14. Elementary Problem Analysis, Idea Generation, and Solution Invention

Prof. Dr. Uwe Aßmann
Softwaretechnologie
Fakultät Informatik
Technische Universität Dresden
2013-1.0, 13-5-6
http://st.inf.tu-dresden.de/vba

1) Good Questions
2) Problem Analysis and Idea Generation
3) GAP Analysis (Generation, Assessment, Prioritization)
4) Assessment and Prioritization Methods
    1) Qualitative and Quantitative Analysis for Olympic and Efficiency Criteria
5) Solution Processes
6) Aspect-Oriented Problem Analysis with SWOT
7) Aspect-Oriented Problem Analysis with UCEW

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann
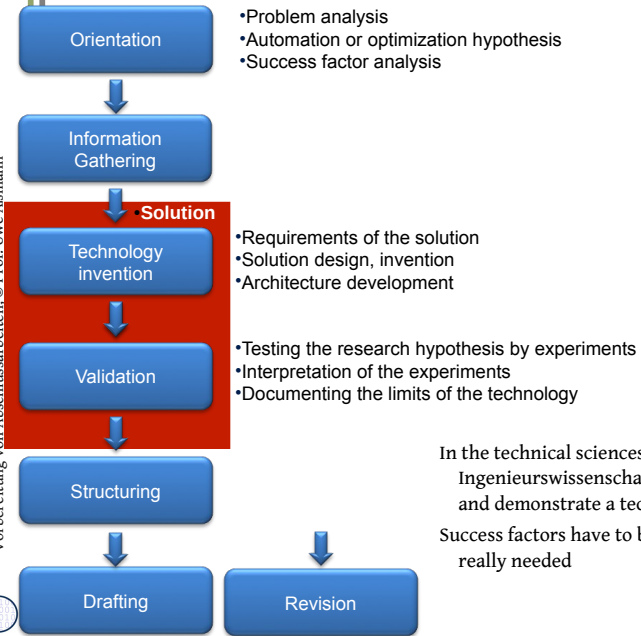
1

References

2

- ► [Thiele] Albert Thiele. Die Kunst zu überzeugen. Faire und unfaire Dialektik. Springer.
- ► [Leicher] R. Leicher. Verkaufen. TaschenGuide. Haufe-Verlag.
- ► [Scherer] Hermann Scherer. 40 Minuten für eine gezielte Fragetechnik. Gabal Verlag
- ► [deBono] Edward de Bono. de Bono's neue Denkschule. Kreativer denken, effektiver arbeiten, mehr erreichen. mvg-Verlag, München.
- ► [VanGundy-ProblemSolving] Arthur B. Van Grundy. Techniques of structured problem solving. Van Nostrand Reinhold Company, 2nd edition, 1988. The bible of problem solving techniques.
- ► [Hill] Bernd Hill. Der Methodenbaukasten - Ein Kompendium von Methoden zur Erkennung und Lösung technischer Probleme. 2. erw. u. überarb. Aufl. [Taschenbuch bei amazon]
- ► Rohrbach, Bernd: Kreativ nach Regeln – Methode 635, eine neue Technik zum Lösen von Problemen. Absatzwirtschaft 12 (1969) 73-76, Heft 19, 1. Oktober 1969.
- ► Basili, V.R.; G. Caldiera, D. Rombach (1994). The Goal Question Metrics Approach. Encyclopedia of Software Engineering (Wiley).
- ► O Nierstrasz. Identify the champion. Pattern Languages of Program Design, 2000. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.77.3459&rep=rep1&type=pdf
- ► Ziel-orientierte Projektplanung (ZOPP) from GTZ (Gesellschaft für technische Zusammenarbeit) www.gtz.de:
    - ▪ http://portals.wi.wur.nl/files/docs/ppme/ZOPP_project_planning.pdf
    - ▪ GTZ is a German society for development. ZOPP is a general-purpose project planning and requirements analysis method. Google for it.....
- ►

3

- ► Mark Sh. Lewin's web page on problem analysis and solving: http://www.mslevin.iitp.ru/
- ► Ritchey's book on Wicked Problems and GMA: Tom Ritchey. Wicked Problems – Social Messes. Decision Support Modelling with Morphological Analysis. Series: Risk, Governance and Society, Vol. 17. 1st Edition., 2011, Springer.
    - ▪ http://www.springer.com/business+%26+management/technology+management/book/978-3-642-19652-2

Obwohl ich diese Unterscheidungen nur zum Hausgebrauch mir zurechtgelegt habe, zur eigenen Orientierung in den verwickelten Erscheinungen meines Beobachtungskreises, muß ich hier doch ausdrücklich auf sie hinweisen, um die Gesichtspunkte meiner Ausführungen genügend erkennbar zu machen.

Ernst Abbe in Gesammelte Abhandlungen III
Vorträge, Reden und Schriften sozialpolitischen und verwandten Inhalts
Editor: S. Czapski
http://www.gutenberg.org/1/9/7/5/19755/

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Rept. The OIS-SDR Research Process for Technical Science Thesis

4

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

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

Information Gathering

Solution

Technology invention
- •Requirements of the solution
- •Solution design, invention
- •Architecture development

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

Structuring

Drafting   **Revision**

How do I find a solution? How do I invent a technology?

In the technical sciences (engineering science, Ingenieurswissenschaft), a thesis must be technical, i.e., achieve and demonstrate a technical result.

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

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Eternal Problems While Inventing

- ► Edison tried more than 2000 different variants of the light bulb before he found a successful design in 1879
    - ▪ http://www.shapell.org/btl.aspx?2718806
- ► You have written the literature review – but how to find a solution for your research problem?

> Use systematic methods to
> speed up finding a solution

Problem Solving with VanGundy Problem Solving Method

- ► [VanGundy-ProblemSolving] contains a structured, very general process to solve structure problems: ARGESI
    - ▪ Problem analysis and Redefinition
    - ▪ Generating Ideas
    - ▪ Assessment and Evaluation of Ideas
    - ▪ Selection of ideas
    - ▪ Implementation and Realization

14.1 Good Questions

- ▪ [Thiele, Leicher, Scherer]

The Law of Questions for Problem Solving

- ► 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!

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!

Rudyard Kipling „Just so stories"
http://www.gutenberg.org/cache/epub/2781/pg2781.txt

The 6+1 Honest Men and the 7 W-Fragen

▸ 6 hones serving-men do not contain "for what?"

▸ [Thiele] shows that the 7-W questions must be instantiated for different purposes in form of checklists. E.g., for problem analysis, goal analysis

	Problems	Goals
Who?	Who is responsible to treat the problem?	Who has defined this Goal? Who benefits from achieving this goal?
What?	What is the real problem? What are the subproblems of the problem?	What are the subgoals of this goal?
How?	How does this problem affect us? How can we solve this problem? How can we delay the handling of the problem?	How will we achieve this goal?
Where?	Where did the problem occur?	
When?	In which situation did the problem arise?	When will we achieve this goal?
Why?	Why did the problem occur?	Why is it important?
For what? To which end?	What would a solution for the problem help us to achieve? What will happen if we don't solve the problem?	What will the achieved goal further enable?

Different Types of Questions

▸ **Open questions:** begin with who, why, when, which (the 7 W)...
  • Motivatory
  • The asked person can talk afterwards... (collect-information phase)
  • Good for papers
▸ **Closed questions:** ask for a boolean value
  • "Do you?" "Don't you?"
  • These questions force decisions and are to be answered by yes/no (commitment or conclusion phase)
  • Use rarely in papers!
▸ **Alternative questions** are to be answered by one of two alternatives
  • "Would you prefer alternative A or B?"
  • "is a red or blue car better?"
▸ **Rangierfrage:** change the "playground", I.e, the field of discussion
  • "What do you think, shouldn't we first talk about the background/side condition/cause/effects of this problem?"
  • "What do you think, how is problem X related with your problem?"
  • For dialectic, pivot paragraphs

Different Types of Questions – Somewhat Critical for a Paper

▸ **Mirroring questions** mirror the attitude of the dialogue partner.
  • "So you think that this solution is not appropriate for your problem?"
  • "This means that you think that this is not your main problem?"
  ▪ Mirroring questions transform statements into questions
  ▪ "Our competitor is too expensive." --> "Do you also feel that our competitor is too expensive?"
▸ **Suggestive questions** are rhetoric, that is, not real questions, but pseudo questions
  • "Is it true that you are interested to simplify your production?"
  • Handle them with care, because they can create anger
  • Suggestive questions are dangerous, because they can make the reader angry
▸ **Positive questions:** try to avoid negative questions, make the dialogue partner answer "Yes". They prepare other, open questions:
  • "Are there any problems on your side?" --> "What happened?"

Problem Questions are Good for Introductions

- ► A **problem question** analyzes together with the dialogue partner (reader, listener, customer, etc.) his problems.
  - Problem questions clear the mind of the dialogue partner
  - Show him the situation more clear
  - Create interest
- ► Examples
  - "What are the obstacles to automate this function?"
  - „What is disturbing with your supplier?"
  - "Which functionality is your product lacking?"
  - "Which problems do you have with the tool you use these days?"
- ► Problem questions lead to ZOPP-like development schemes

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

State Questions for Setting the Scene in Introductions

- ► A **state question** asks the dialogue partner (customer) about his/her state of affairs
  - „How can I help you?"
  - „Which functions are you interested in?"
  - „With which supplier do you work these days?"
  - „How large is your budget?"
  - „How is the decision process?"
- ► State questions are asked first, to enter the discussion
- ► **State paragraphs (setting-the-scene paragraphs)** discuss a state question in the introduction, for setting the scene

- ► A **summarization question** summarizes the results of the analysis and attempts to get the agreement with the customer about the analysis
- ► For your summary or intro

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Effect Questions (Auswirkungsfragen)

- ► An **effect question** analyzes together with the dialogue partner the effect of his problems and the consequences of his decisions. It opens a cause-effect analysis (CEA)
- ► Effect questions
  - Visualize the effects of the current situation to the customer
  - Look into the future
  - Highlight trends and developments
  - Bring the customer the insight that he must solve his problem
- ► Examples for positive effects
  - „What is the significance of this problem with your supplier?"
  - Which other problems would this cure?
  - What should be changed to increase the effitivity of this tool?
  - What does the solution of your problem mean to the win/balance of your company?
- ► Examples for negative effects
  - „What is the significance if this problem is not solved?"
  - Which other problems would result if this is not solved?
  - Supposed you leave it like it is, what would result?

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Benefit Questions

- ► A **benefit question (usefulness question)** is a special type of effect question, highlighting a benefit to the dialogue partner.
  - „Which additional space could you win buying this new machine?"
  - "Which advantages will you get from introducing this new technology?"
  - "which group of people will benefit from this new technology?" (Who)
- ► **Olympic questions:** faster, higher, farer
  - "what do you gain with this method?" "How far do you come with this?" "How much faster are you?"
  - „How would the win of your company rise, given you buy this machine?"
- ► **Efficiency questions:** How much better will it be?
  - "when will you be able to achieve turnaround with this method"
  - "what do you think about this simplification?"

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

> Effect and Benefit questions are very important because they lead to controlling ideas of texts and talks.

The 6 Honest Men (7 W-Questions) Instantiated for Benefit Questions

▶ For finding a controlling idea of a text or talk, the 7-W-Questions should be tried to expand into a checklist. This checklist can be used to create alternatives for C.I.

	Benefit	Success factors
Who?	Who will benefit from solving this problem?	Who has defined this success factor?
What?	What is the real benefit of this solution? What is the cost?	What are the success factors to measure the achievement of this benefit?
How?	How do we increase the benefit of this solution? How is this benefit achieved?	How will we measure the success of this?
Where?	Where did the problem occur?	Where will we measure the success of this?
When?		
Why?	Why do we need the benefit?	
For what? To which end?	Why do we need the benefit? What will happen if we don't solve the problem?	

Excercise: Instantiate the 6 Honest Men for

▶ Summary Questions
▶ Olympic questions
▶ Efficiency questions

The Law of Paragraph Question and the Classes of Questions

▶ Remember the Law of Paragraph Question
▶ Which class of question fits to your paragraph?
  - open? probably closed is hard to write about
  - Problem questions lead to problem description paragraphs
  - Summarizing questions to summaries
  - Alternative questions lead to a development scheme called comparison and contrast" (dialectic development)
  - Benefit questions are always nice
  - Effect questions lead to cause-effect development scheme

> Law of Paragraph Question:
> Never write a paragraph without an invisible question you answer in the paragraph.

14.2 Problem-Objective Analysis (POA) for POPP (Problem-Objective-Oriented Project Planing) ZOPP (Ziel-orientierte Projektplanung)

> Without problem-goal analysis no way to invention, to technology nor to a scientific result.
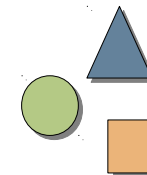
The Swiss Knife of Solving Problems: Problem and Objective Analysis POA for POPP

- ▸ POA/POPP is a **goal-oriented problem-solving analysis and planning method** with success proof:
  - With a set of success criteria, it is checked whether the solution solves the problem
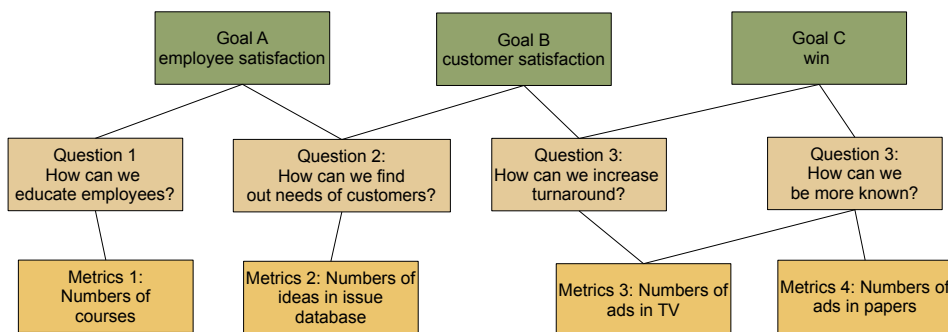- ▸ Ubiquituous like the V-model

---
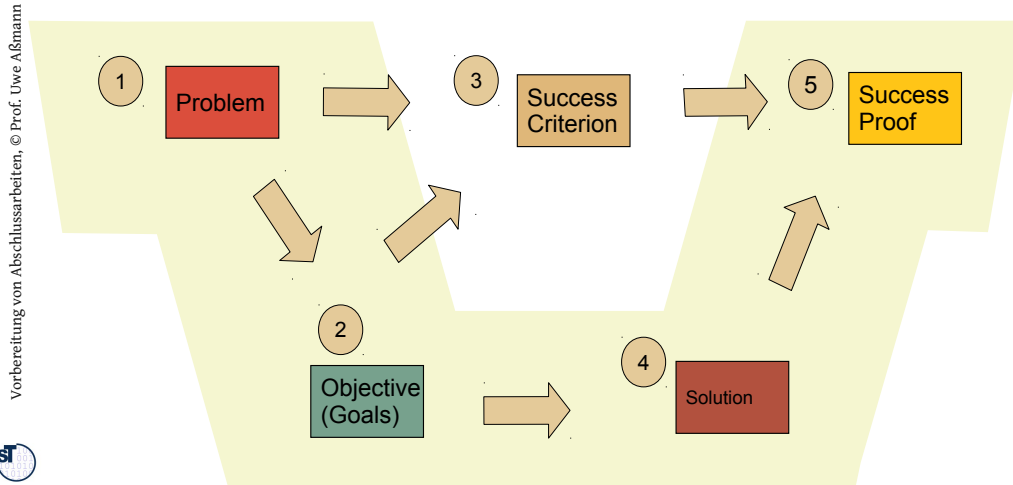
Exc.: Solving Some Practical Problems

- ▸ "I am so lonely"
- ▸ "I am so hungry"
- ▸ "Germany has too many unemployed people"
- ▸ "Neonazis are a danger for democracy"

Goal-Question-Metric Approach (GQM)

- ▸ GQM [BasiliRombach] is a special POPP method
- ▸ The original GQM approach uses a multi-bush (3-level multi-hierarchy) of goal level, question level and metric level.
  - Questions can be related to several goals
  - Metrics can be related to several questions
- ▸ Idea: Achieve the goals by answering questions with metrics
- ▸ Use the 6 honest serving men to generate questions

Exc.: Solving Some Practical Problems with GQM

- ▸ "I am so lonely"
  - Different goals may solve this problem, "have a beer in the evening", "marry in 12 months", "move into a Wohngemeinschaft"
  - Correspondingly, questions and metrics are different
- ▸ "I am so hungry"
- ▸ "Germany has too many unemployed people"
- ▸ "Neonazis are a danger for democracy"

Hierarchical Problem and Goal Analysis ZOPP

▶ ZOPP is a hierarchical goal-oriented problem-solving method with success proof, more general than GQM. Developed by GTZ, ubiquituous like the V-model

▶ PROblems, GoaLs, Success factOrs, Success proof, see course ST-2
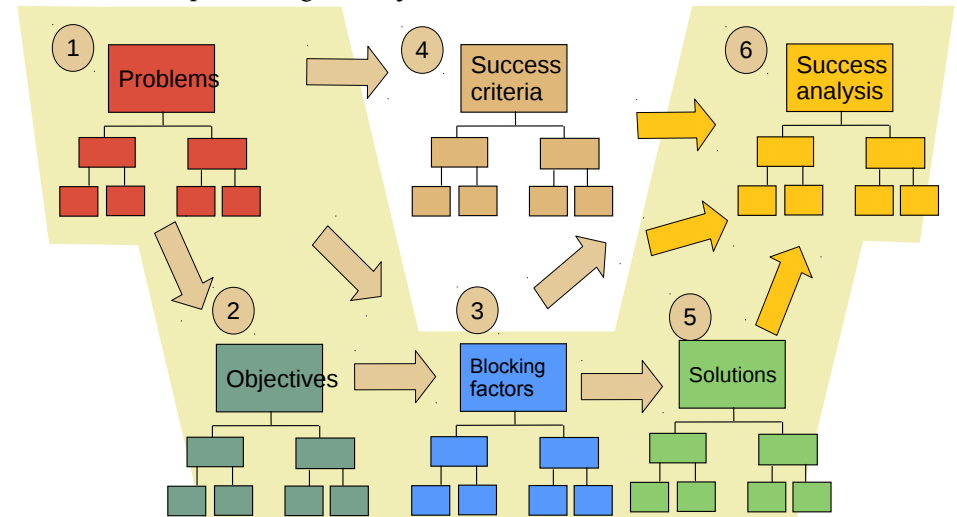

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Hierarchical Problem and Goal Analysis PROBLOSS

▶ Sometimes, it is possible to determin **blocking factors** preventing that the objectives are reached.

▶ PROBLOSS is a ZOPP-like problem and efficiency analysis that checks blocking factors preventing that objectives are reached.

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann
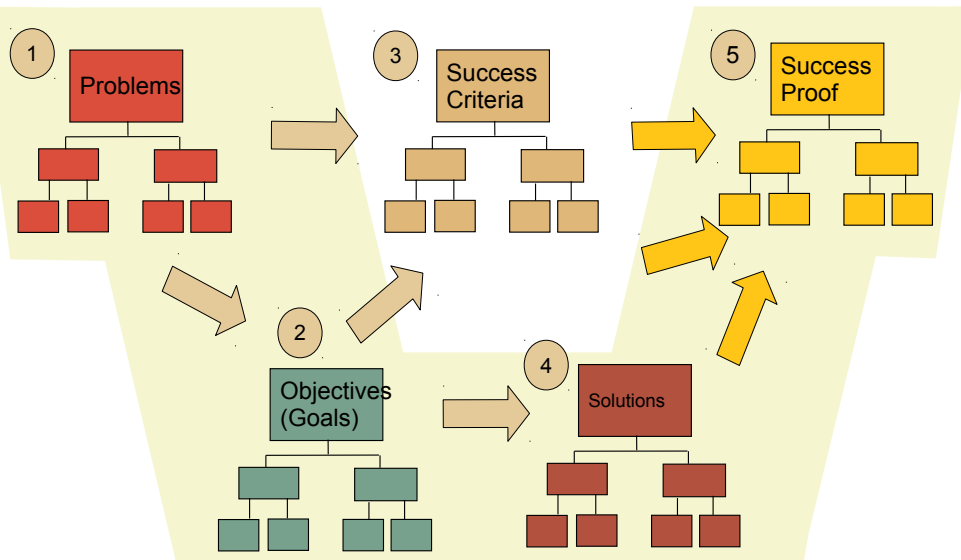
POPP For Your Research

▶ **For all kinds of research:** Bachelor, Master, PhD thesis, Research paper, Essay, Analysis study

▶ **Do a GQM, ZOPP or a PROBLOSS** and refine it over all the duration of the research

▶ Benefits:
  - If you do not solve a real problem, your research is not relevant
  - Goal analysis helps to think
  - Hierarchical goal analysis helps to focus on the more important issues
  - If your decomposition of the problem is good, you may say something about the *solution's coverage of the problem:*
    • Did I forget to solve a subproblem or are all problems solved? How complete is the solution?

• Benefits for your reports
  - Usually a good ZOPP or PROBLOSS gives you an introduction for free: just write a paragraph or a section on each of the steps
  - In particular, the *research contributions (research results)* become very clear.
  - An entire report can be structured like ZOPP or PROBLOSS

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Exercise:

▶ Repeat the paper "Zähmt den Kapitalismus" of Schmidt, and look at his arguments again.

▶ Do a PROBLOSS with his article.

▶ Did Schmidt really treat all problems?

▶ Which of his problems are blocking factors?

▶ Did he distinguish problems and goals?

▶ Did he mention success factors?

▶ Rewrite the paper starting from your own PROBLOSS.

▶ Write an introduction by writing a sequence of apragraphs:
  ▪ background problem → technical problems
  ▪ goals
  ▪ blocking factors
  ▪ success factors
  ▪ solution, approach
  ▪ success validation

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Exercise with LaTeX

► a) Put PROBLOSS into a LaTeX template with comments marking up the parts

```
% problems
% objectives
….
% success analysis
```

► b) Put PROBLOSS into a LaTeX style file, defining commands for your documents:

```
\def\problems#1{#1}
\def\objectives#1{#1}
….
\def\successAnalysis#1{#1}
```

► c) do the same defining LaTeX environments

```
\newenvironment\problemEnv{}{}
```

Exercise

► a) Reanalyze Churchill's "Finest hour" speech, in particular the last concluding paragraph, with BATE-PROBLOSS.

- Which goals does Churchill have?
- Which questions does he derive from the goals?
- What's the background, what's the technical problems?
- What is the success factor? Is he giving a metrics?

► b) Write a exposé for a Bachelor oder Master's or PhD Thesis with BATE-PROBLOSS.

Improved BATE-PROBLOSS

► For technology research, it is useful to split problems into **background** and **technical problems**
► Background problems show economic, societal, ethical importance
► Good for research project proposals!
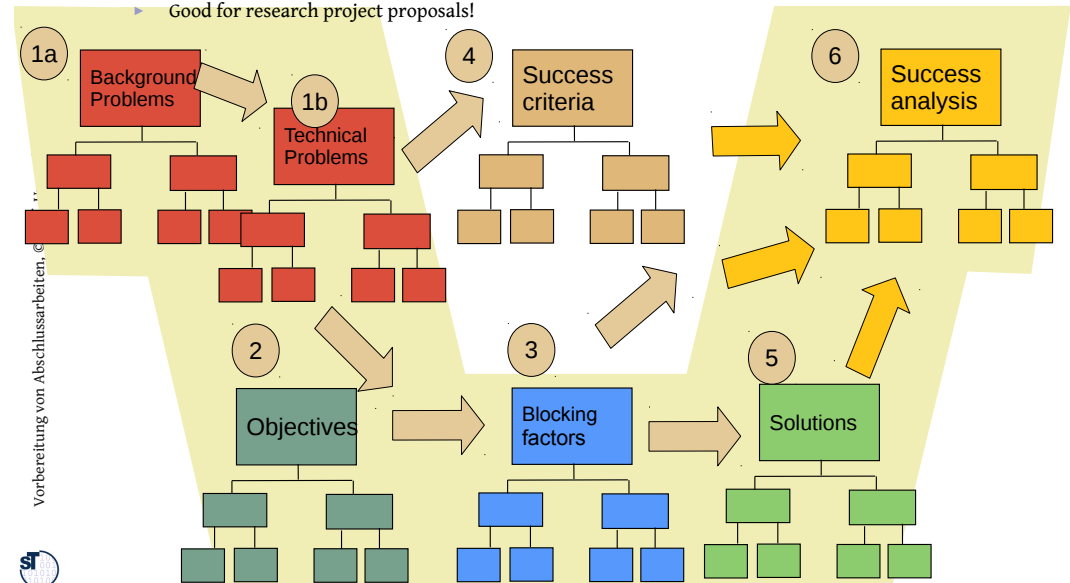
Improved BATEID-PROBLOSS for Theorem Papers

► For idealized research, it is useful to split problems into **background** and **technically practical,** and **idealized (model) problems**
► Split also success factors and success analysis: This is called **funnelling**
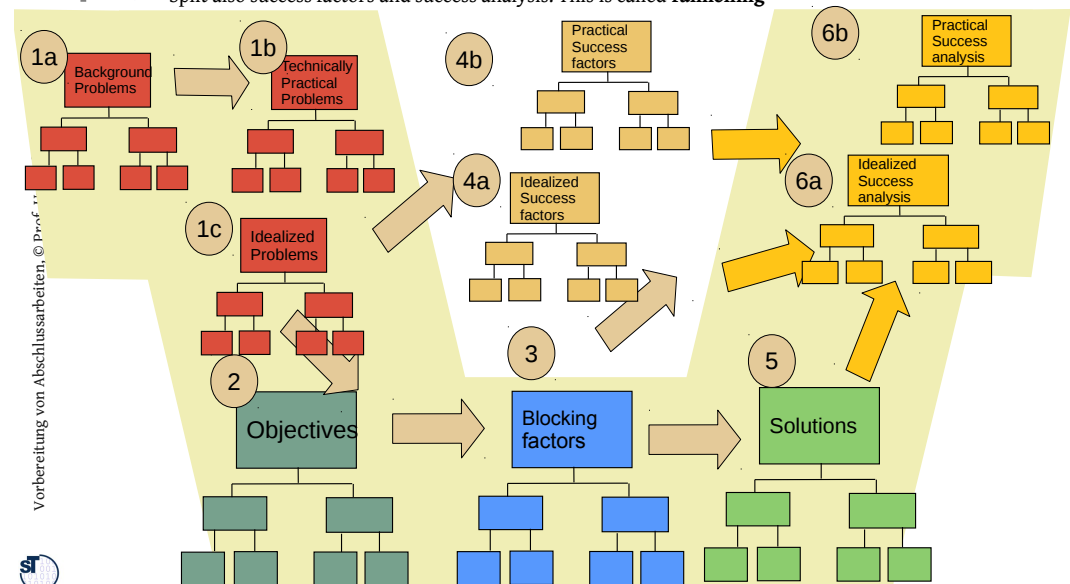
3
3

- ▶ [Uwe Aßmann. Graph rewrite systems for program optimization. ACM Transactions on Programming Languages and Systems (TOPLAS), 22(4):583-637, June 2000.]
- ▶ **General Background:** Inefficient software is costly for society.
- ▶ **IT Background:** Construction of program optimizers is hard and costly, at least 1-3 person years are necessary. (economic problem)
- ▶ **Technical problem:** Optimizers cannot be generated, there are diverse theories for single steps, but none is used for generation
- ▶ **Goal:** generate optimizers from specifications to speed up development
- ▶ **Blocking factors:** no uniform theory for model-driven development of program analyzers and transformers is available.
  - ▪ No theory can make it possible to shift analyses into transformations and vice versa
- ▶ **Solution:** Use graph rewriting to specify optimizers
  - ▪ Definition: Use *edge-addition rewrite systems* to specify program analysis for reachability
  - ▪ Definition: Use *exhaustive graph rewrite systems* to specify transformation
  - ▪ Uniformity because everything is graph rewriting
  - ▪ Theorem: Use stratification to order complex rewrite systems, based on a rule dependency graph which allows for moving rules to other rule systems
  - ▪ Theorem on implementation: show that a specific algorithm avoids inefficient redex search (order algorithm)
- ▶ **Success factors:** show the specification of several analyses and transformations
  - ▪ show the uniformity; show how the optimizer works; show how fast it is running; show optimization effectiveness
- ▶ **Success proof:**
  - ▪ Mathematical proof of the theorems

14.3 Generation of Ideas, Alternative Analysis, and Prioritization (GAP Analysis)

35

- ▪ [VanGundy-ProblemSolving]

3
4
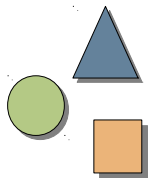
- ▶ 1) Write the introduction section of a
  - ▪ "Why adaptive software architecture can help to solve the German SmartGrid problem"
  - ▪ Use BATE-PROBLOSS
- ▶ 2) Write the introduction section of a theorem paper on
  - ▪ "Composition of finite real-time automata for driving trains in time"
  - ▪ see www.railcab.de and the research of Prof. Schäfer's group in Paderborn as inspirement
  - ▪ Use BATEID-PROBLOSS for idealized research
- ▶ 3) Write the outline of a research project proposal for a funding agency, such as EU or DFG, with BATE-PROBLOSS
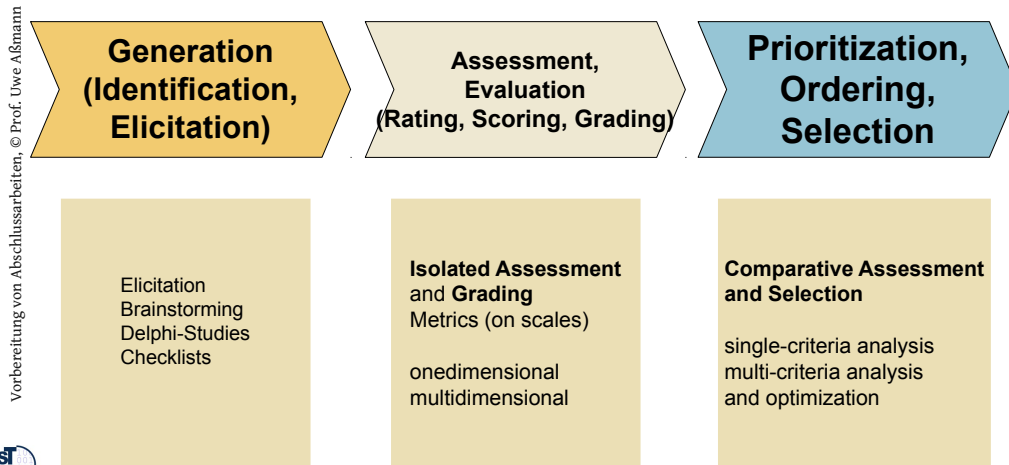 - ▪ "Service robots for helping elderly people in their home"

3
6

- ▶ In a **design phase** of a thesis, not only one design should be investigated, but several alternatives
  - ▪ They should be compared, assessed and documented in the report (alternative analysis)
- ▶ Technical science motivates the selection of a best technology according to assessment criteria
- ▶ Your work is not scientific if you just choose the first solution and do it

Design task → Alternative generation → Alternative analysis: comparison and prioritization → Alternative selection
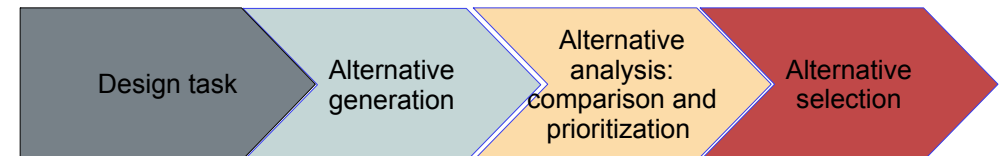
Generation of Prioritized Lists with GAP

- ► For assessments and analyses of ideas, problems, solutions, risks, etc
- ► For alternatives if difficult decisions have to be taken
- ► For example: What do I do if I have a research goal, but no research problem?

Generation (Identification, Elicitation)	**Assessment, Evaluation (Rating, Scoring, Grading)**	**Prioritization, Ordering, Selection**
Elicitation Brainstorming Delphi-Studies Checklists	**Isolated Assessment** and **Grading** Metrics (on scales) onedimensional multidimensional	**Comparative Assessment and Selection** single-criteria analysis multi-criteria analysis and optimization

Scientific Aspect of GAP for Design Chapters of Final Theses

- ► For a problem of technical science, usually, several designs exist to solve it (tool and software architectures, etc)
- ► Though one design must be selected, the alternatives should be
  - ▪ G: generated (invented, developed, documented)
  - ▪ A: evaluated and assessed
  - ▪ P: prioritized, ordered and selected
- ► A good design chapter discusses several alternatives and why the chosen design is the best!

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

- ► [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

Alternatives	Possibilities	Choices

Variation and Extension Method for GAP Analysis

- ► **Variation Method about Variability Analysis** [Hill, Zwicky]
  - ▪ In a basic solution, try to *find variables (variation points)* which might be changed. In specifications or designs, the variables are called *variation points*
  - ▪ Analyze their range: which values may they take?
  - ▪ Change the variables
  - ▪ Build variant solutions
- ► **Extension Method, Extensibility analysis**
  - ▪ In a basic solution, try to find *variables* which might be *extended*. In specifications or designs, the variables are called *extension points*
  - ▪ Analyze their range
  - ▪ Extend the variables
  - ▪ Build variant solutions

Zwicky's General Morphological Analysis (GMA), a Specific Variation Method

- ▶ [http://www.swemorph.com/ma.html]
- ▶ When variables and their values span up dimensions, they can be written up in a 2-d matrix, combinations can be formed of the values (value tuples).
  - ▪ The value tuples form a third dimension
- ▶ The structure is called **3-d morphological field**
- ▶ **Morphological analysis** works out, step by step, a 3-d morphological field by considering all combinations in the value tuple variant space

Variable 1	Parameter 2	Variable 3
Value 1.1	Value 2.1	Value 3.1
Value 1.2	Value 2.2	Value 3.2
Value 1.3	Value 2.3	
	Value 2.4	

14.3.2 Round-Robin Rotation Methods for Idea Generation

- ▪ for augmentation of ideas by groups

---

635 Method for Brainwriting with your Friends

- ▶ The 635-Methode (Bernd Rohrbach (1968) is a method for round-robin brainwriting [Wikipedia:Methode_635]
- ▶ 6 people write 3 new ideas to what they see already, in 5 rounds
- ▶ First round: initial ideas into empty table
- ▶ Round 2-5: after rotation, look at the fillings and write the next row into the table
- ▶ 635 can be done for problems, problems and solutions, alternatives, and many more.
- ▶ 635 can be seen as a "group-GMA".

Idea 1	Idea 2	Idea 3

Science Speed Dating

http://en.wikipedia.org/wiki/Speed_networking

- ▶ Participants sit at a table, with one on the opposite side
- ▶ Round 1: find an initial idea and draw it on a A3 sheet
- ▶ Round n: rotate to neighbor to the right, and work on the sheet there

- ▶ After: pin solutions to pinwalls and assemble comments, e.g., about the realisability of solutions and ideas
- ▶ Can be used for solution finding
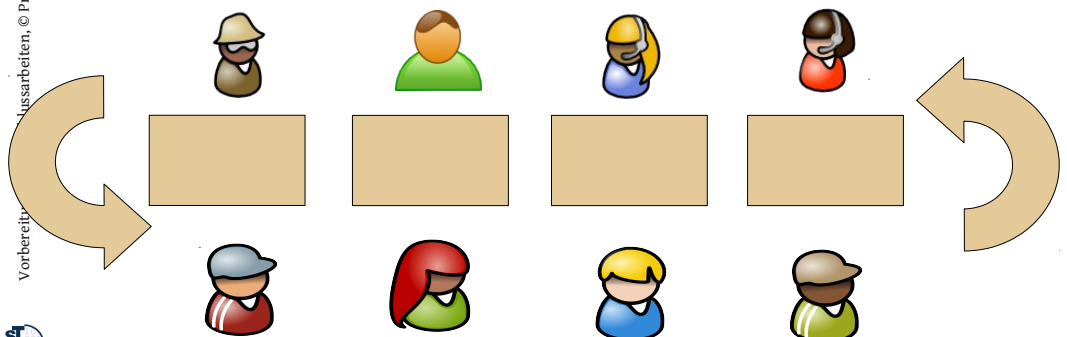
14.4 Assessment and Prioritization Methods
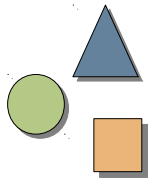
Prioritization with Simple Numeric Grading (Ordinal Scales)

[Hill]

- **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
- **"Percent grading":** express the adequateness as a quotient of value and whole (20%, 81%, 2/3, ¼, etc)
- **"Factor scaling":** express the adequateness by a real number between 0 and 1 (e.g., stochastic or probabilitic grading)
- **"Identify the Champion"** for taking an explicit standpoint and forcing of decisions (Oscar Nierstrasz)
  - A: I fill fight for it
  - B: I am in favor, but I will not fight for it
  - C: I am against, but I will not fight against it
  - D: I will fight against it

Another Simple Form of Assessment and Binary Prioritization: de Bono's PMI (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

Plus	Minus	Interesting

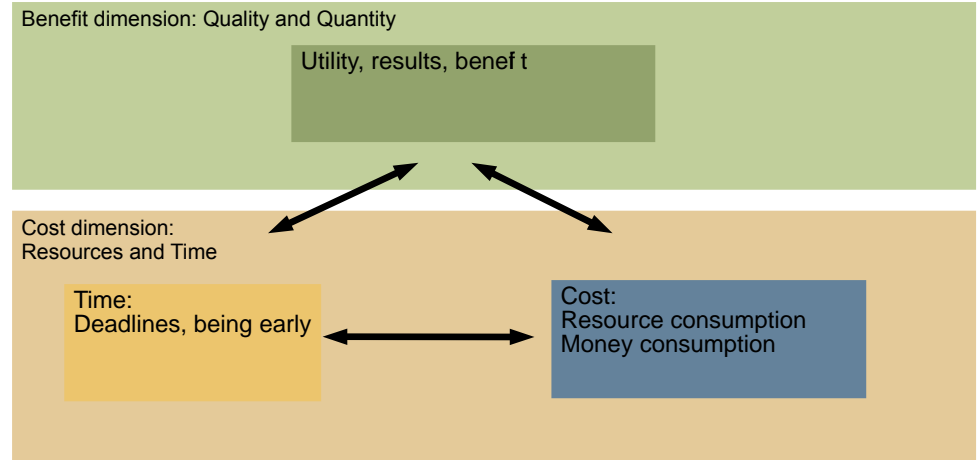## 14.4.1 Quantitative and Qualitative Comparisons for Olympic and Efficiency Success Criteria
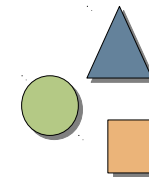
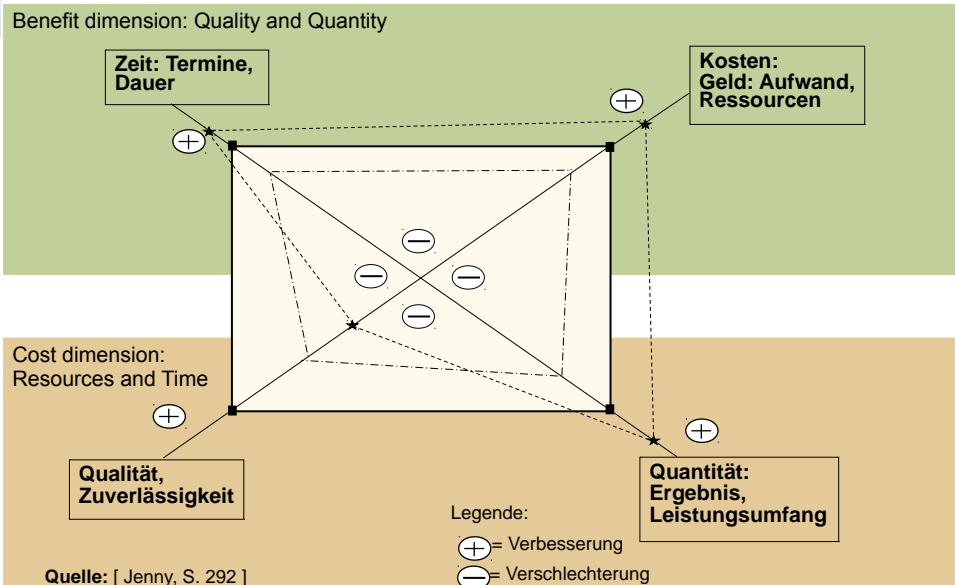## Olympic Evaluation Questions and Efficiency Evaluation Questions

- ▶ Approaches, ideas, and solutions can be evaluated with regard to
  - Olympic criteria (faster, higher, farer) or
  - Efficiency criteria (cost vs utility)
  - (see types of questions)

"Magic Triangle" of Objectives

- ▶ Many research problems in technical science deal with **benefit (utility)** or **cost (resource consumption)**
- ▶ An **olympic research problem** is about increasing benefit or reducing cost
- ▶ Others are **efficiency problems:** increase benefit while reducing cost
- ▶ These are related to **olympic** or **efficiency goals**

Benefit dimension: Quality and Quantity

Utility, results, benef t

Cost dimension:
Resources and Time

Time:
Deadlines, being early

Cost:
Resource consumption
Money consumption

Eternal Questions in Solution Assessment: Gummi-Twist der Prozess- und Produkt-Ziele

Benefit dimension: Quality and Quantity

Zeit: Termine, Dauer

Kosten: Geld: Aufwand, Ressourcen

Cost dimension:
Resources and Time

Qualität, Zuverlässigkeit

Quantität: Ergebnis, Leistungsumfang

Legende:
⊕ = Verbesserung
⊖ = Verschlechterung

Quelle: [Jenny, S. 292]

Olympic Analysis with BeNeSiLo – Which Progress are we interested in?

- ▶ BeNeSiLo is a 4-D attribute analysis measuring progress qualitatively or quantitatively (Better, Nicer, Simpler, LongerLasting)
- ▶ Enter your own technology and competitors into BeNeSiLo for qualitative or quantitative olympic analysis
- ▶ **Qualitative comparison:** without scales
- ▶ **Quantitative comparison:** with scales (e.g., ordinal)
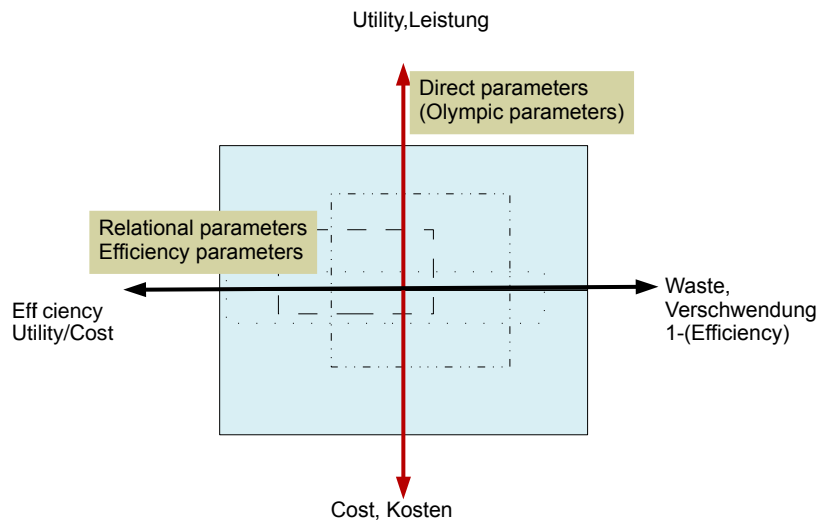
Better

Longer lasting — Nicer

Simpler
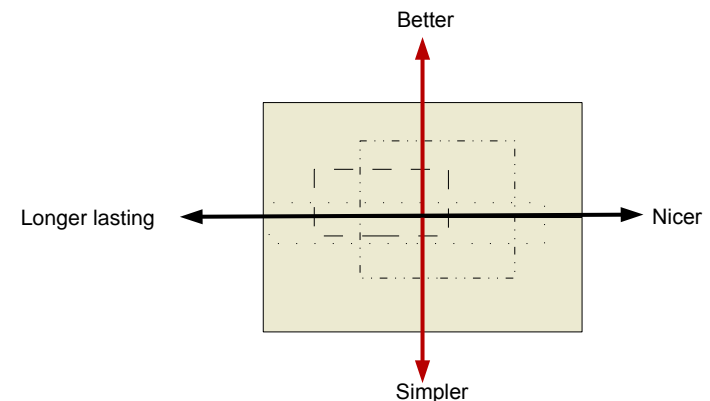
Exercise: Comparing Sort Algorithms

- ▶ Sorting is a well researched field of algorithmics
- ▶ Do a BeNeSiLo analysis for comparison of sort algorithms
- ▶ Look for comparing papers of sort algorithms
- ▶ Compare according to three criteria:
  - ▪ Speed (complexity)
  - ▪ Average speed (average complexity)
  - ▪ Memory consumption
  - ▪ Energy consumption
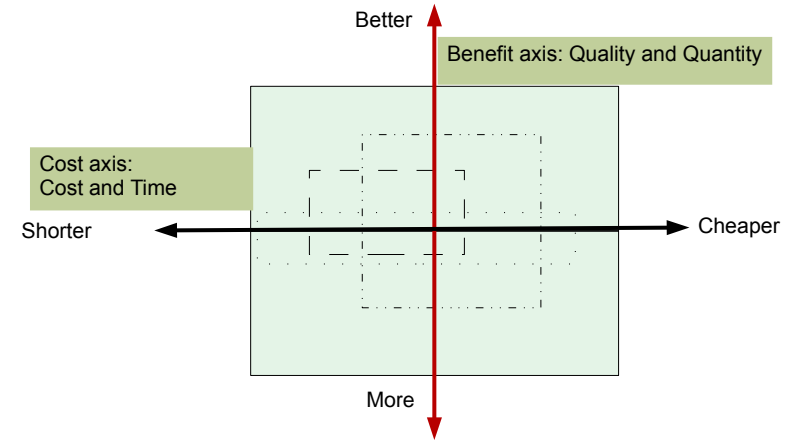- ▶ Draw several BeNeSiLo cross diagramm and comment it with a text

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Efficiency Analysis (Cost-Benefit Analysis) with CoTiQQ
How Efficient is our Technology?

- ▶ **CoTiQQ (Cost, Time, Quantity, Quality)** is a special 4-D analysis on cost and benefit axis
- ▶ Compare different technologies for *efficiency*
  - ▪ Larger areas mean *better efficiency*
- ▶ Enter your own technology and competitors into CoTiQQ for qualitative or quantitative analysis

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Olympic and Efficiency Analysis Combined with UCEW:
How Olympic and Efficient is our Technology?

- ▶ **UCEW** is a 4-dimensional attribute analysis comparing *efficiency* of a product, process, service, based on *olympic, direct* parameters (utility, cost) and indirect relations (efficiency, waste)
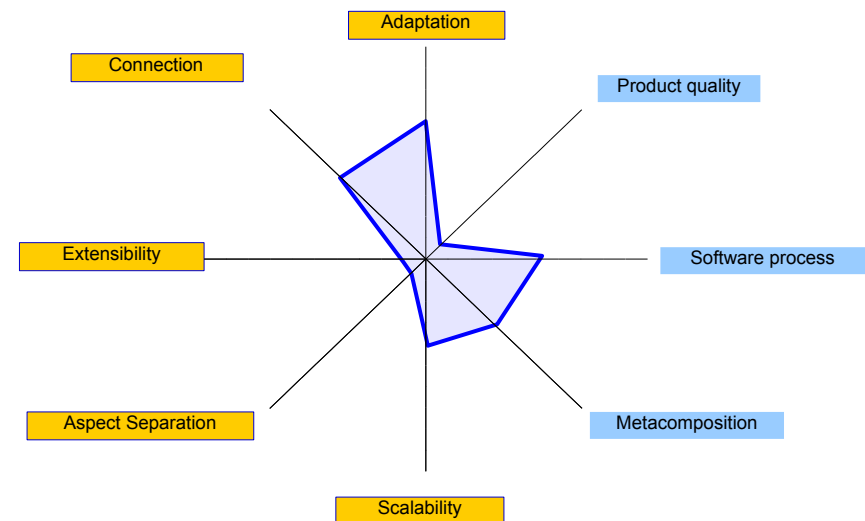

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

Multi-Criteria Attribute Analysis with Kiviat-Graphs

- ▶ A **Kiviat-Graph** draws a vector from an n-dimensional space into the plane.
- ▶ It visualizes a multi-criteria analysis

*Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann*

Exercise: Comparing Sort Algorithms with Kiviat

- ▶ Take up your BeNeSiLo analysis for comparison of sort algorithms
- ▶ Construct a Kiviat graph with the dimensions:
  - ▪ Speed (complexity)
  - ▪ Average speed (average complexity)
  - ▪ Memory consumption
  - ▪ Energy consumption
- ▶ Draw several sorting algorithms into the axes of the Kiviat graph

---

14.4.4 Advance Analysis - Comparisons for Approaches with Regard to Success Criteria

- ■ Advance analysis compares a set of approaches in the literature with regard to some success attributes/criteria/factors.
  - ▪ These criteria may stem from a literature analysis or classification.
  - ▪ The comparison is usually multi-criteria.
  - ▪ Display with tables, kiviat, or portfolios.
  - ▪ Qualitative (boolean) or quantitative (scales)
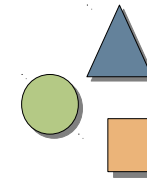
Ex.: Boolean Advance Analysis

- ▶ Boolean values in the multi-criteron analysis

	Approach 1	Tool 2	Technology 3	My approach
Criterion 1	no	no	no	yes
Criterion 1.2	may be	yes	no	yes
Criterion 1.3	no	unclear	yes	yes
Criterion 2	yes	yes	no	yes
Criterion 3	yes	no	no	yes

Ex.: American Woman Advance Analysis

- ▶ A "American Woman Comparison table" lists several approaches with grades 1-10 in the multi-criteron analysis, indicating the best approach
- ▶ For an advance analysis, you have to compare your own approach with all others
- ▶ Ex. Scientific evaluation of Papers: Papers are often evaluated with American Woman Analysis according to multiple criteria, e.g., Innovation depth

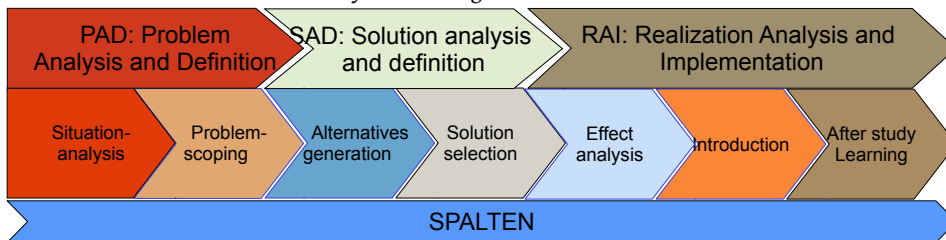|	Approach 1	Tool 2	Technology 3	My approach
Technical quality	5	3	9	7
Innovation depth	3	3	7	8
Presentation quality	6	4	8	7
Validation quality	7	2	7	9
Practicality	8	3	10	7
Expert level of Reviewer	10	7	8	9

Ex.: School Grade Analysis for Student's Theses

- ► German Grades 1-5 in the multi-criterion analysis, with 1/3 steps, or equivalently Abi-School grades:
- ► 0.7 (15 – not handed out), 1.0 (best, 14), 1.3 (13), 1.7 (12), 2.0 (11), 2.3 (10), 2.7 (9), 3.0 (8), 3.3 (7), 3.7 (6), 4.0 (5), 5.0 (4, 3, 2, 1, 0)
- ► For theses in Assmann's group, 3 Groups of Criteria exist: technical, presenation, and process quality

	Approach 1	Tool 2	Technology 3	My approach
Technical quality	12	4	3	12
Presentation quality	14	5	10	12
Process quality	12	8	8	11

14.5 Complete Problem Solving Processes (PSP)

- ■ A **problem solving process PSP** is a structured process to solve problems
  - ■ Problem analysis and definition (PAD)
  - ■ Solution design: generation, evaluation and selection (SAD)
  - ■ Realization analysis and Implementation (RAI)
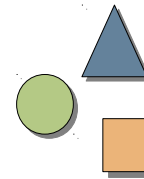

S.P.A.L.T.E.N. is a Solution Process with Assessment of Multiple Solutions

- ► SPALTEN is a problem solving process combining a GAP with a realization process
  Steps: [Wikipedia/Problemlösen]
  - ■ PAD: Problem analysis and definition:
    - · Situation analysis (Ist-Analyse)
    - · Problem analysis (demarcation, scoping, identification)
  - ■ SAD: Solution analysis and design with idea generation, evaluation and selection:
    - · Alternative generation (ideation, solution identification and generation)
    - · Evaluation (Assessment)
    - · Selection (Prioritization)
  - ■ RAI: Realization Analysis and Implementation:
    - · Effect, risk and consequence analysis
    - · Introduction (measures and processes)
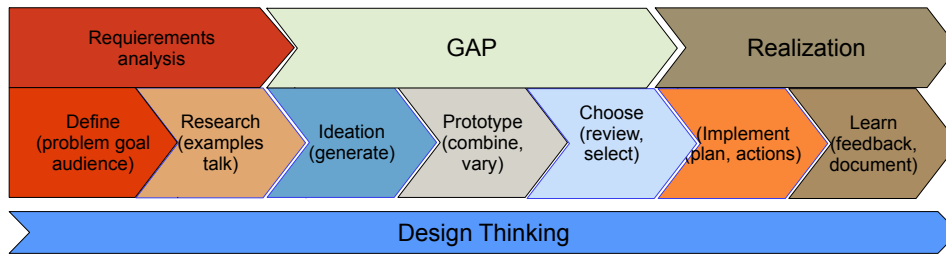   - · After study and learning

---

Write a Project Plan (GANTT) for the SPALTEN Process of Your Next Project

"Design Thinking" is a Solution Process with Assessment of Multiple Solutions

- ▶ http://en.wikipedia.org/wiki/Design_thinking
- ▶ Similar to SPALTEN

Design Thinking process: Requierements analysis (Define (problem goal audience), Research (examples talk)) — GAP (Ideation (generate), Prototype (combine, vary), Choose (review, select)) — Realization ((Implement plan, actions), Learn (feedback, document))

14.5 Aspect-Oriented Problem Analysis with SWOT-PROBLOSS

- ■ Cool, but fancy
- ■ The secret of my group, don't trade it
- ■ Dijkstra's swiss knife of scientific thinking

Dijkstra on Separation of Concerns

E. W. Dijkstra "On the Role of Scientific Thought", EWD 447 Selected Writings on Computing: A Personal Perspective, pages 60–66, 1982.

"Let me try to explain to you, what to my taste is *characteristic for all intelligent thinking.*

It is, that one is willing to study in depth an aspect of one's subject matter in isolation for the sake of its own consistency, all the time knowing that one is occupying oneself only with one of the aspects.

We know that a program must be correct and we can study it from that viewpoint only; we also know that it should be efficient and we can study its efficiency on another day, so to speak. In another mood we may ask ourselves whether, and if so: why, the program is desirable. But nothing is gained --on the contrary!-- by tackling these various aspects simultaneously.

It is what I sometimes have called ***"the separation of concerns"***, which, even if not perfectly possible, is yet the only available technique for effective ordering of one's thoughts, that I know of.

This is what I mean by "focussing one's attention upon some aspect": it does not mean ignoring the other aspects, it is just doing justice to the fact that from this aspect's point of view, the other is irrelevant. It is being one- and multiple-track minded simultaneously.

Intelligent thinking and scientific thought

Scientific thought comprises "intelligent thinking" as described above. A scientific discipline emerges with the --usually rather slow!-- discovery of which aspects can be meaningfully "studied in isolation for the sake of their own consistency", in other words: with the discovery of useful and helpful concepts. Scientific thought comprises in addition the conscious search for the useful and helpful concepts.

PROBLOSS (Rept.)

- ▶ PROBLOSS is a ZOPP-like problem and efficiency analysis that checks *blocking factors* preventing that objectives are reached.
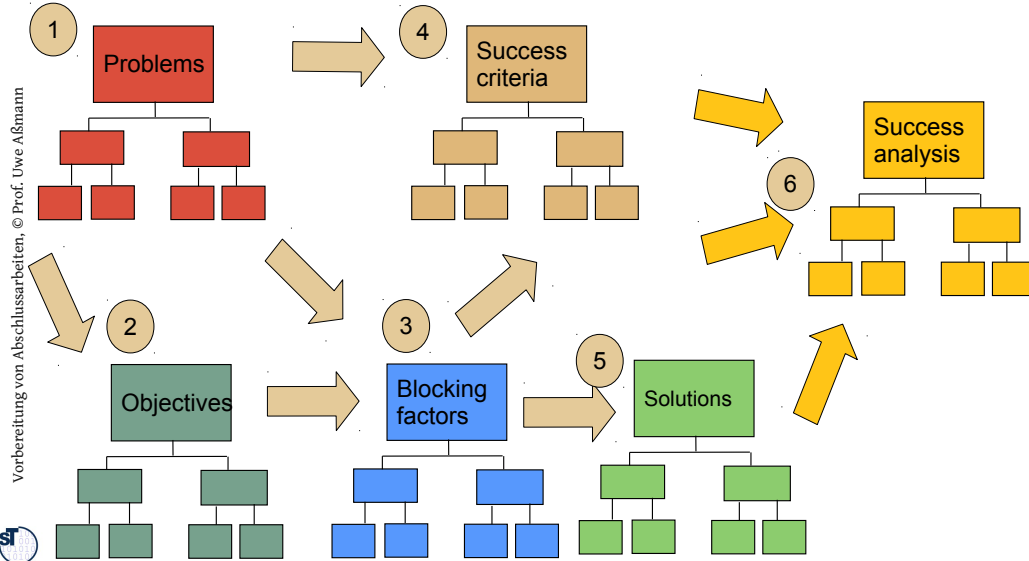

Purpose of Problem Analysis

- ▶ Analyzing the real demand of the customer, client, person, stakeholder
- ▶ Finding out ideas about what to sell to the customer
- ▶ Finding out niches in markets
- ▶ Do this for different perspectives of stakeholders
- ▶ Do this for different *concerns* or *aspects*

SWOT Analysis (Rpt.)

- ▶ SWOT ist eine 4-dimensionale Attributanalyse zur Ermittlung der Strategie einer Firma, eines Projekts [Albert Humphrey]
- ▶ Für strategische Entscheidungen
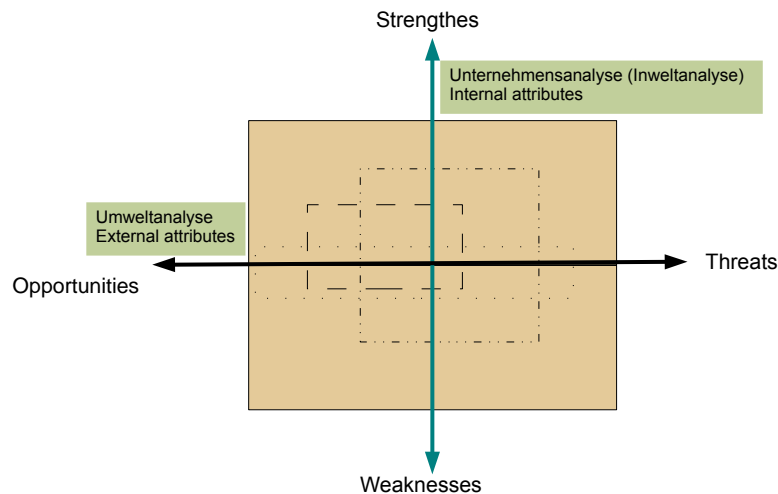
Aspect-oriented Problem Analysis (AO-POA)

An **aspect-oriented problem analysis** analyses a problem with a set of concerns in mind and produces a cross-product of a concern space with a problem analysis scheme

- ▶ The problem analysis method is done for all concerns
  - ▪ Concerns are compared
  - ▪ Quadratic many steps in the problem analysis (crossproduct)
- ▶ An **olympic AO-POA** uses an olympic concern space
- ▶ An **efficiency AO-POA** uses an efficiency concern space

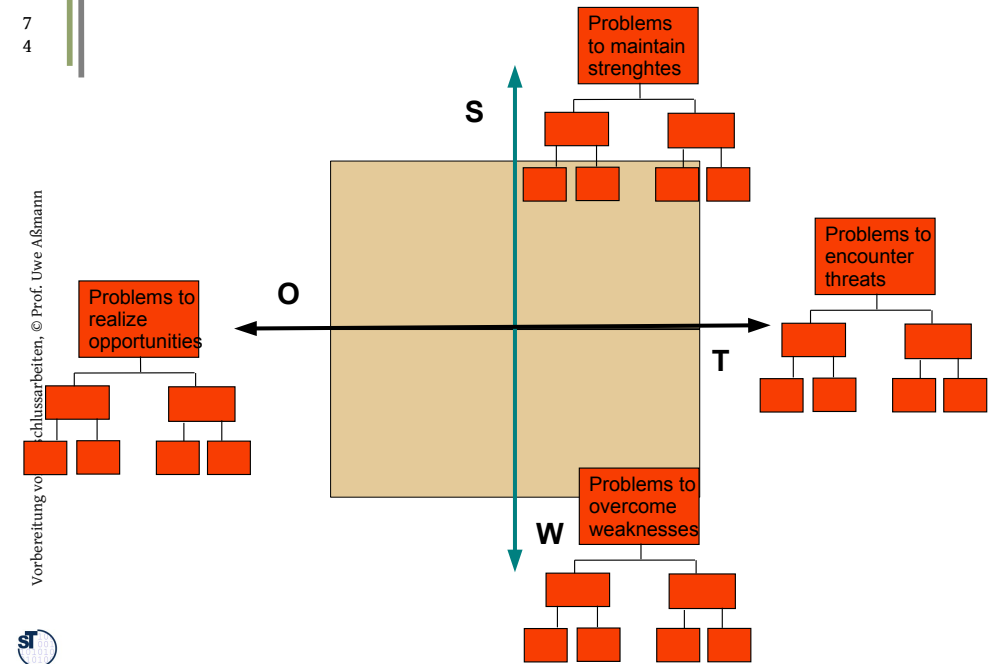

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann
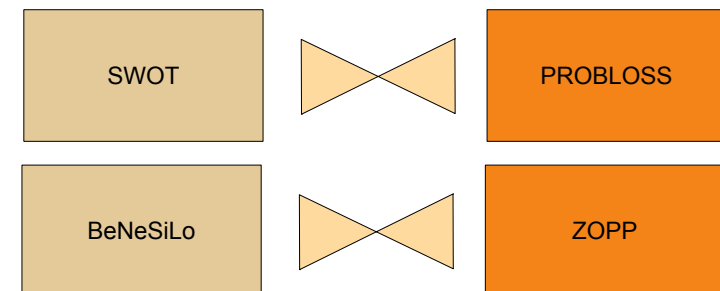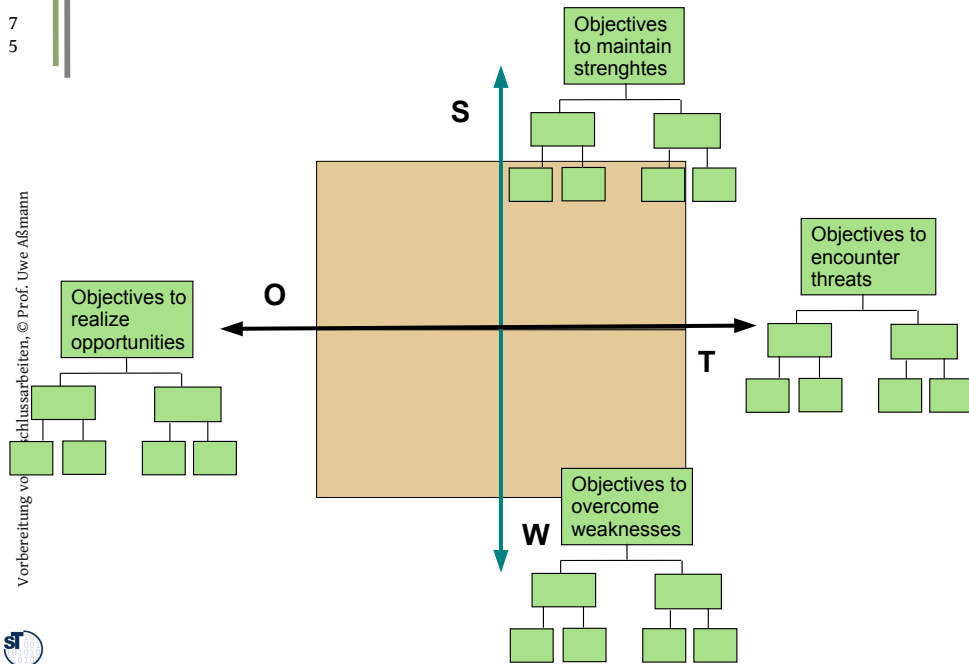
SWOT-PROBLOSS Problem Analysis

- ► SWOT-PROBLOSS is an *aspect-oriented problem analysis*
- ► SWOT are the *concerns (aspects)* of the customer or stakeholder (internal, external)
- ► PROBLOSS is the problem analysis
- ► SWOT-PROBLOSS is a ***strategic problem-goal analysis***

Do a PROBLOSS problem-goal analysis for all SWOT
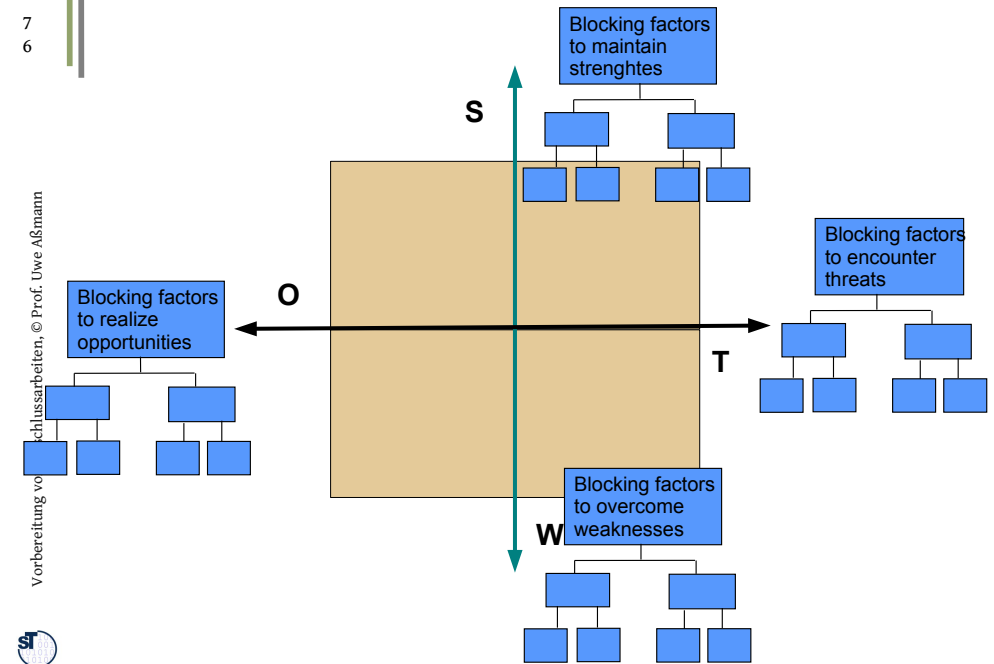**concerns (aspects)** (internal and external) of the your customer.

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

The Problem World of the Customer, Divided by Concerns of SWOT

Vorbereitung vo... chlussarbeiten, © Prof. Uwe Aßmann

The Objectives World of the Customer, Analyzed by SWOT

Vorbereitung vo... chlussarbeiten, © Prof. Uwe Aßmann

The Blocking Factors Preventing the Customer to reach her Goals, Divided by SWOT Concerns
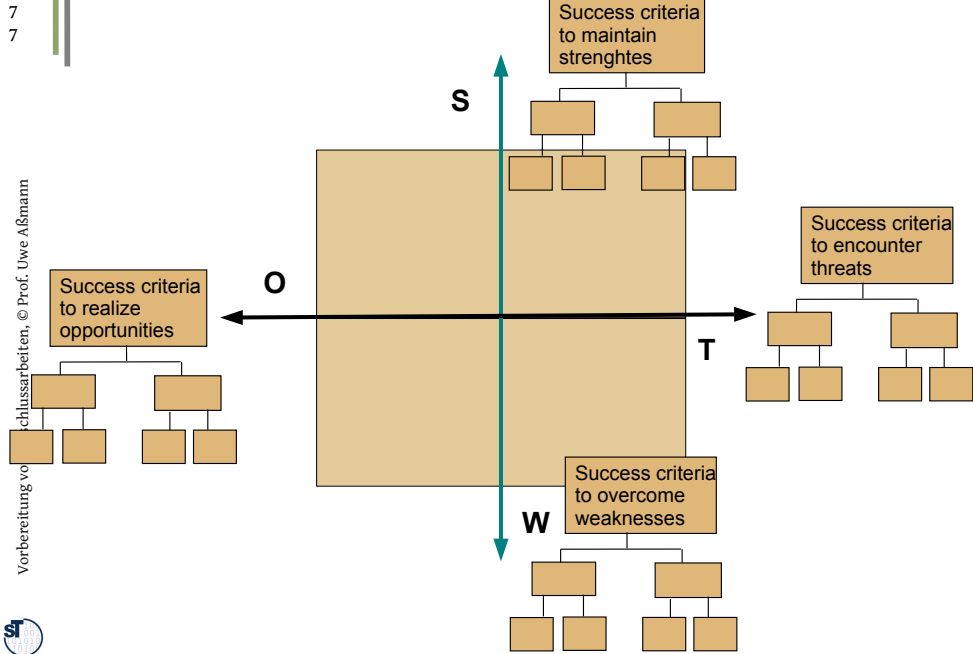
Vorbereitung vo... chlussarbeiten, © Prof. Uwe Aßmann

- S
- Success criteria to maintain strenghtes
- Success criteria to encounter threats
- O
- Success criteria to realize opportunities
- T
- Success criteria to overcome weaknesses
- W

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

- S
- Success analysis for maintaining strenghtes
- Success analysis for encountering threats
- O
- Success analysis for realizing opportunities
- T
- Success analysis for overcoming weaknesses
- W

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann
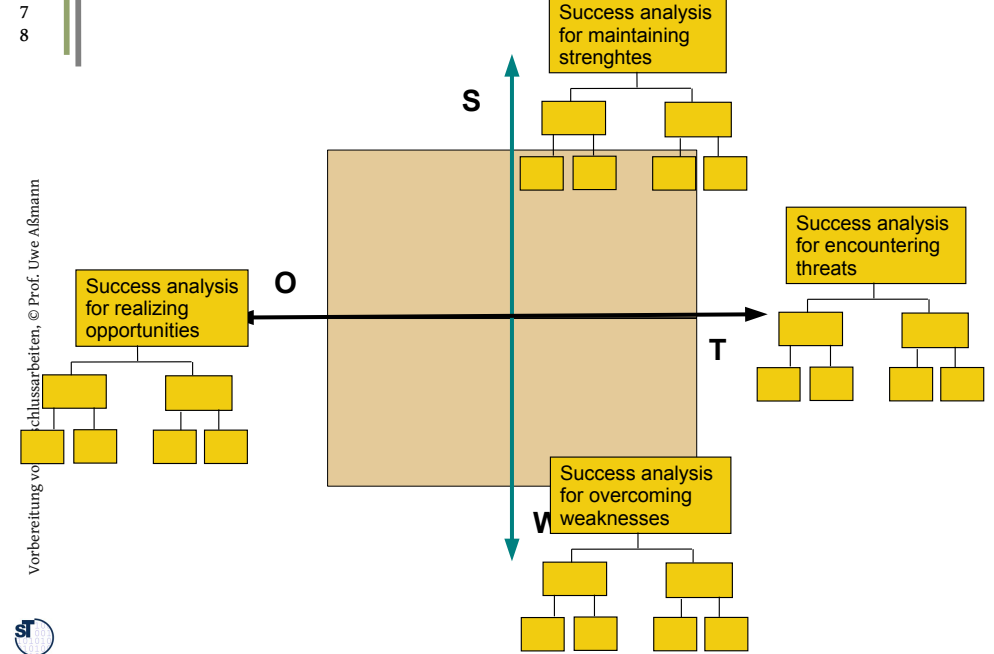
SWOT-PROBLOSS is an Aspect-Oriented Problem Analysis

▶ SWOT-PROBLOSS checks blocking factors preventing that objectives are reached, with regard to all aspects of SWOT. You will get ideas!!

1. Problems (S, O, T, W)
2. Objectives (S, O, T, W)
3. Blocking factors (S, O, T, W)
4. Success criteria (S, O, T, W)
5. Solutions (S, O, T, W)
6. Success analysis

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann
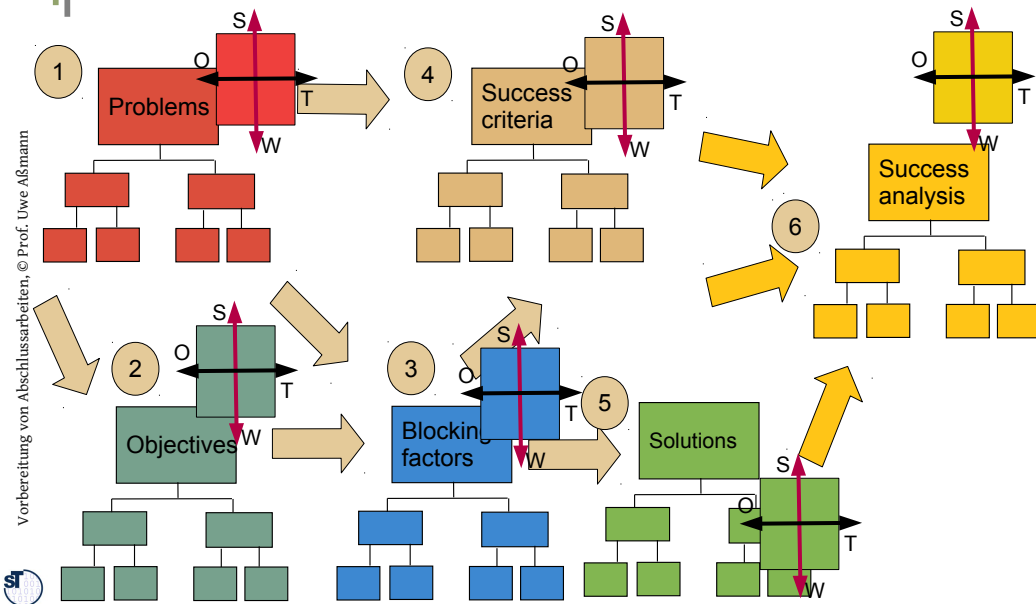
Alternative Notation for SWOT-PROBLOSS
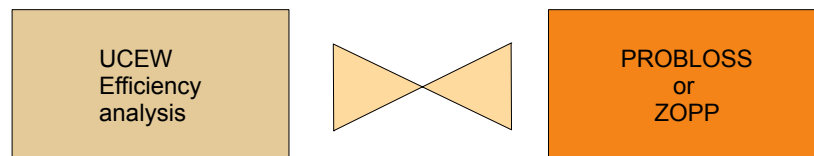
▶ For any AO-POA, create a table and brainstorm on the crossproduct

	Problems	Objectives	Blocking factors	Success criteria	Solutions	Success proof
Strengthes						
Weaknesses						
Opportunities						
Threats						

Vorbereitung von Abschlussarbeiten, © Prof. Uwe Aßmann

For What Can I Use This?

- ▶ Exc.: SWOT-BATEID-PROBLOSS Outline Analysis of Ritchie's Book on Wicked Problems
- ▶ Why is this a good scientific outline of a book?
- ▶ [Ritchie-Wicked] Go to http://www.springer.com/business+%26+management/technology+management/book/978-3-642-19652-2
- ▶ and download the free ToC
- ▶ http://www.springer.com/cda/content/document/cda_downloaddocument/9783642196522-t1.pdf?SGWID=0-0-45-1173288-p174106575
- ▶ Where has he used SWOT?
- ▶ Where is the "success proof" of PROBLOSS?
- ▶ What are the technical and idealized problems?
- ▶ What are the "blocking factors"?

14.6 Aspect-Oriented Efficiency Analysis UCEW-PROBLOSS

- ▪ Utility-Cost, Efficiency-Waste

Efficiency Analysis as Aspect-oriented Problem Analysis

- ▶ UCEW can be used as concern space in an aspect-oriented problem analysis. It evaluates the efficiency (cost-utility relation).
- ▶ **Aspect-oriented efficiency analysis** combines an *efficiency concern space* with a problem analysis method.
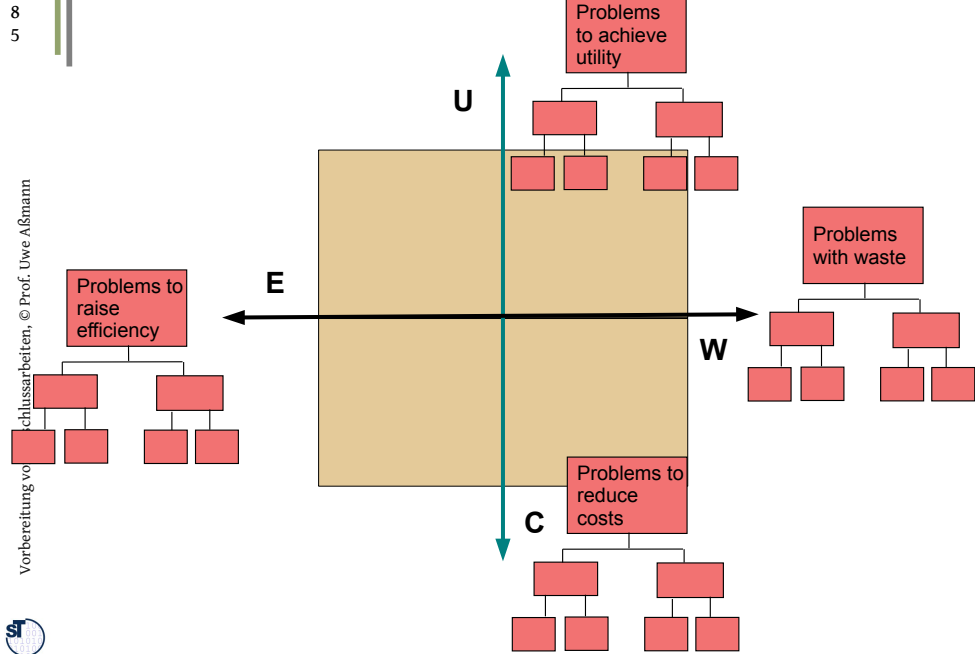 - ▪ The problem analysis method is done for all efficiency concerns

| UCEW Efficiency analysis | ⋈ | PROBLOSS or ZOPP |

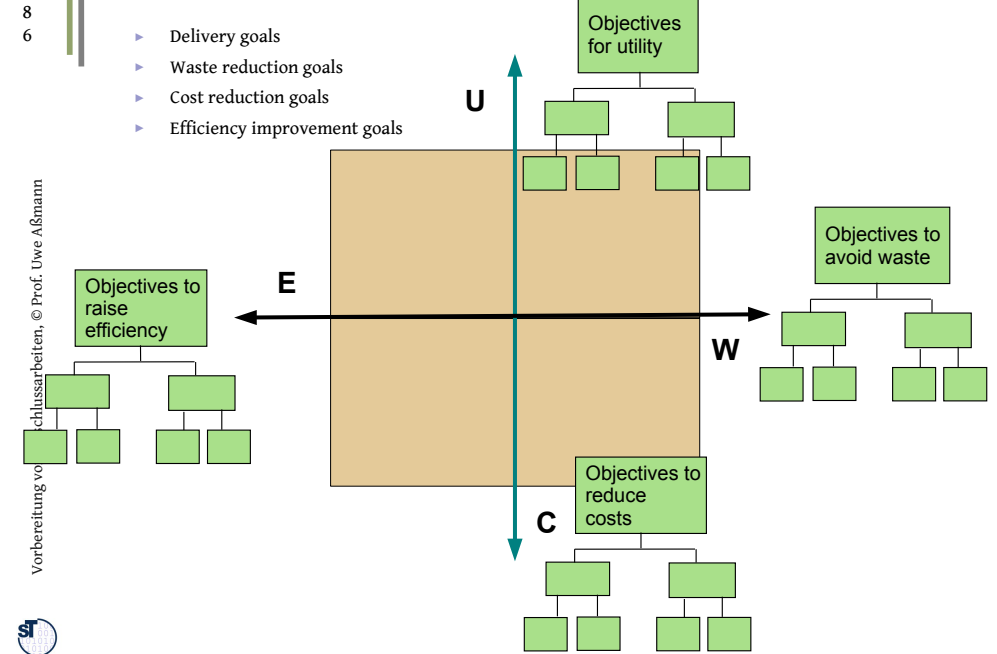## UCEW-PROBLOSS Efficiency Analysis

- ▶ UCEW-PROBLOSS is an *aspect-oriented problem analysis*
- ▶ UCEW are the concerns of the customer or stakeholder (internal, external)
- ▶ PROBLOSS is the problem analysis

Do a PROBLOSS analysis for all UCEW efficiency concerns (direct and relational) of the customer.
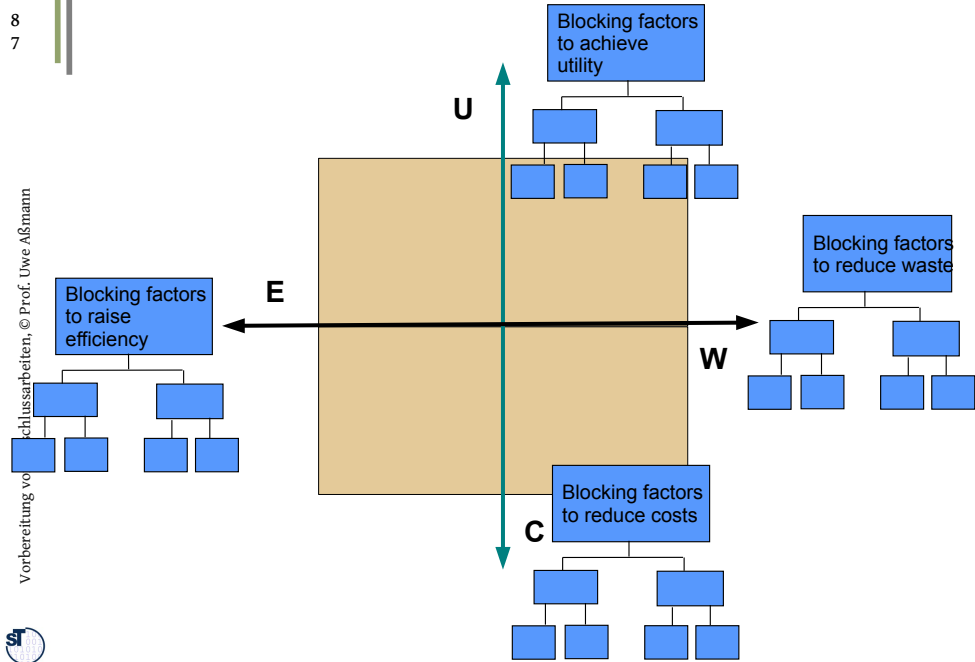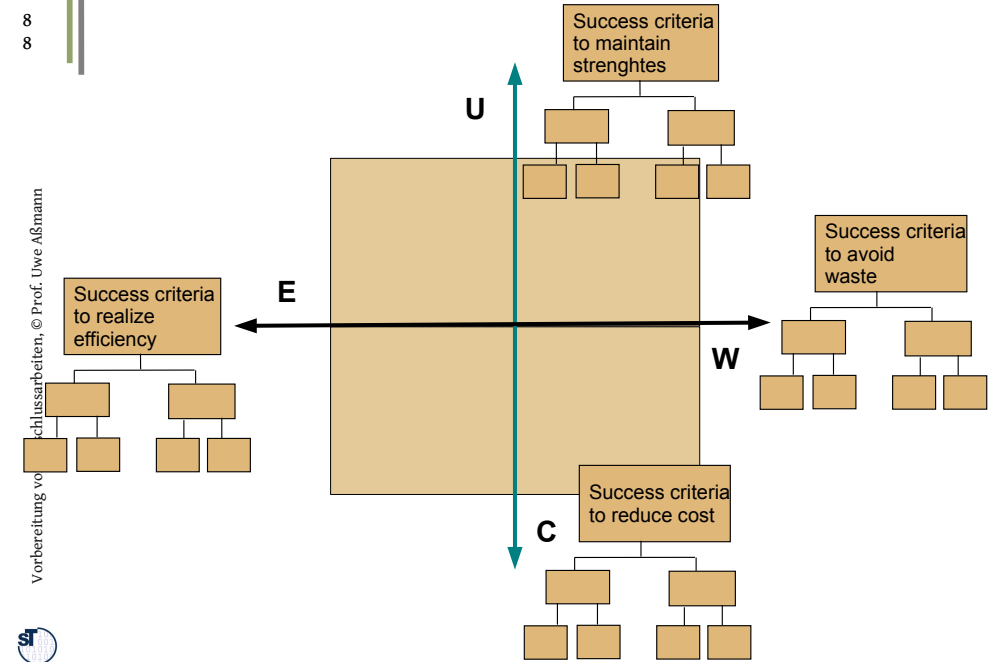
The Efficiency Problem World of the Customer

8
5

- Problems to achieve utility
- Problems to raise efficiency
- Problems with waste
- Problems to reduce costs

U
E
W
C

The Efficiency Objectives World of the Customer

8
6

▸ Delivery goals
▸ Waste reduction goals
▸ Cost reduction goals
▸ Efficiency improvement goals

- Objectives for utility
- Objectives to avoid waste
- Objectives to raise efficiency
- Objectives to reduce costs

U
E
W
C

The Blocking Factors Preventing the Customer to reach her Efficiency Goals

8
7

- Blocking factors to achieve utility
- Blocking factors to reduce waste
- Blocking factors to raise efficiency
- Blocking factors to reduce costs

U
E
W
C

The Efficiency Success Criteria of the Customer

8
8

- Success criteria to maintain strenghtes
- Success criteria to avoid waste
- Success criteria to realize efficiency
- Success criteria to reduce cost

U
E
W
C

Vorbereitung vo... schlussarbeiten, © Prof. Uwe Aßmann

The Efficiency Success Analysis for the Customer

Success analysis for maintaining strenghtes

U

E

W

Success analysis for realizing efficiency

Success analysis for avoiding waste

C

Success analysis for reduce costs
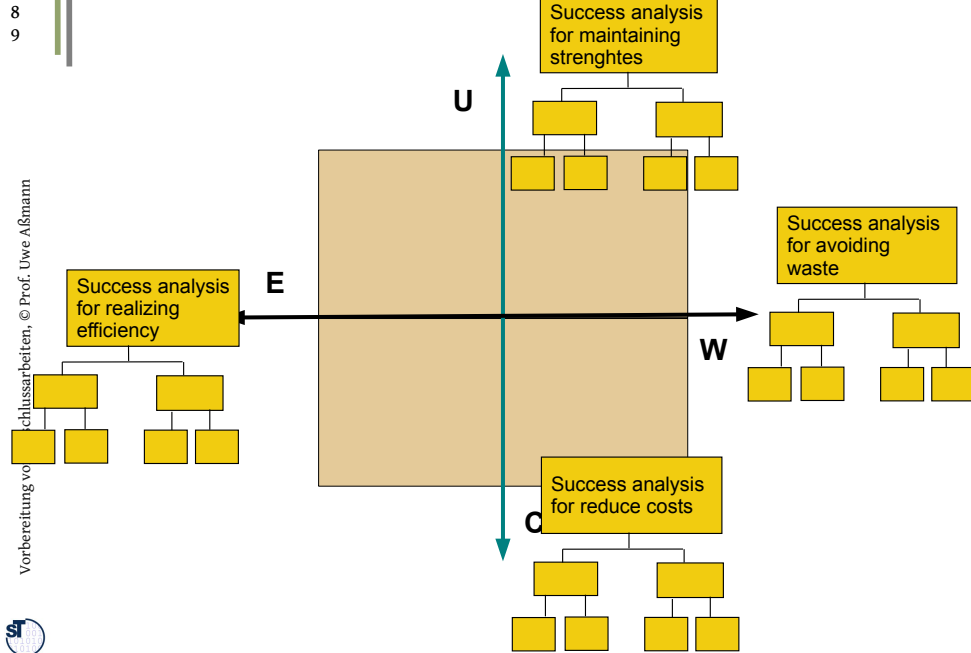
UCEW-PROBLOSS in One Slide

▶ UCEW-PROBLOSS analyses problems with efficiency concerns in mind.

1 Problems
4 Success criteria
Success analysis
6
2 Objectives
3 Blocking factors
5 Solutions
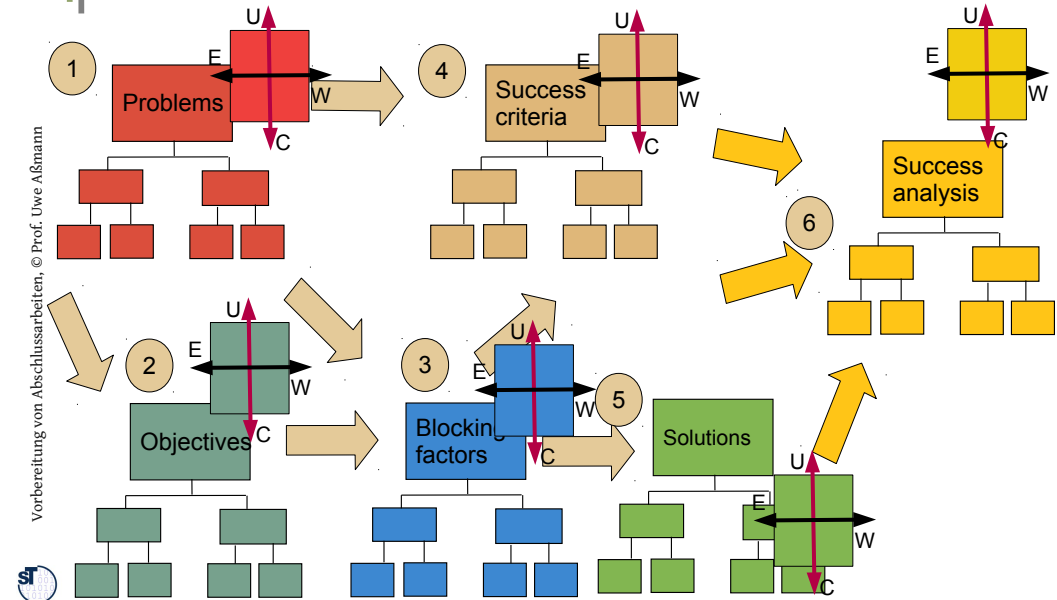
Aspect-Oriented Problem Analyses

▶ Dijkstra said "Separation of Concerns is about intelligent thinking"

SWOT ⋈ PROBLOSS or ZOPP

UCEW ⋈ PROBLOSS or ZOPP   "efficiency"

The 6 honest serving men ⋈ GQM

BeNeSiLo ⋈ GQM   "olympic"
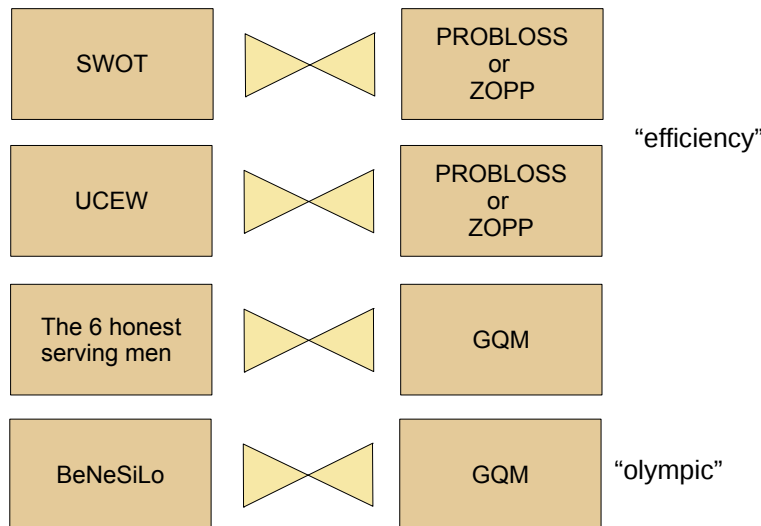
How to Apply AO-POA to Your Research?

▶ **Information Gathering:** Comparison of Literature
  - Find with a SWOT-PROBLOSS gaps in the state of the art
▶ **Finding research questions and hypothesis:**
  - Research questions and hypothesis can be *olympic* or *efficiency-based*
  - With a BeNeSiLoo-POPP, finding possible improvements of another approach is easy "faster, higher, farer"
  - With an CoTiQQ- or UCEW-PROBLOSS, finding inefficiencies is easy
  - "Finding inefficiency means finding opportunity" (Barrack)
▶ **Finding ideas for solutions**
  - Often, from the blocking-factor-problem-goal analysis, an idea for a technology emerges
▶ **Writing studies for other people**
  - As a consultant, for strategic problem and objective analysis, you can earn money. With a SWOT-PROBLOSS, you always deliver something interesting
▶ **Writing overview papers**
  - For instance, for the paper, we will write.

Rept.: 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.
- ▶ We will write an overview paper in 5-people groups in this course.
- ▶ To prepare, we 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. 10.1007/978-3-540-24841-5_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. 10.1007/3-540-44806-3_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
  - – Decide on a structure for your paper in your group.

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

Exc.:

- ▶ Generate ideas for improvement of the paper of Vinoski
- ▶ Do a BeNeSiLoo-PROBLOSS with his middleware appraoches in section "Evolution"
- ▶ Then, do a SWOT-PROBLOSS to generate ideas for the section "Future"

Exc.

- ▶ Do an efficiency AO-POA for Germany's move to natural energy
- ▶ Do an olympic AO-POA for your salary and employment
- ▶ Do a GQM for the question "What Dresden should do to keep its welfare 30 years after the Wende"

How to develop an Aspect-Oriented Problem Analysis (AO-POA) Yourself

- ► Generate
  - ▪ 1) Find a concern space (2d, 3d, 4d, tree-shaped etc.)
  - ▪ 2) Fix a problem analysis method (PROBLOSS, ZOPP, GQM, ...)
  - ▪ 3) Fix the crossproduct analysis
  - ▪ 4) Fix crossfertilization steps
- ► Prioritize
  - ▪ Create a prioritized problem list with a multi-criteria analysis

Homework – The Weekly Schmidt

- ► Read the essay - "Innovationen sichern den ökonomischen Erfolg". (1996)
- ► Analyze the problem-goal analysis of Schmidt by trying to relate all points to a BATE-PROBLOSS.
  - ▪ Which problems does Schmidt identify? Which super-, which subproblems?
  - ▪ Which problems are background problems? Which ones are technical problems (problems economical politics can influence)?
- ► Write from the BATE-PROBLOSS an outline of a new essay, your own analysis.

Homework – The Weekly Churchill

- ► Read first Winston Churchill's speech "Never despair".
  - ▪ https://www.winstonchurchill.org/learn/speeches/speeches-of-winston-churchill/1946-1963-elder-statesman/102-never-despair
- ► Analyze the problem-goal analysis Churchil presents to the house of commons about the atomic and the hydrogen bomb.
- ► Do a BATE-PROBLOSS yourself, ordering the problems and goals by decomposition and subordination. Find out blocking factors and success factors.

Appendices

Ziel- und Effektivitätsanalyse Kaplan/Norton

▸ SMART-POPP ermittelt durch Erfolgsbeweis auf Erfolgskriterien (Kennzahl, Vorgabe) hin, ob eine Lösung ein Ziel erreicht und ein Problem löst

▸ SMART-POPP erfüllt automatisch das SMART-Kriterium Measurable

▸ Nach Kaplan/Norton besteht es aus 4 Schritten: {Objective, KPI (Kennzahl), Threshold (Vorgabe), Measure (Maßnahme) }

▸ Ziele und Maßnahmen können hierarchisch strukturiert sein

① Ziel → ② Kennzahl (KPI) → ③ Vorgabe → ④ Maßnahme