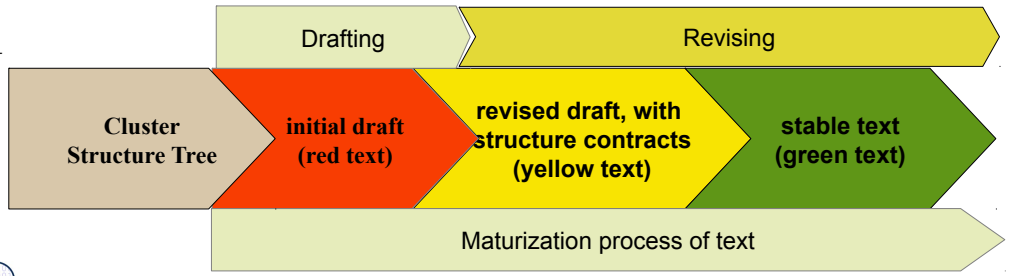
- The **skeleton** of a section is the sequence of all thesis statements of all paragraphs.
  - The skeleton is an abstraction of the text
- The skeleton results from Point maturization, Support analysis, and Skeleton maturization
- A section (or essay) has **unity** if all points of the paragraphs support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



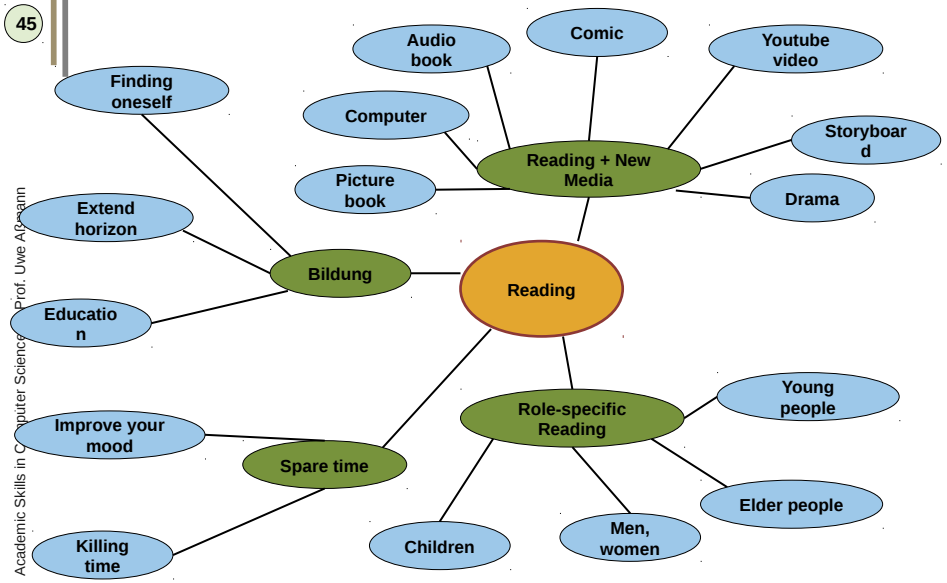
11.5.2. Drafting and Revising for Diffusion: Textification, Talkification and Demonstrating

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.
  - Unter three versions, don't believe a text is mature.

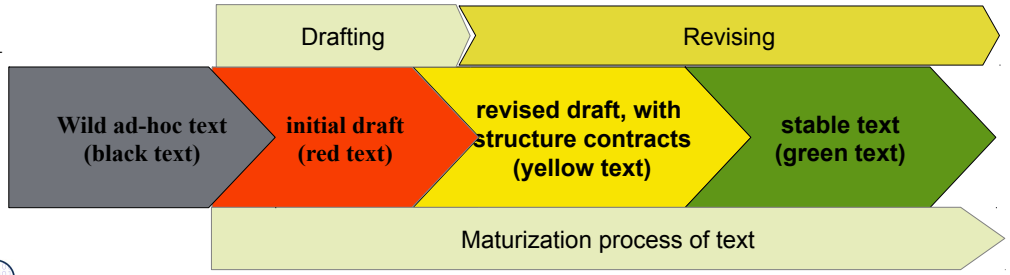


Exercise: Textify the Bush "Reading"



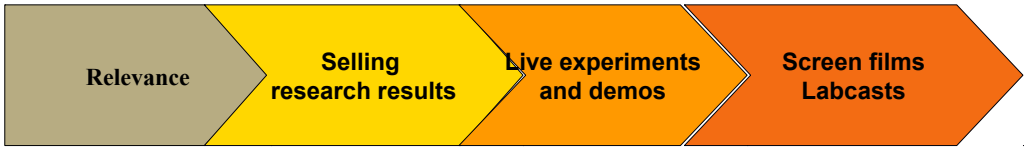
Revision for ... Unity and Coherence with Controlling Ideas

- 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.

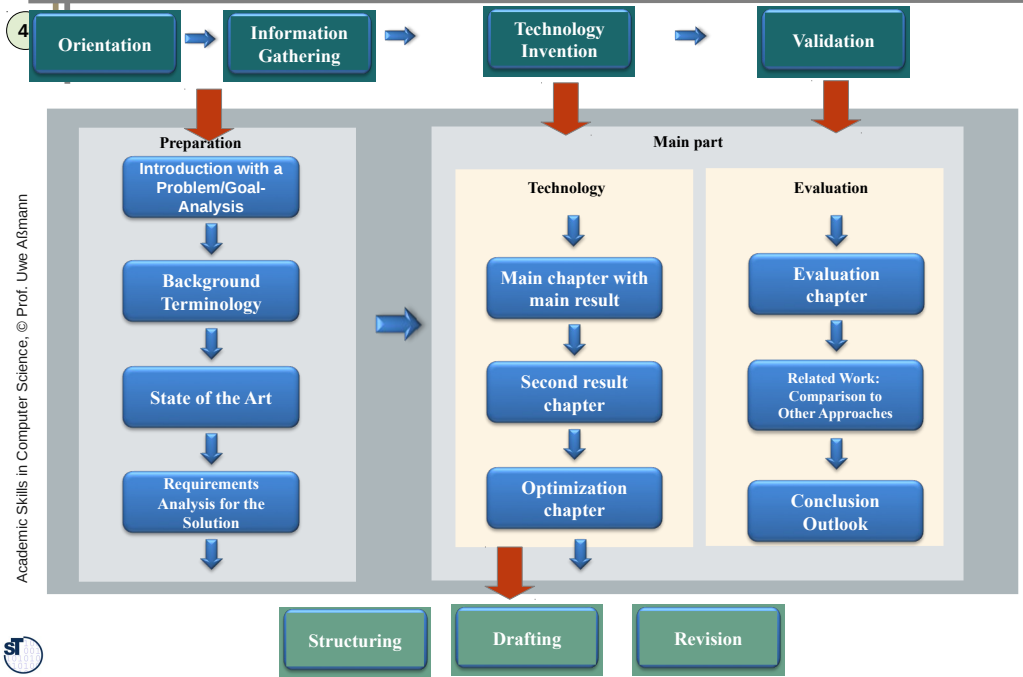


Demonstrating

- 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)

- 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)

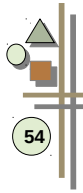
- Winston Churchill is also a good read? This week, read:
- Winston Churchill. "Their finest hour". Speech in the House of Commons. June 18, 1940. https://www.winstonchurchill.org/learn/speeches/speeches-of-winston-churchill/1940-finest-hour/122-their-finest-hour
- Look at the last paragraph. Construct 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

- Several slides are courtesy to Sebastian Cech