14. Basic Solution Design and Invention

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2016-0.8, 4/23/16
http://st.inf.tu-dresden.de/teaching/asics

1) Complete Solution Processes

2) Variants of Hierarchical POPP

3) nABC

    1) Elevator Pitches

4) GAP Analysis (Generation, Assessment, Prioritization)

    1) Assessment and Prioritization Methods

    2) Qualitative and Quantitative Analysis for Olympic and Efficiency Criteria

5) Writing POS papers

6) Writing POSE papers

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▶ [Scherer] Hermann Scherer. 40 Minuten für eine gezielte Fragetechnik. Gabal Verlag

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▶ [Hill] Bernd Hill. Der Methodenbaukasten - Ein Kompendium von Methoden zur Erkennung und Lösung technischer Probleme. 2. erw. u. überarb. Aufl. [Taschenbuch bei amazon]

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▶ 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.

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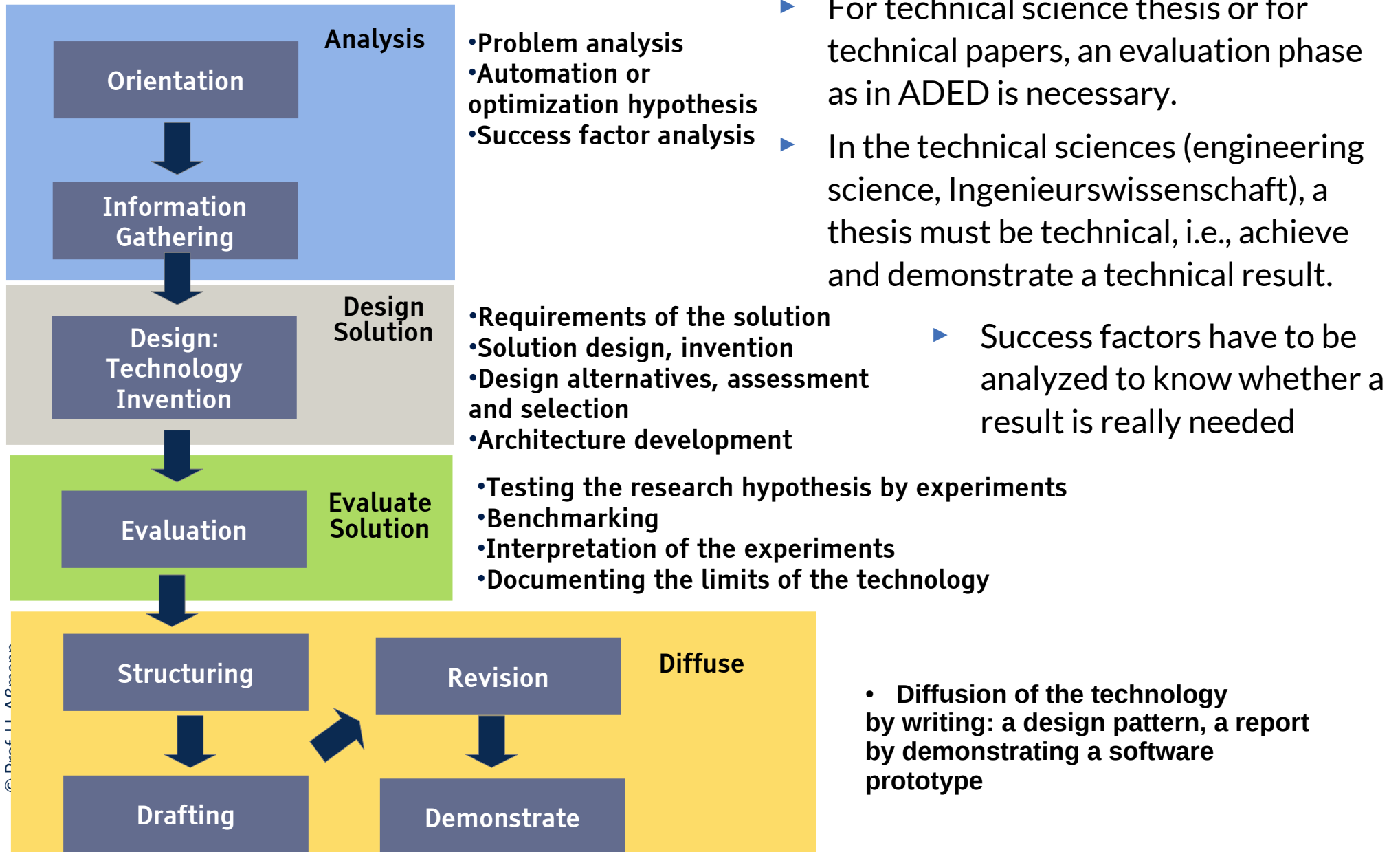
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Governance and Society, Vol. 17. 1st Edition., 2011, Springer.

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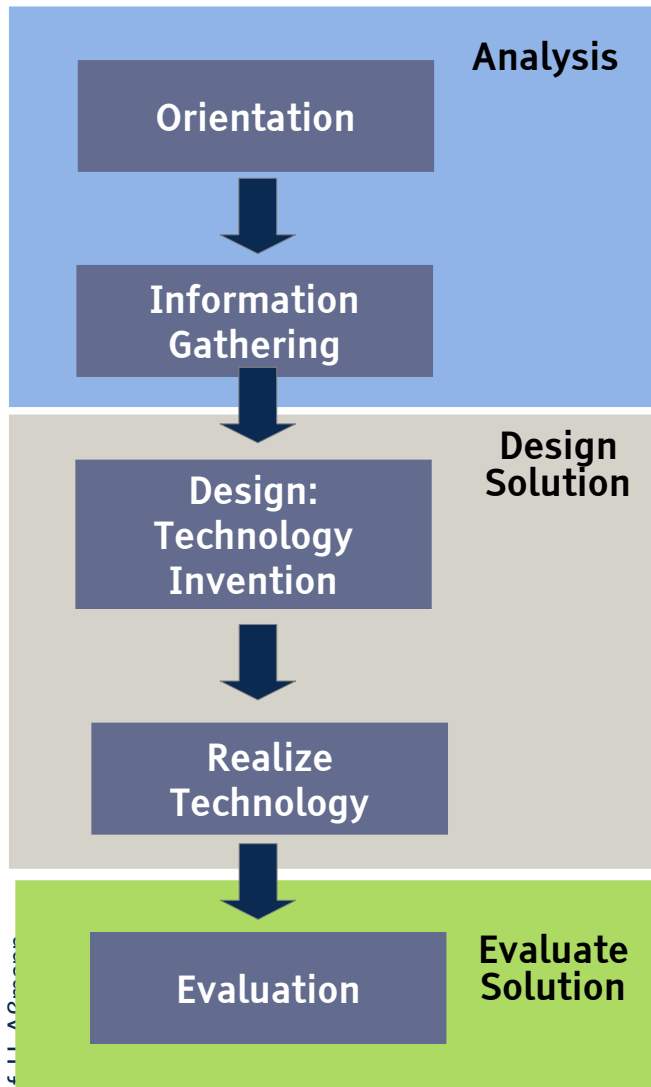%26+management/technology+management/book/978-3-642-19652-2

> 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/

The ADED Research Process for Technical Science Thesis

Analysis

Orientation

Information Gathering

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

▶ For technical science thesis or for technical papers, an evaluation phase as in ADED is necessary.

Design Solution

Design: Technology Invention

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

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

Evaluate Solution

Evaluation

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

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

Diffuse

Structuring

Revision

Drafting

Demonstrate

- **Diffusion of the technology by writing: a design pattern, a report by demonstrating a software prototype**

The AD-R-ED Research Process for Technical Science Thesis

Analysis

Orientation

↓

Information Gathering

Design Solution

Design: Technology Invention

↓

Realize Technology

Evaluate Solution

Evaluation

▶ For technical science, in particular software engineering, a *realization phase* is required so that evaluation can take place

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

- Realize the architecture (implement components)
- Tune the system
- Stabilize the system for better quality (non-functional requirements)

Diffuse

→ Structuring → Revision

Structuring ↓ Drafting

Revision ↓ Demonstrate

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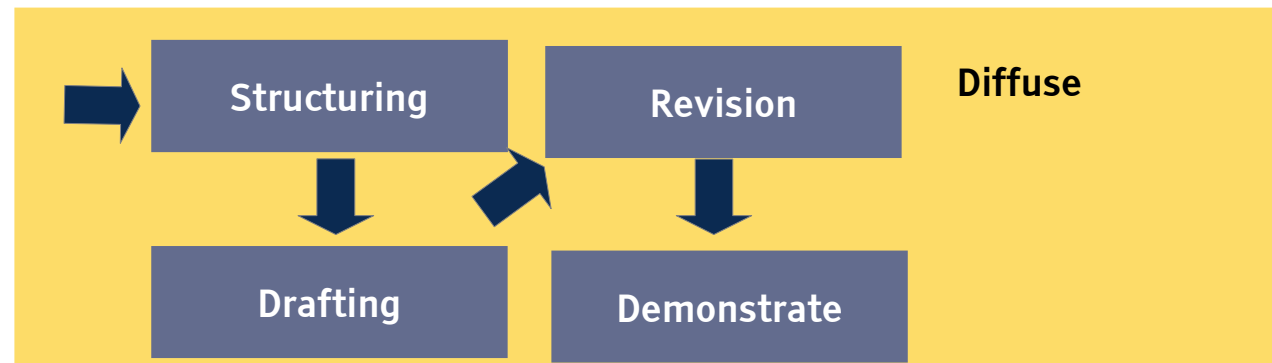
Eternal Problems While Inventing

After problem analysis and literature analysis, solutions must be invented, designed, and selected.

Use systematic methods to speed up finding a solution

| Analysis | Design Solution | Realize Solution | Evaluate Solution | Diffuse |

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14.1 Complete Problem Solving Processes (PAD-SAD-RAD)

▶ 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, Implementation, and Documentation (RAD)

Complete Solution Processes Refine the First 4 Phases of ADRED

▶ For your research (Master's thesis, paper, etc.), you need a complete solution process

▶ Most often, problem-solving processes are driven by a problem analysis

▶ In general, there refine the 4 first steps ADRE of ADRED:

- PAD: Problem analysis and definition
- SAD: Solution analysis and design
- RAD: Realization Analysis, Implementation, and Documentation
- VAD: EValuation Design and Analysis

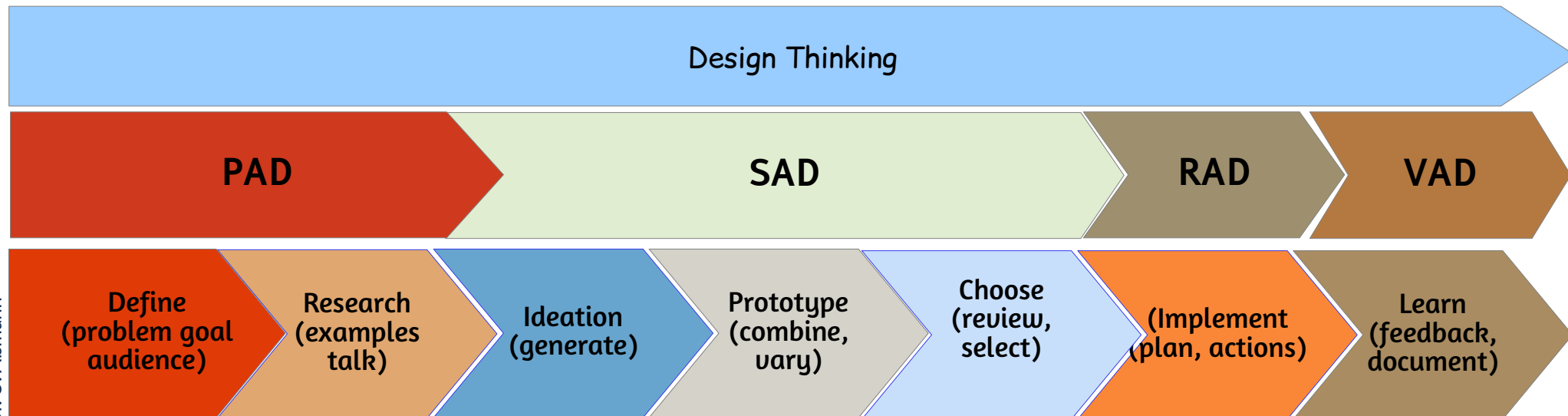▶ PARGESI, SPALTEN, and DesignThinking, POPP, are fantastic solution processes for your Master's thesis and PhD thesis
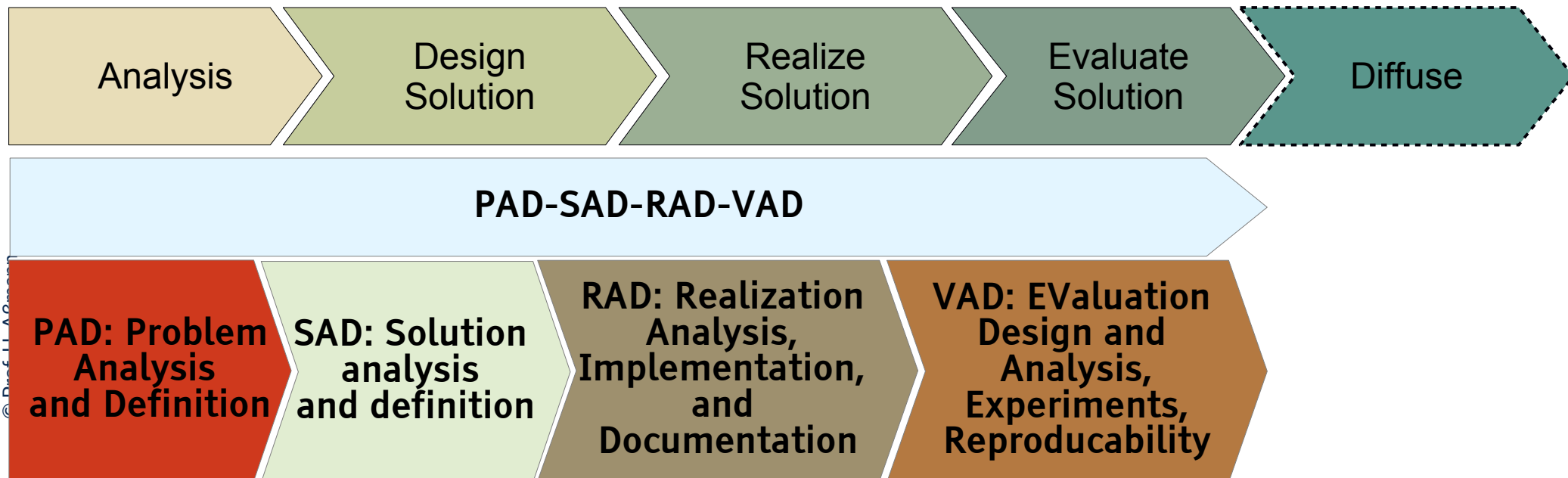
Analysis	Design Solution	Realize Solution	Evaluate Solution	Diffuse

PAD-SAD-RAD-VAD

PAD: Problem Analysis and Definition	SAD: Solution analysis and definition	RAD: Realization Analysis, Implementation, and Documentation	VAD: EValuation Design and Analysis, Experiments, Reproducability

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

► SPALTEN is a problem solving process. Steps: [Wikipedia/Problemlösen, Albers]

- PAD: Problem analysis and definition:
  · Situation analysis (Ist-Analyse, literature analysis)
  · 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)
- RAD: Realization Analysis, Implementation, and Documentation
  · Effect, risk and consequence analysis
  · Introduction (measures and processes)
  · After study and learning, documentation

S.P.A.L.T.E.N			
PAD	SAD	RAD	VAD
Situation-analysis / Problem-scoping	Alternatives generation / Solution selection	Effect analysis / Einführung/Introduction	Nachbereitung After study Learning

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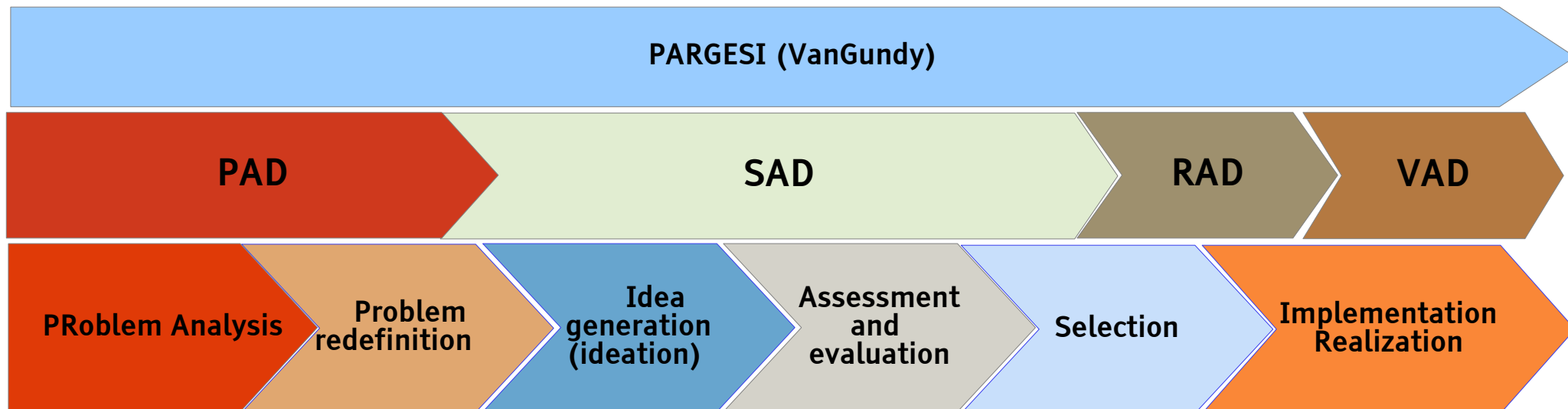# "Design Thinking" is a Solution Process with Prototyping and Assessment of Multiple Solutions

▶ http://en.wikipedia.org/wiki/Design_thinking

▶ Similar to SPALTEN, but using prototyping to test and select ideas

▶ Used by D-School in Stanford and HPI in Potsdam

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Problem Solving with VanGundy Problem Solving Method PARGESI

▶ [VanGundy-ProblemSolving] contains a structured, very general process to solve structure problems: PARGESI

- Problem analysis and Redefinition: It is an experience that the first problem definition is not stable, but must be reiterated.

- Generating Ideas

- Assessment and Evaluation of Ideas

- Selection of ideas

- Implementation and Realization

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PARGESI (VanGundy)					
PAD		SAD		RAD	VAD
PRoblem Analysis	Problem redefinition	Idea generation (ideation)	Assessment and evaluation	Selection	Implementation Realization

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

- ▶ PARGESI, SPALTEN, DesignThinking are fantastic solution processes for your Master's thesis
  - ▪ Write a project GANTT chart
  - ▪ Estimate weeks for every phase
  - ▪ What would you prefer for your Master's thesis?
- ▶ For a PhD thesis, they have to be iterated several times

14.2 Variants of Hierarchical POPP

▶ POPP/ZOPP and its variants are simple Solution Design Processes

▶ Hierarchic, no alternative generation, covering of all problems provable
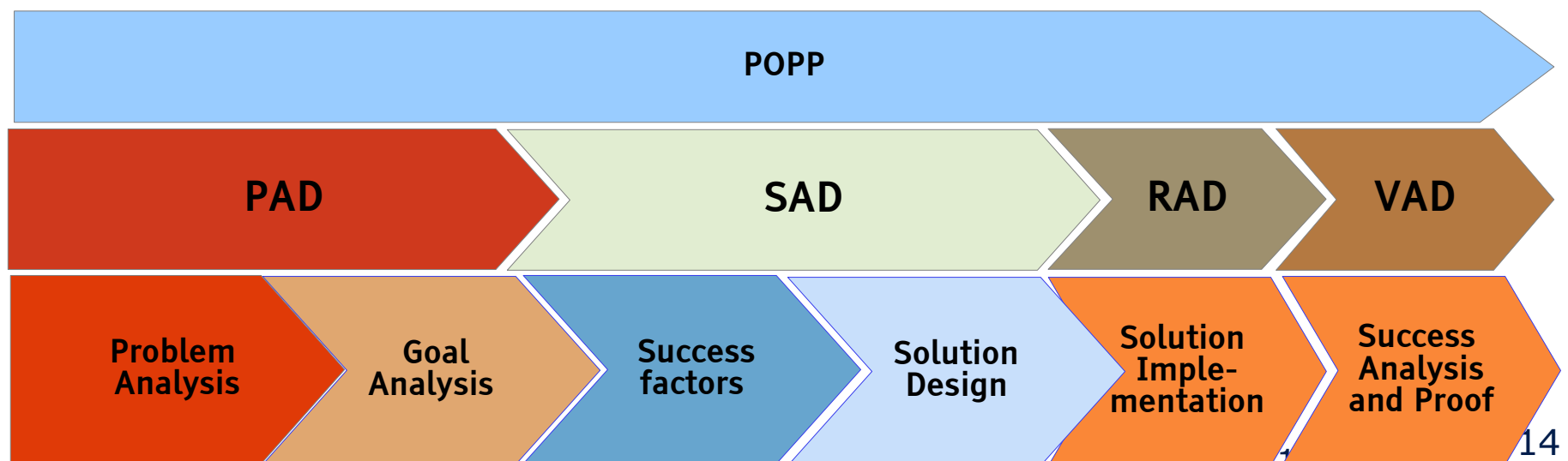
POPP					
PAD	SAD		RAD	VAD	
Problem Analysis	Goal Analysis	Success factors	Solution Design	Solution Imple-mentation	Success Analysis and Proof

14

Hierarchical Problem and Goal Analysis ZOPP

▶ POPP is hierarchical, to get traceability between problems, objectives, solutions

▶ Completeness proofs for covering all problems are easy

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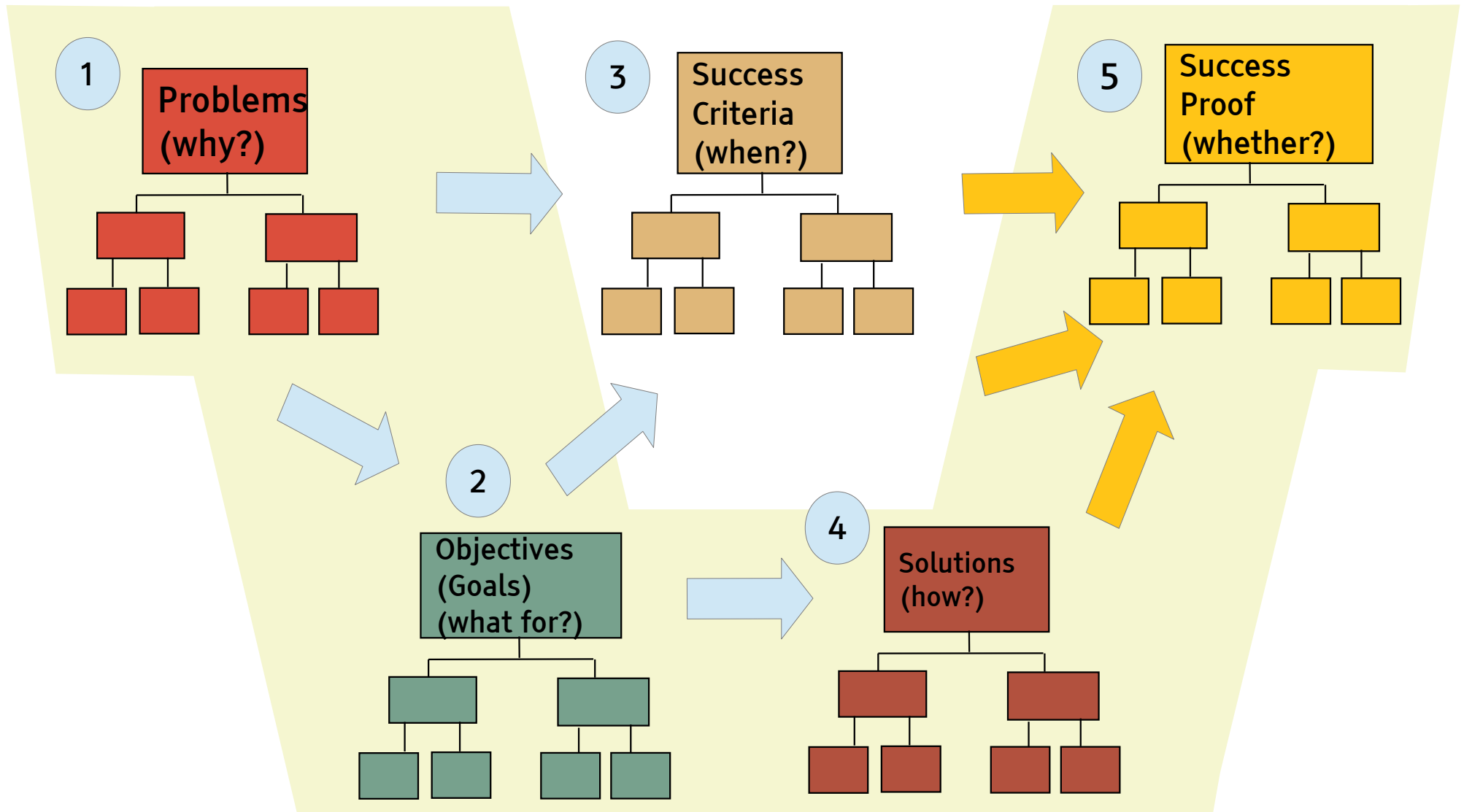
# Hierarchical Problem and Goal Analysis with Blocking Factors (B-POPP)

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

▶ B-POPP is a ZOPP-like problem and efficiency analysis that checks blocking factors preventing that objectives are reached.
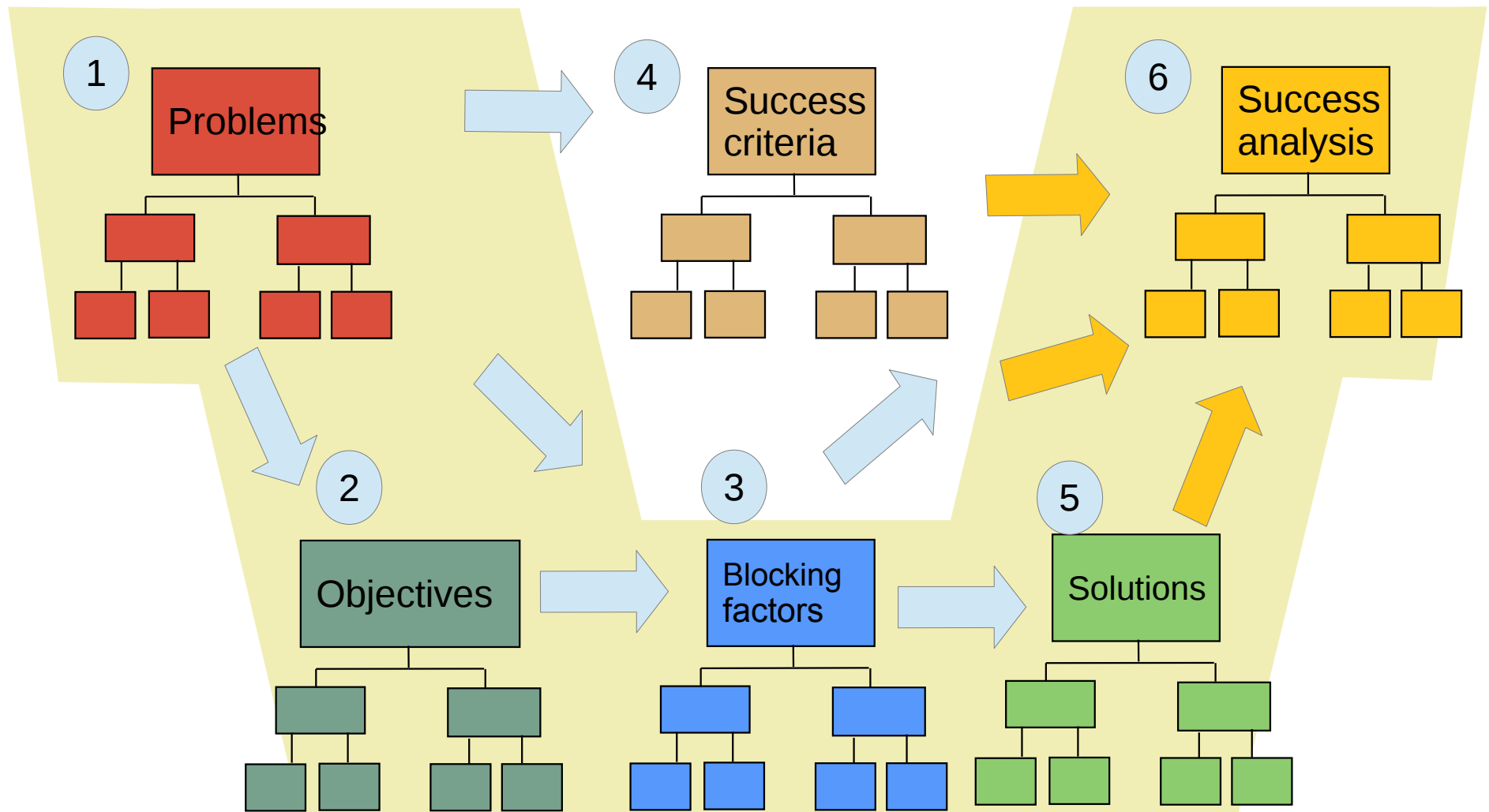
Hierarchical ReLOMTA

▶ Combining B-POPP with ReLOMTA gives us a wonderful hierarchic solution process with problem coverability.

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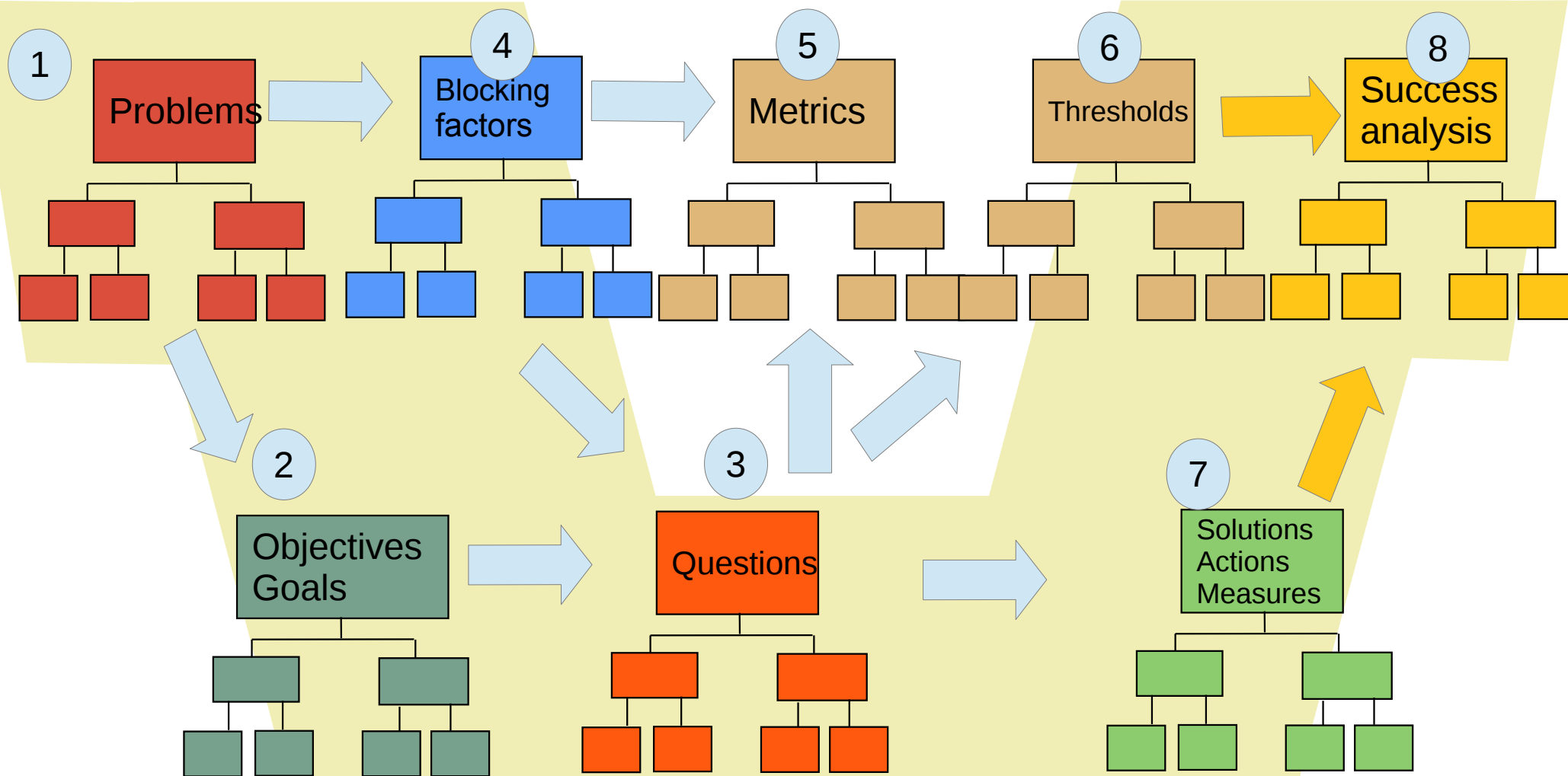
14.2.1 BATE-POPP for Papers

POPP For Your Research

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

▶ Do a GQM, ZOPP, OMTA-POPP, ReLOMTA-POPP, or a variant of B-POPP 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 B-POPP 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 B-POPP

Exercise:

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

▶ Do a B-POPP 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 B-POPP.

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

Exercise with LaTeX

▶   a) Put B-POPP into a LaTeX template with comments marking up the parts

% problems

% objectives

....

% success analysis

▶   b) Put B-POPP into a LaTeX style file, defining commands for your documents:

\def\problem#1{#1}

\def\objective#1{#1}

\def\blockingFactor#1{#1}

....

\def\successAnalysis#1{#1}

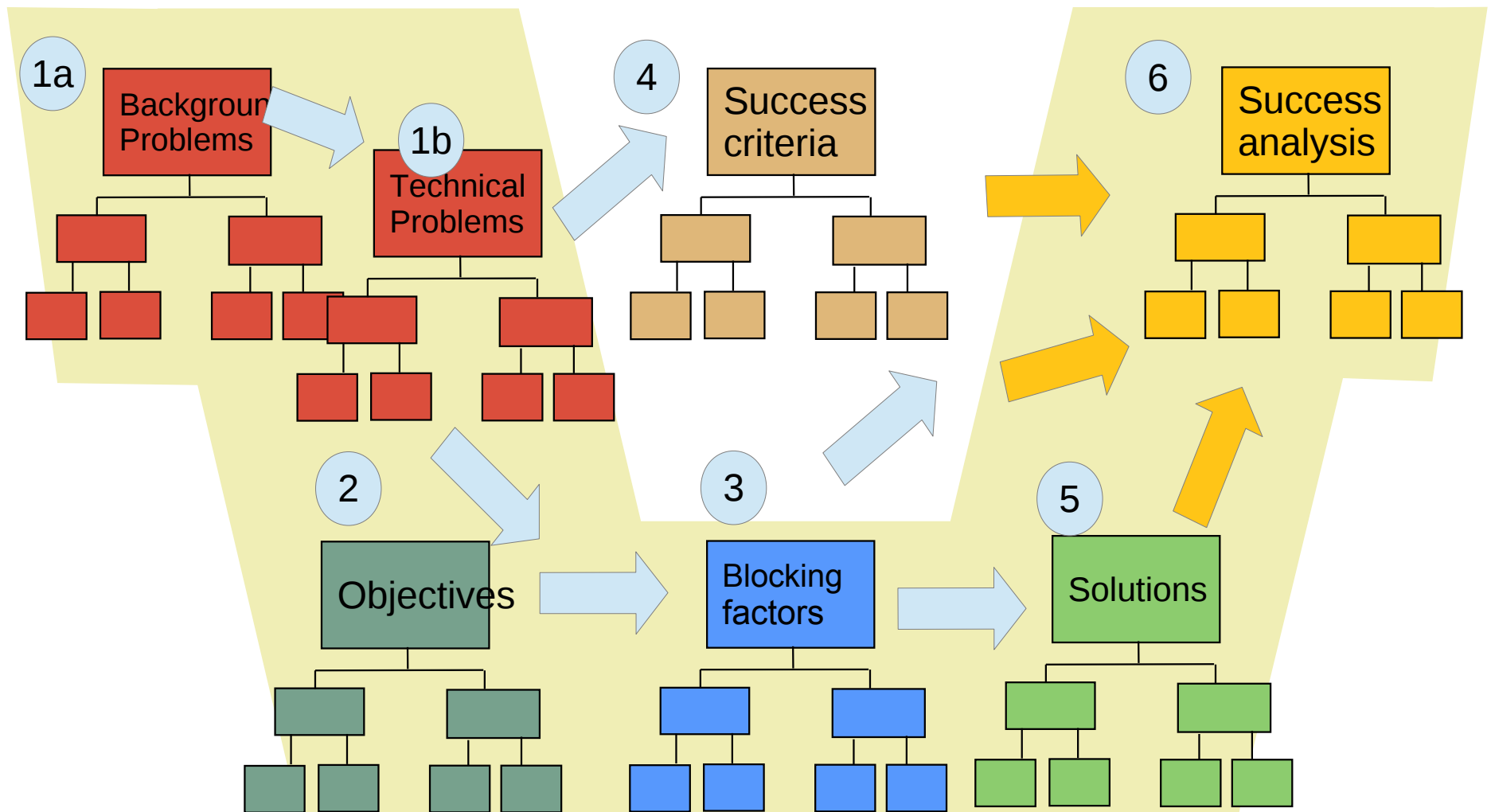▶   c) do the same defining LaTeX environments
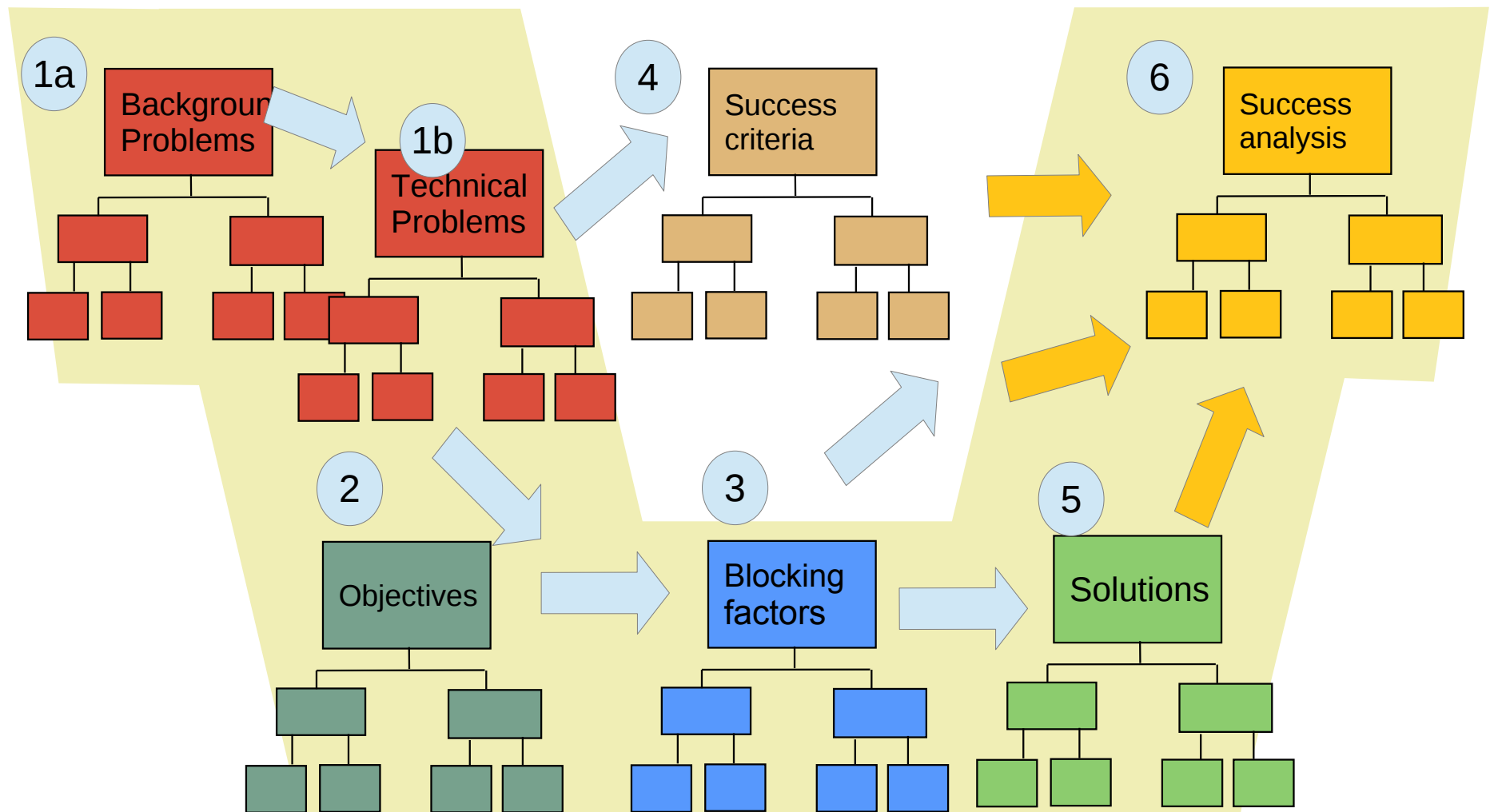
\newenvironment\problemEnv{}{}

Improved BATE-POPP

- ▶ 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 BATE-POPP

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Exercise

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

- 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-B-POPP.

Improved BATEID-POPP 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
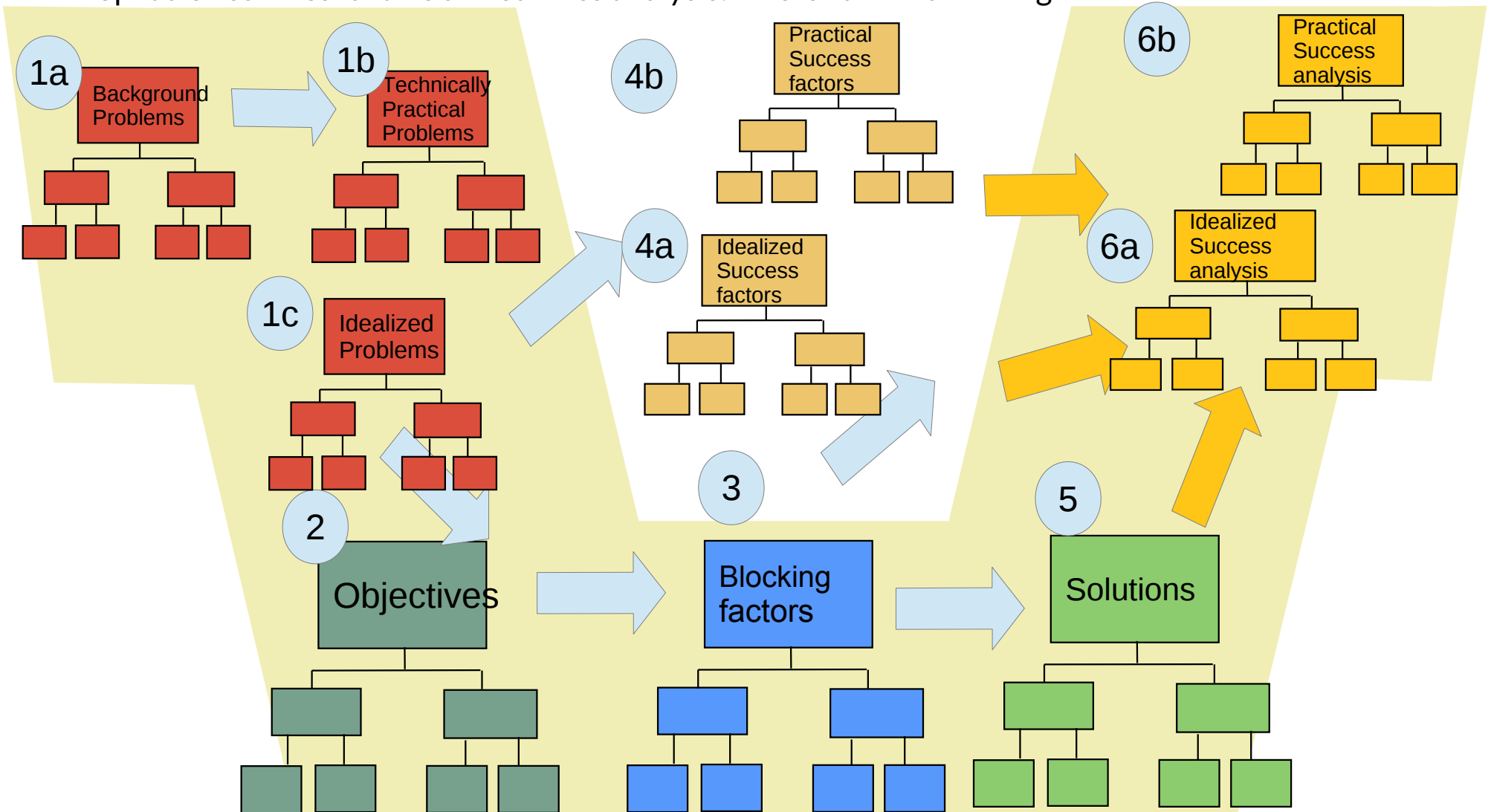
# Theorem Paper Outline of [Aßmann00] – How I Would Write It Today – with BATEID-POPP

- [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
    - Case studies of the implementation of the optimizer generator OPTIMIX

PainGain-POPP for Customer Analysis and Practical Research Papers

▶ Distinguish special hurting problems (pains) and special desired objectives (gains)

▶ Disginguish objectives in pain killers and gains (added values)

▶ Can be used for Value Proposition Analysis (VPA)
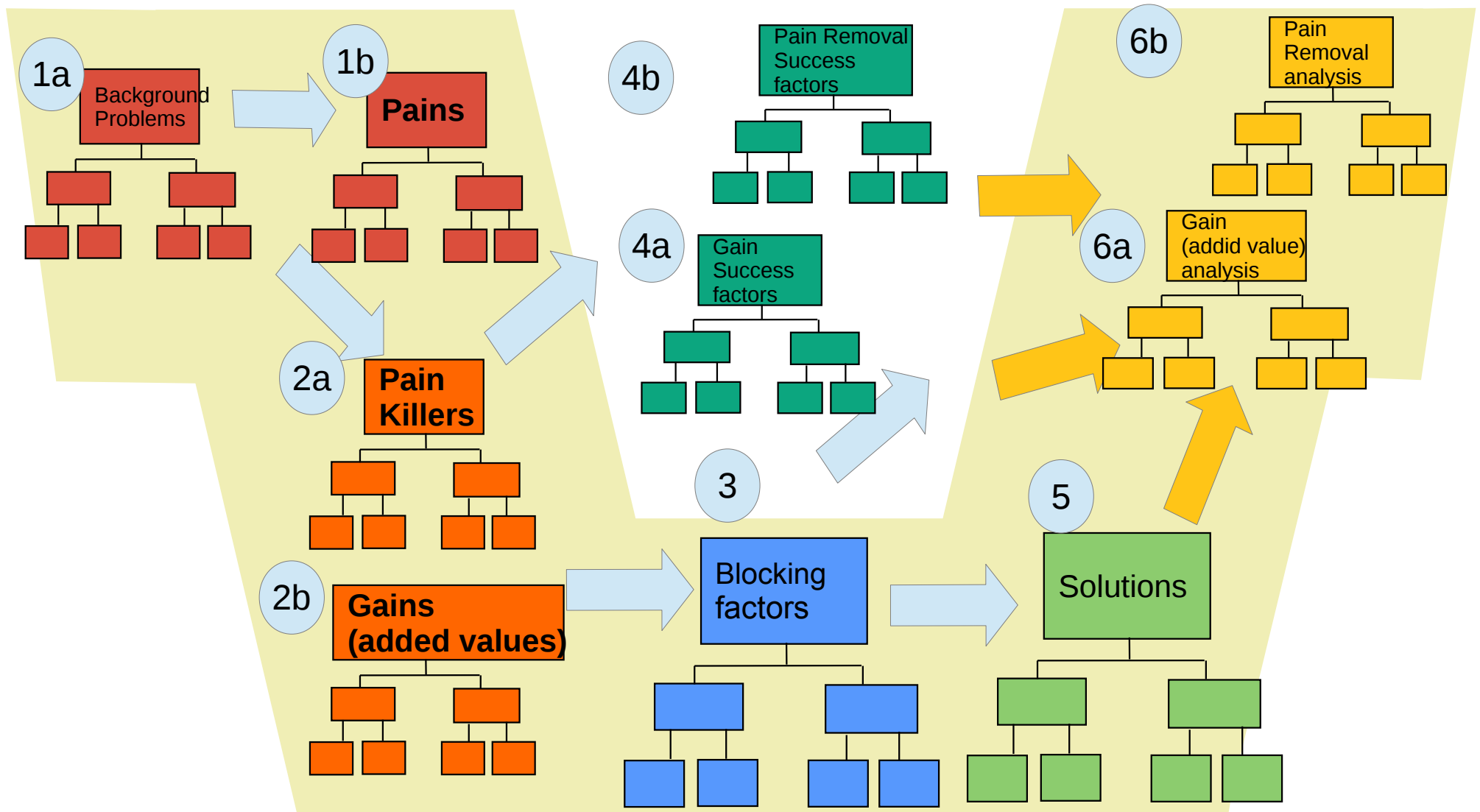
More Exercises

- ▶ 1) Write the introduction section of a
    - ▪ "Why adaptive software architecture can help to solve the German SmartGrid problem"
    - ▪ Use BATE-POPP

- ▶ 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-B-POPP for idealized research

- ▶ 3) Write the outline of a research project proposal for a funding agency, such as EU or DFG, with BATE-POPP
    - ▪ "Service robots for helping elderly people in their home"

14.3 nABC Value Proposition of Carlson/Wilmot

NABC Analysis [Carlson-Wilmot]

What does the customer really need?
What is of value for her?
What is a *pain* for the customer?

How does your company solve the needs of the customer?
How does it create value for her?

Carlson-Wilmot NABC

Need → Approach → Benefit for Cost (quantitative) → Competition
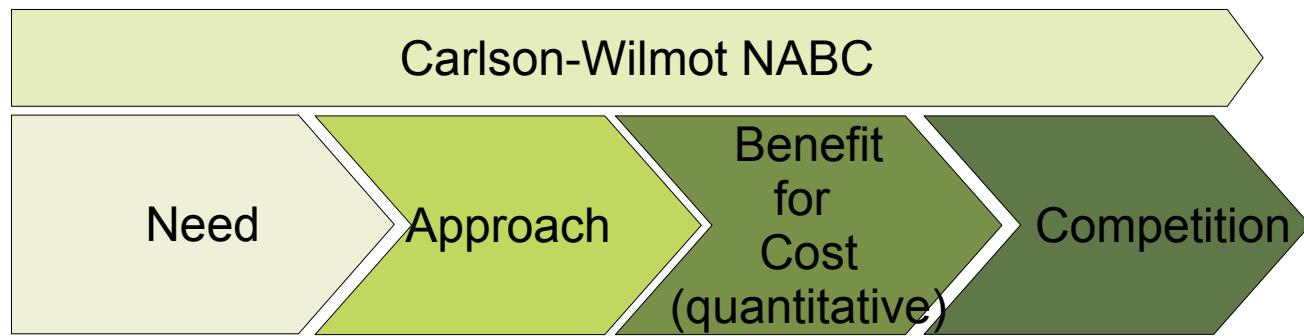
How efficient is the solution?
How large is the benefit?
How large are the costs?
If possible, measured quantitatively

Who is in the market already?
What are your competitors

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Exercise: Preparation for Application Interview

▶ For preparing your next application for a job,

▶ Analyze the future employer with NABC:

  ▪ What are his needs?

  ▪ What is your approach?

  ▪ What is your benefits for his costs? (if possible, do it quantitatively)

  ▪ Who are your competitors?

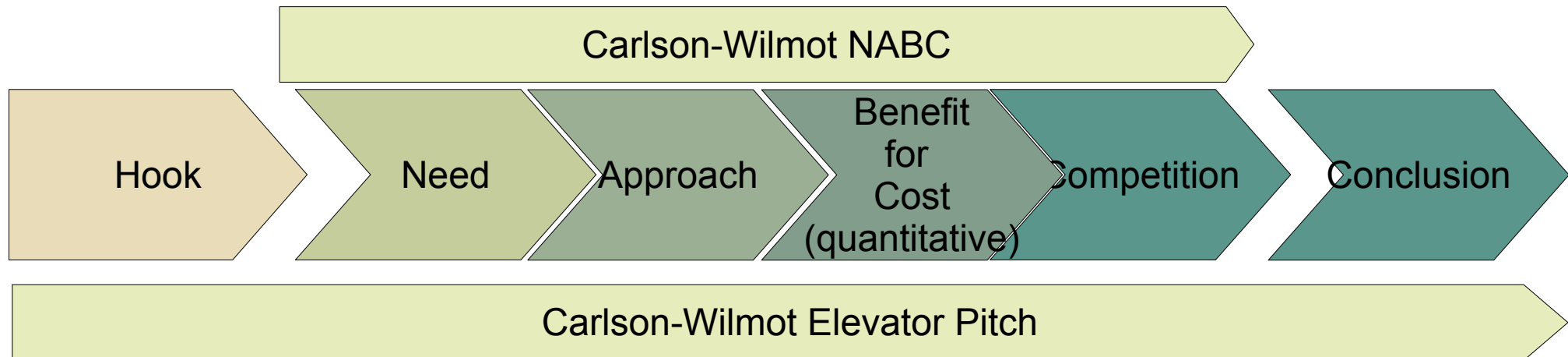▶ Learn the answers for these questions by heart, to be able to present them in the interview!

NABC Value Proposition

▶   After doing a ZOPP, you also should do an NABC Value Proposition [Carlson/Wilmot] and an elevator pitch

▶   The Value proposition is more directed to customers of your PhD thesis than to other scientists

▶   It explains ordinary people what your research is about, which need it solves

14.4 Elevator Pitches

NABC Elevator Pitches

► An ***elevator pitch*** is a 2-minute speech about the nABC of your project

► You should be able to tell it

  ▪ an important investor in an elevator (2 min)

  ▪ your professor

  ▪ your grandmother

► It combines a problem solving scheme with a hook, a gripping introductory remark.

► Very good: use nABC with a hook and quantitative benefit-for-cost.

► my solution is 30% better than the competitors'

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Carlson-Wilmot NABC

| Hook | Need | Approach | Benefit for Cost (quantitative) | Competition | Conclusion |

Carlson-Wilmot Elevator Pitch

Elevator Pitches

▶ Philip Koopman has a scheme for abstract writing which is also good for Elevator Pitches

Koopman's MOPARC

| Hook | Motivation | Problem | Approach | Result | Conclusion |

Koopman's MOPARC Elevator Pitch
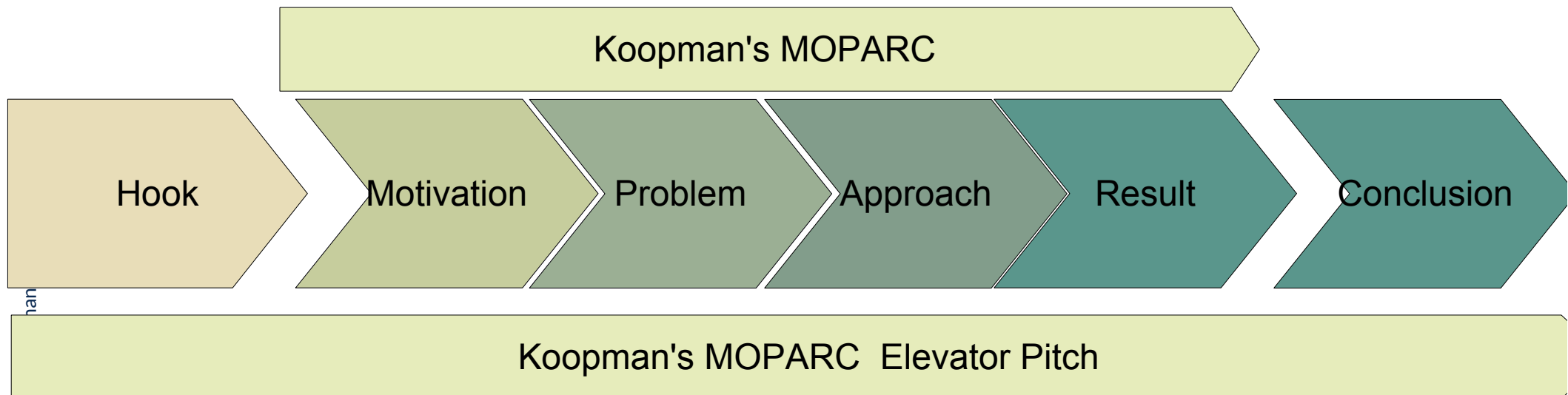
Other Elevator Pitches

▶ The 4-quarter cake of Vigenshow can also be used (uses honest serving men)

4-quarter-cake

| Hook | Why? | What? | How? | What else? |

4-quarter cake Elevator Pitch

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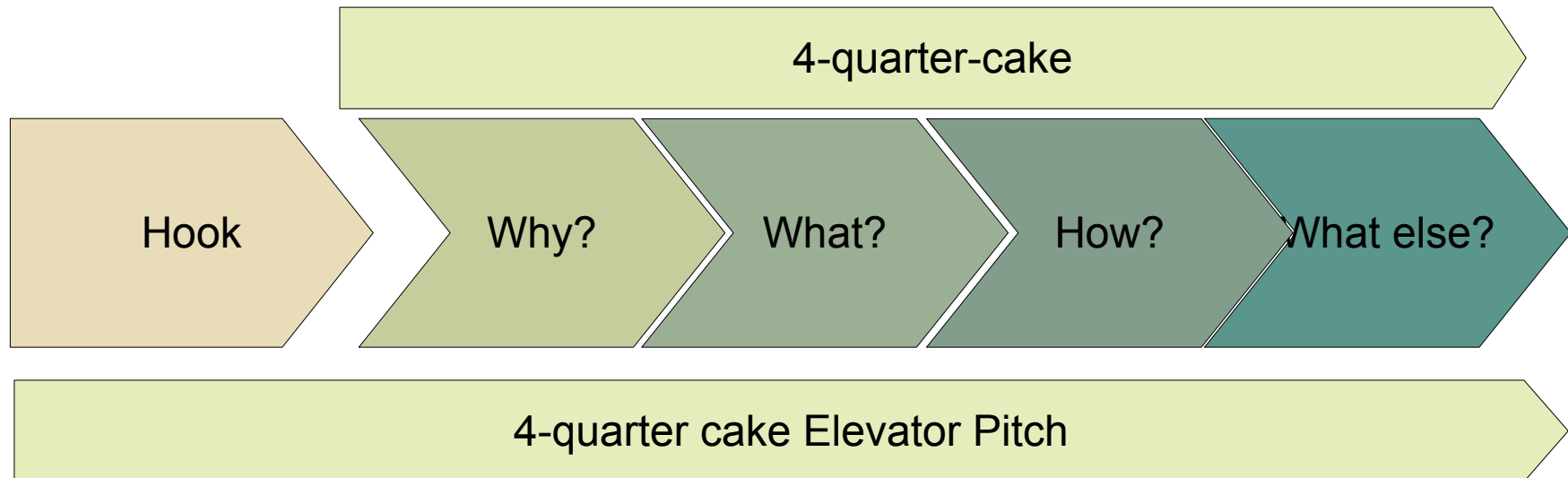
14.4 Canvases

- A Canvas is a structured **collaborative** form, to be printed on a BIG poster
    - It has a **fill order**, in which the fields should be filled
    - Every field has standardized questions
    - Fields are filled by sticky notes
- Canvases are very structured – Mindmaps and Concept Maps are unstructured
- Canvases are **mind maps with normalized discriminators**

Open Project Management Canvas

https://www.openpm.info/display/openPM/Canvas

https://www.openpm.info/download/attachments/12222711/openPM-Canvas_v.1.0.jpg?
version=1&modificationDate=1360611776000&api=v2
https://www.openpm.info/display/openPM/Canvas

Develop a Canvas for Yourself

- ▶ For nABC

- ▶ For B-POPP, BaTeId-POPP

- ▶ For 7W-POPP Matrix

14.5 Solution Design (SAD) with GAP: Generation of Ideas, Alternative Analysis, and Prioritization

▶ When there is not only one solution idea, but many, ideas have to be compared and prioritized
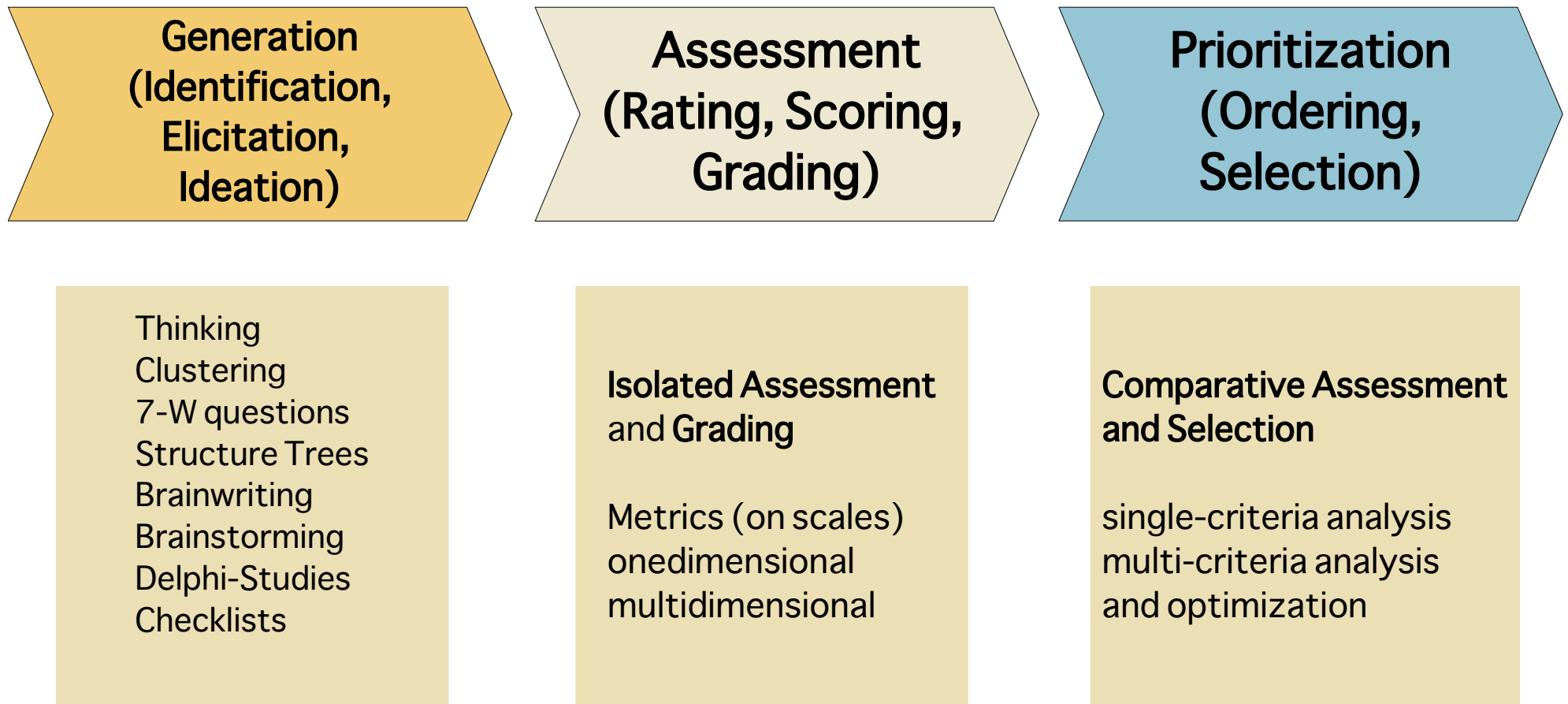
▶ [VanGundy-ProblemSolving]

Motivation: How to Develop Your Chapter on "Design" or "Architecture" in your Bachelor/Master Thesis

- ▶ So far, all solution processes have the disadvantage that they are happy if they find one solution

- ▶ 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 (ideation)** ▶ **Alternative analysis: comparison and prioritization** ▶ **Alternative selection**

Generation of Prioritized Lists with GAP

► GAP is a fine-grained SAD process separating assessment and prioritzation

- For assessments and prioritzations of ideas, problems, solutions, risks, etc
- For alternatives if difficult decisions have to be taken

| Generation (Identification, Elicitation, Ideation)	Assessment (Rating, Scoring, Grading)	Prioritization (Ordering, Selection)
Thinking Clustering 7-W questions Structure Trees Brainwriting 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

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Scientific Aspect of GAP for Design Chapters of Final Theses

- ▶ For a problem of technical science, usually, several designs exist (tool and software architectures, etc)

- ▶ Though one design must be selected, the alternatives should be
  - ▪ G: generated (invented, developed, documented)
  - ▪ A: assessed (evaluated individually)
  - ▪ P: prioritized (evaluated individually), ordered and selected

- ▶ A good design chapter discusses several alternatives and why the chosen design is the best!

Embedding of GAP in the VanGundy Problem-Solving Process

▶ [VanGundy, Kap.2] uses GAP, but combines Assessment and Selection

  ▪ This book has many techniques, both for individual and group processes
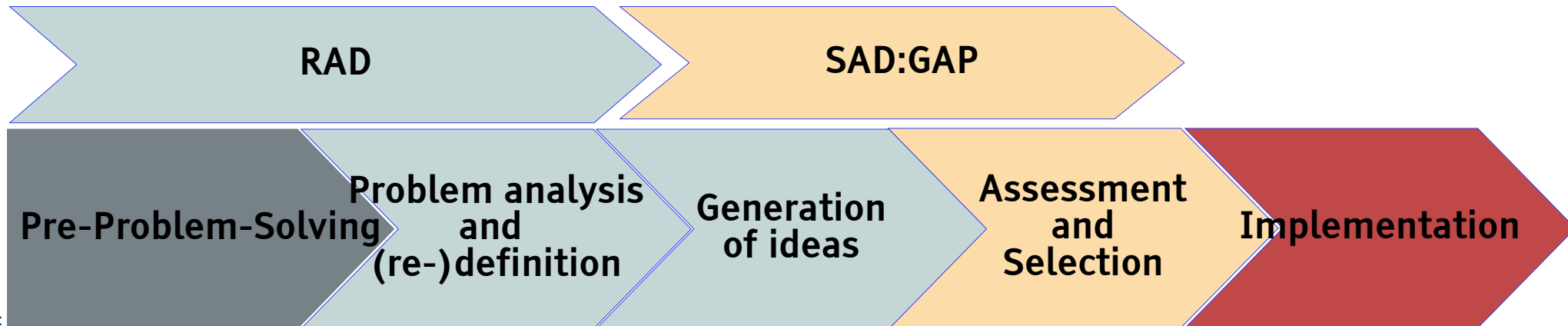
Variation and Extension Method for Ideation

► 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

14.6 Assessment and Prioritization Methods

▶ Comparative Analysis: how do approaches of the literature compare?

▶ Advance Analysis: how far advance is my approach?

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

▶ "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

[Hill]

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

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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
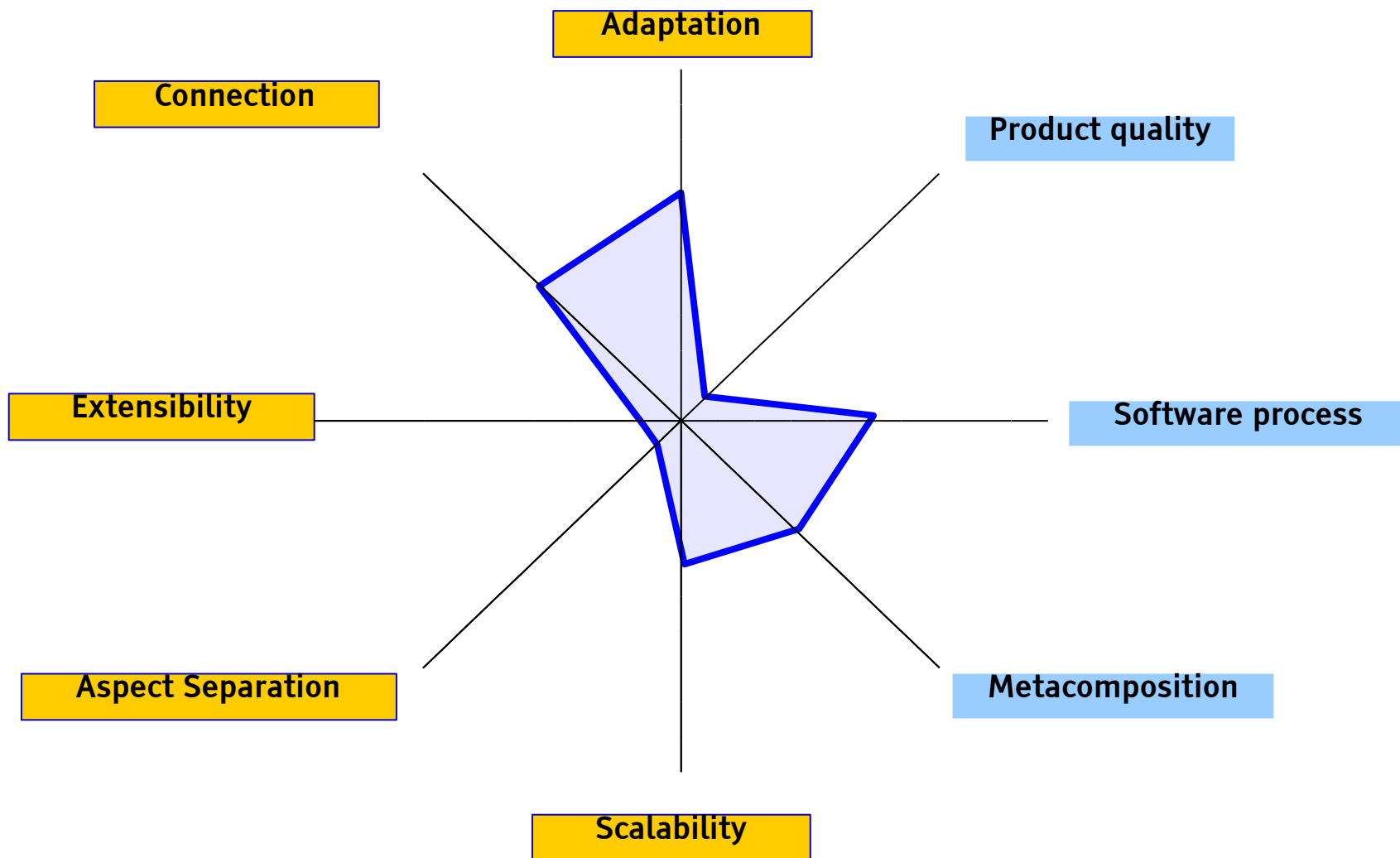
Assesment can be on Olympic Questions or Efficiency Questions

► 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)

14.6.1 Examples for Multi-Criteria Analyses

Quantitative and Qualitative Comparisons for Olympic and Efficiency Success Criteria

- An **olympic research problem** is about increasing benefit or reducing cost
- A **efficiency research problem** is about doing both

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

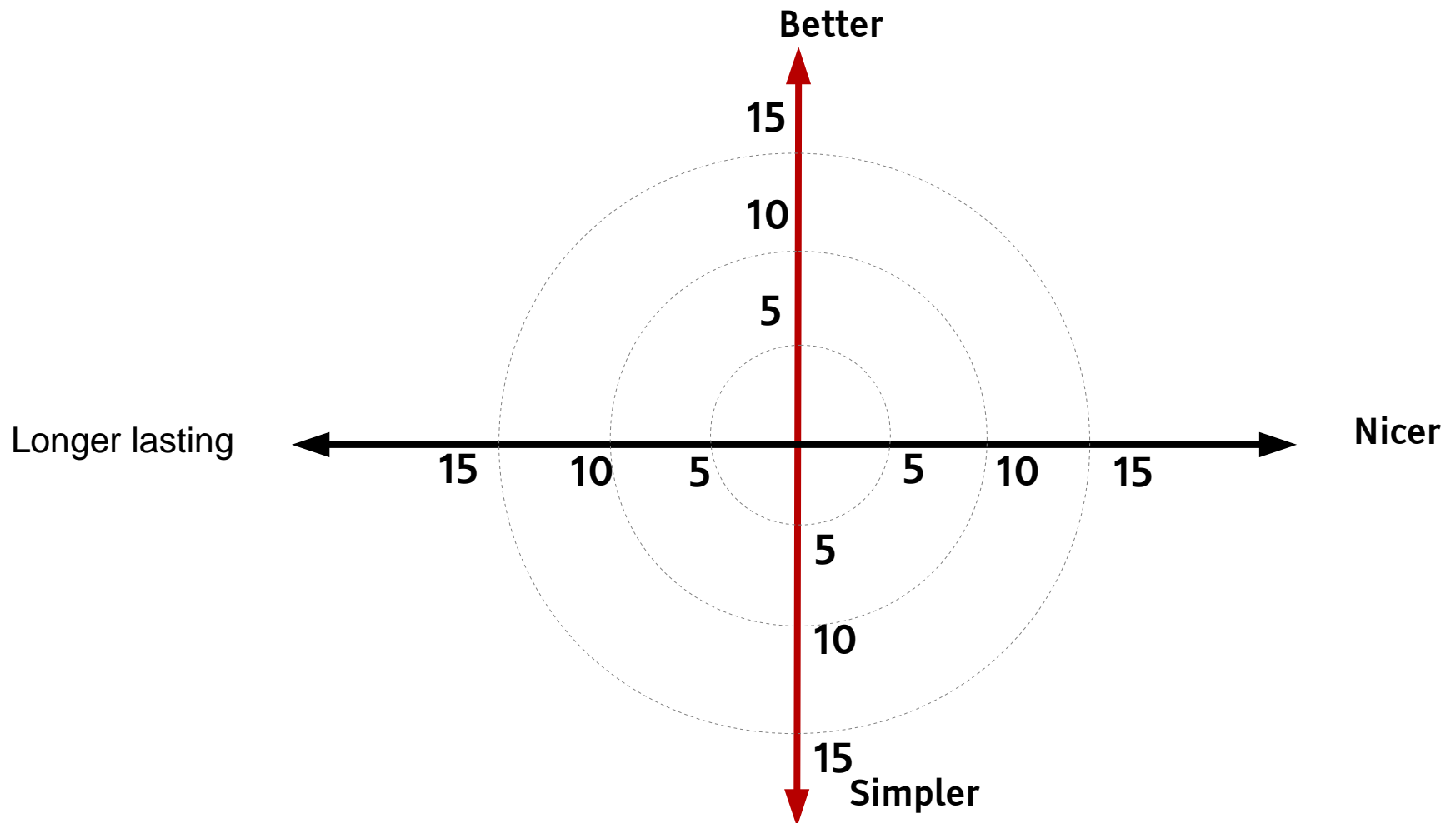53   Academic Skills in Computer Science (ASICS)

- ▶ BeNeSiLo is a 4-D attribute analysis utility (olympic), measuring progress qualitatively or quantitatively (Better, Nicer, Simpler, LongerLasting)
    - ▪ Larger rectangles denote greater utility
- ▶ 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

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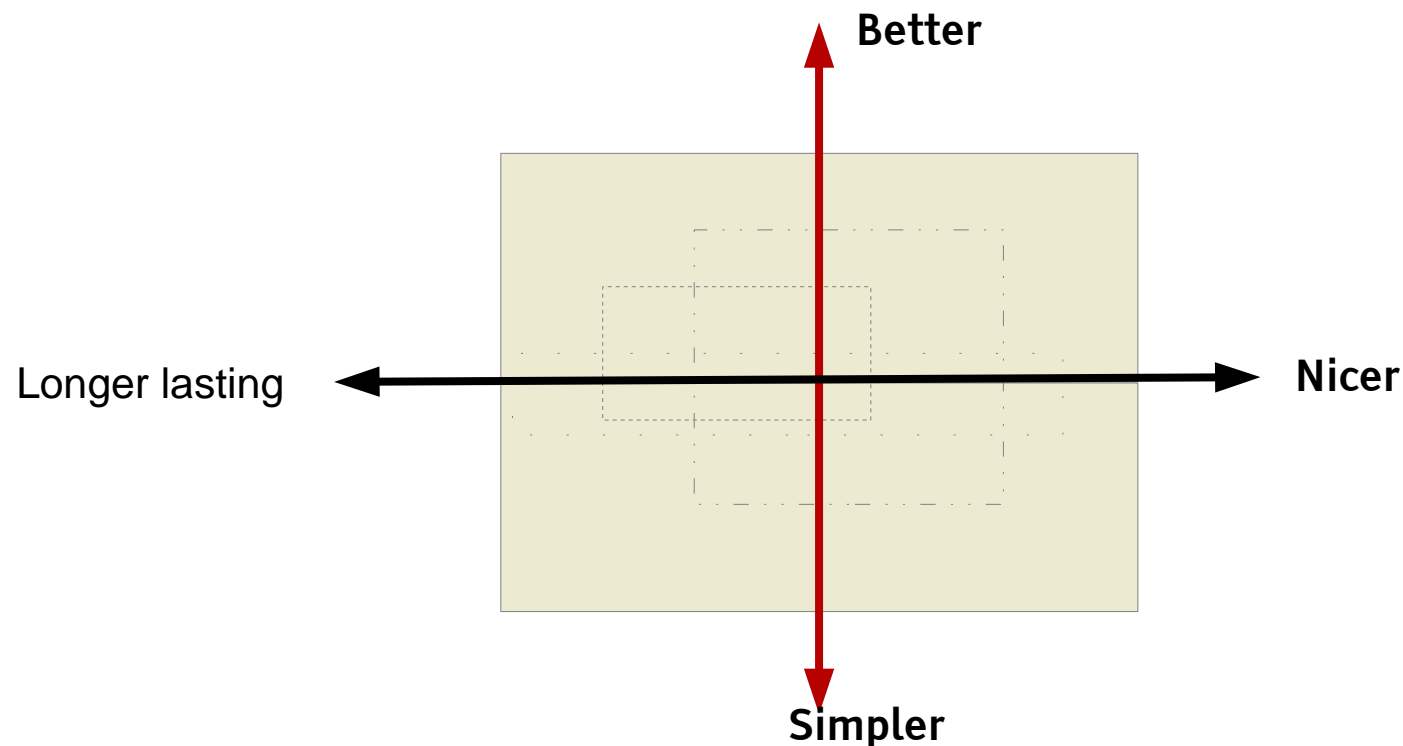
Exercise: Comparing Sort Algorithms

- ▶ 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 the criteria:
  - Speed (complexity)
  - Average speed (average complexity)
  - Memory consumption
  - Energy consumption
- ▶ Draw several BeNeSiLo cross diagramm and comment it with a text

- ▶ 2) Add the dimensions
  - Distributability
  - Security
- ▶ and span up a Kiviat graph (6 arms)

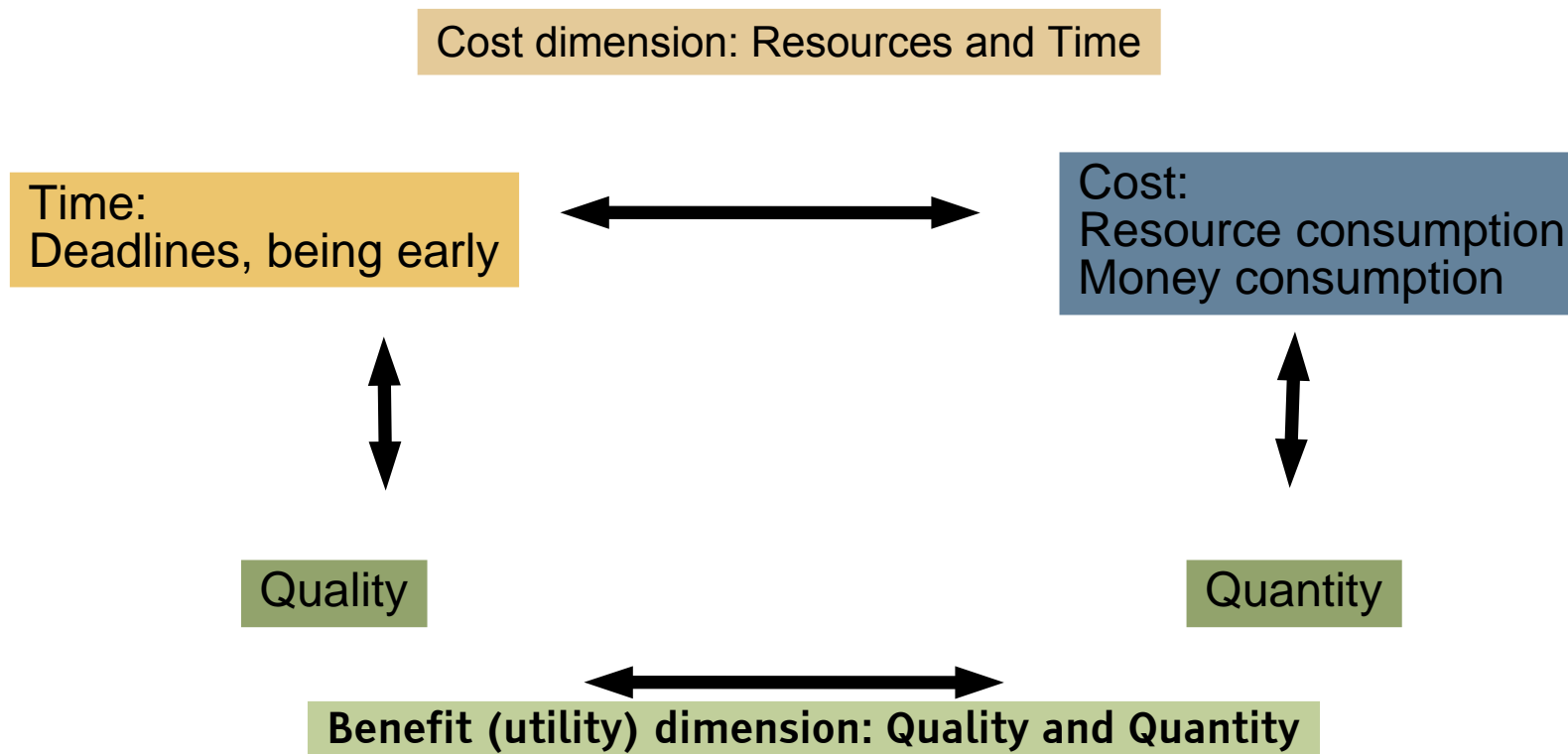# Quantitative BeNeSiLo with Abi Grading for **Utility/Benefit Analysis**

"Magic Rectangle" Efficiency Analysis for Research and Projects (CoTiQQ Diagram)

► Many research problems in technical science deal with benefit (utility) or cost (resource consumption)

► These are efficiency problems: increase benefit while reducing cost

► These are related to efficiency goals

Cost dimension: Resources and Time

Time: Deadlines, being early

Cost: Resource consumption Money consumption

Quality

Quantity

Benefit (utility) dimension: Quality and Quantity

Cost and Utility Interdepend

Quelle: [Bruno Jenny, Projektmanagement S. 292]

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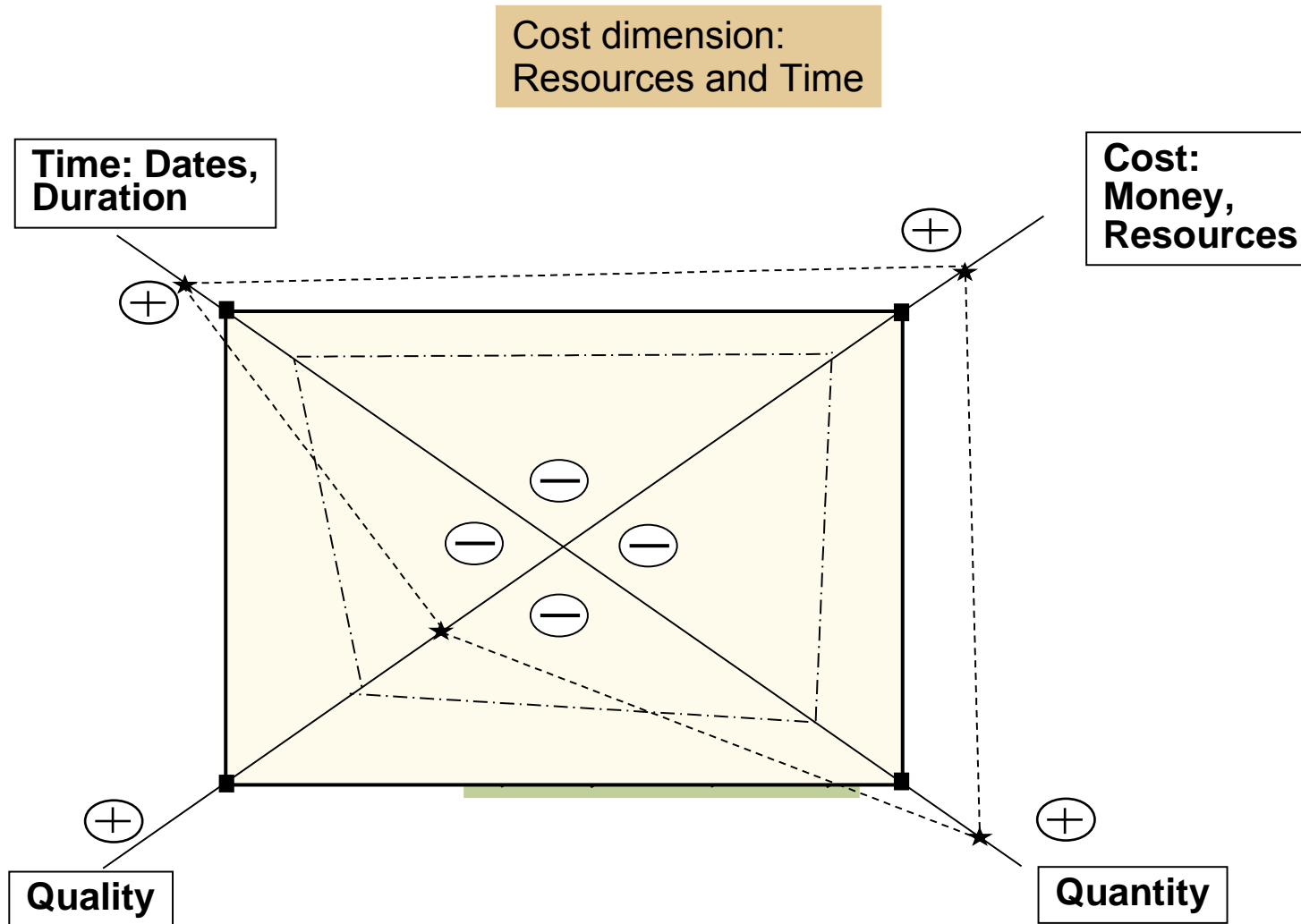
Efficiency Analysis (Cost-Benefit Analysis) with CoBit
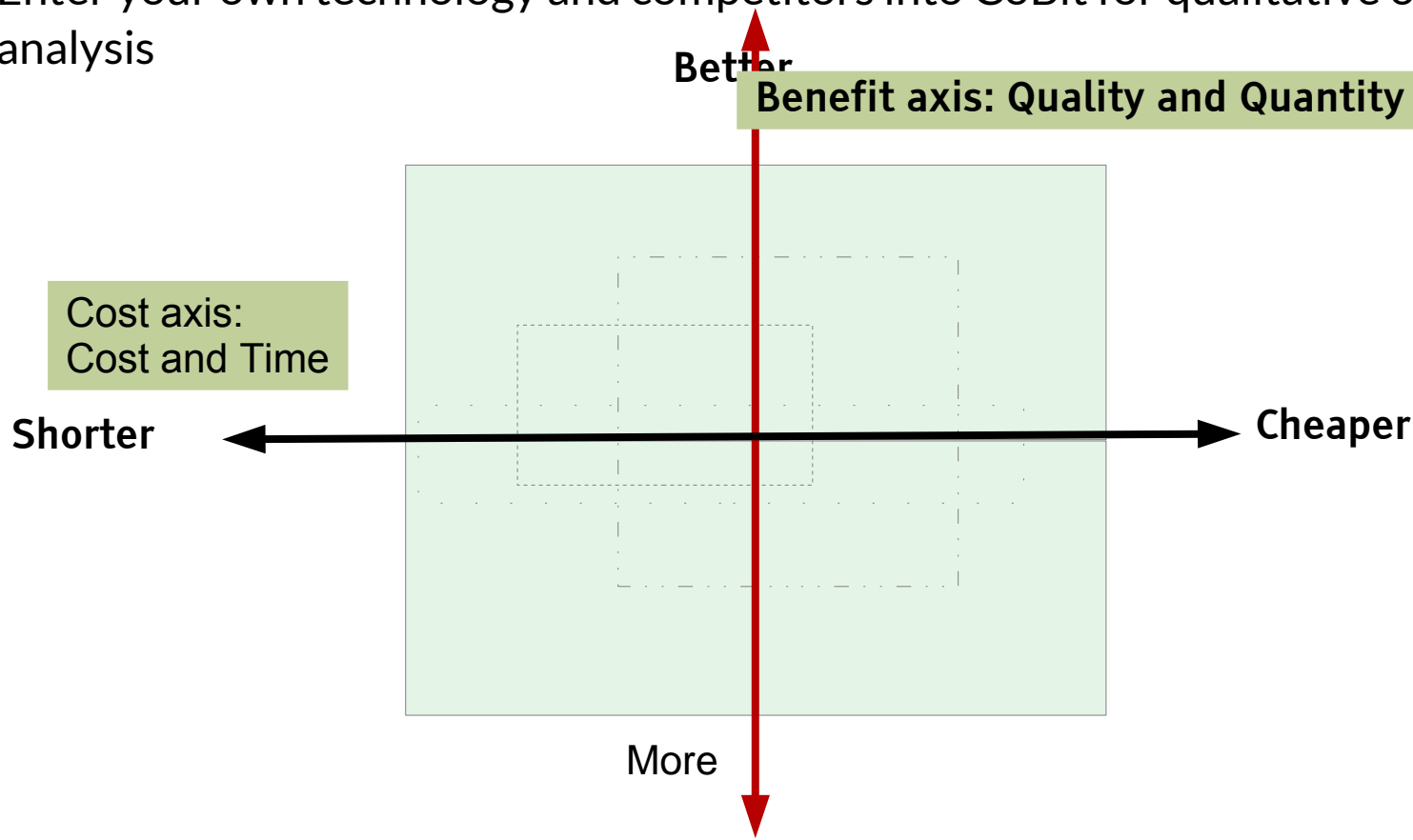# How Efficient is our Technology?

▶ CoBit (Cost-Benefit Analysis on Cost, Time, Quantity, Quality) is a special 4-D efficiency analysis on cost and benefit axis, comparing different technologies for efficiency

  ▪ For instance, on (Better, More) x (Shorter, Cheaper)

▶ In CoBit, larger areas mean greater efficiency

▶ Enter your own technology and competitors into CoBit for qualitative or quantitative analysis

Better

Benefit axis: Quality and Quantity

Cost axis:
Cost and Time

Shorter ←————————————————→ **Cheaper**

More

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

59   Academic Skills in Computer Science (ASICS)

▶ UCEW is a 4-dimensional attribute analysis comparing efficiency of a product, process, service, research result, technique, method

▶ based on olympic, direct parameters (utility, cost) and indirect relations (efficiency, waste)

▶

Utility, Leistung

Direct parameters (Olympic parameters)

Relational parameters Efficiency parameters

Efficiency Utility/Cost

Waste, Verschwendung 1-(Efficiency)

Cost, Kosten

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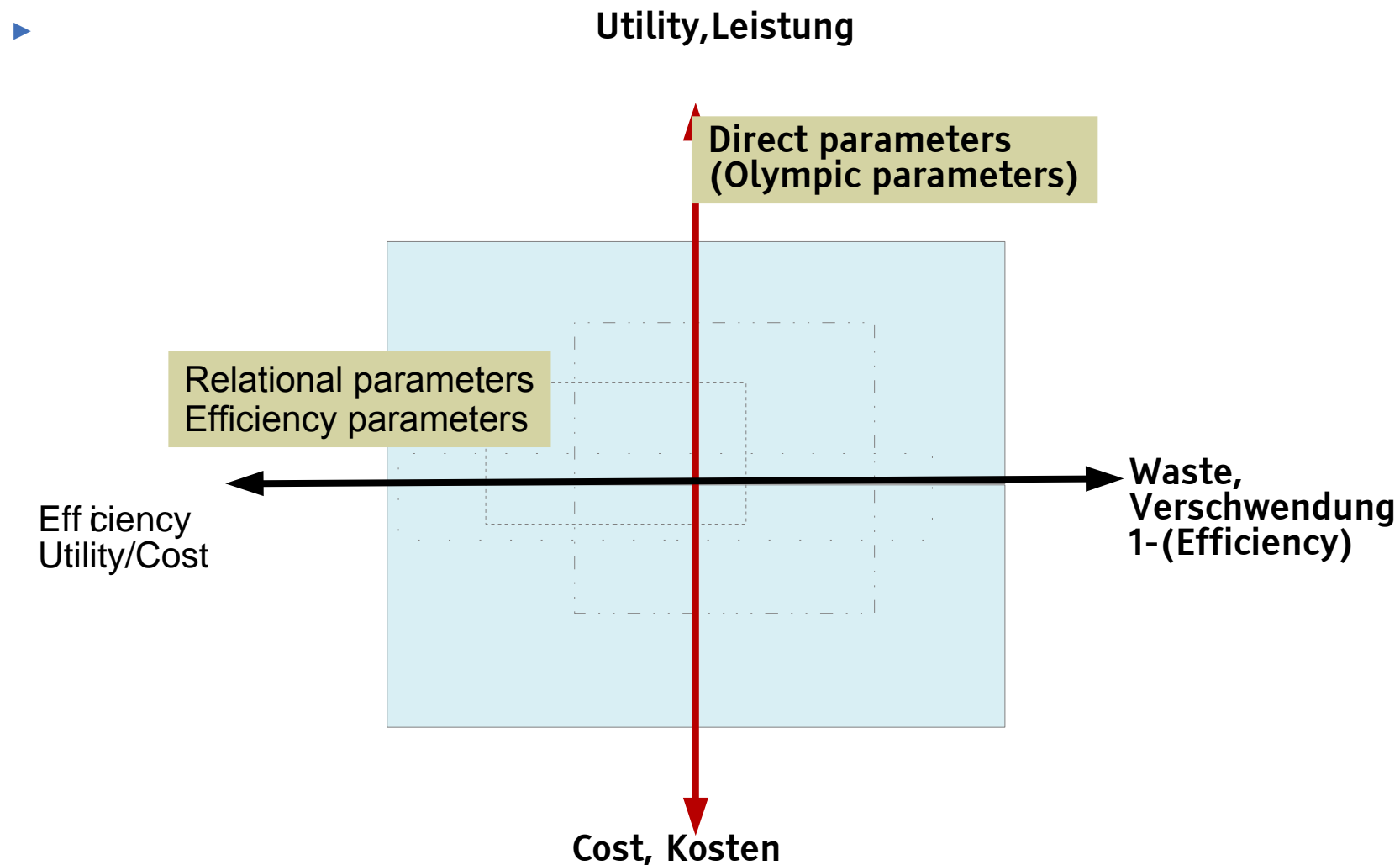
14.6.2 Comparative and Advance Analysis in Tabular Form -
Comparisons for Approaches with Regard to Success Criteria

▶ 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

	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

▶ Boolean values in the multi-criteria analysis

Ex.: Traffic Light Comparative Analysis

▶ Boolean values in the multi-criteria 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

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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

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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, presentation, and process quality

  ▪ Grades are handed out on a scale of 1-15 points

	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

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Ex.: Weighted School Grade Analysis for Student's Theses

		Approach 1		Tool 2		Technology 3		My approach	
Technical quality	0.45	12	5.5	4	1.8	3	1.4	12	5.5
Presentation quality	0.2	14	2.8	5	1	10	2	12	2.2
Process quality	0.25	12	3	8	2	8	2	11	2.8

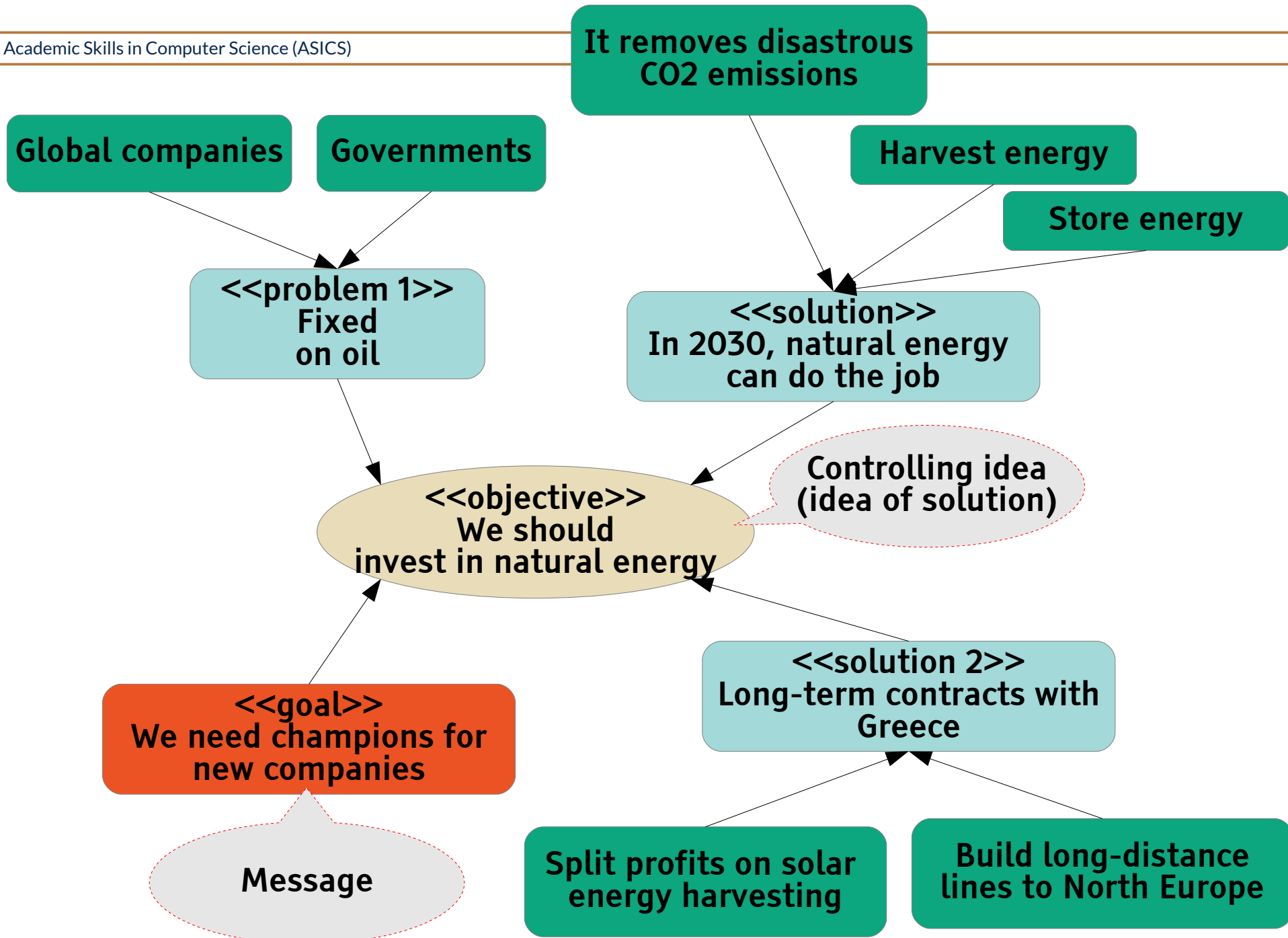Weight factors scale the absolute grades in ordinal scale

14.8 Writing Problem, Objective, Solution-Idea Analysis Papers (POS papers)

Problem, Objective & Solution (POS) Statements

▶ A Problem, Objective & Solution (POS) thesis statement is a thesis statement showing a problem, an objective and a solution

- ▪ If evaluation is added, it is called POSE statement

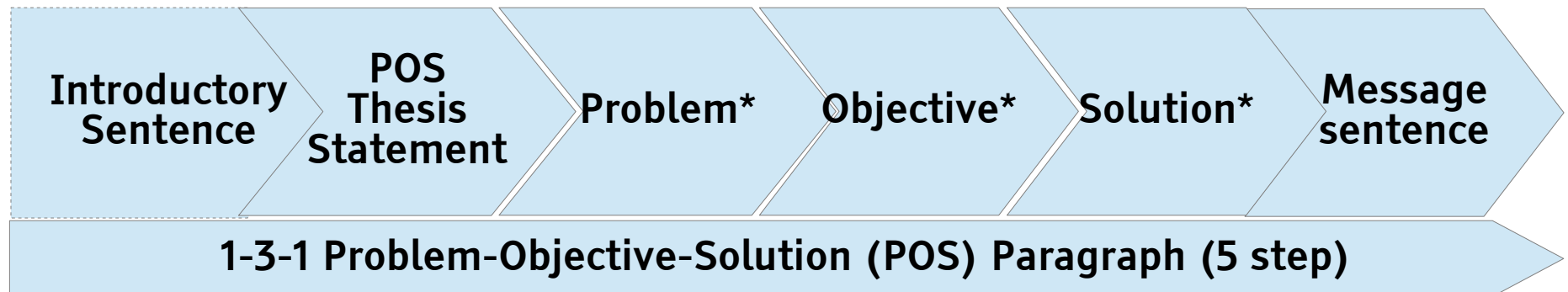▶ Thesis: Problem + Controlling idea (severity) + Development Scheme

▶

**Controlling idea
(idea of solution &
evaluation -
which is to
come while reading)**

**Development
scheme**

**Problem Thesis
Statement**

Problem

Objective

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POPP-like Mindmap

It removes disastrous CO_2 emissions

Global companies

Governments

Harvest energy

Store energy

<<problem 1>>
Fixed
on oil

<<solution>>
In 2030, natural energy
can do the job

<<objective>>
We should
invest in natural energy

Controlling idea
(idea of solution)

<<goal>>
We need champions for
new companies

<<solution 2>>
Long-term contracts with
Greece

Message

Split profits on solar
energy harvesting

Build long-distance
lines to North Europe

POS Paragraphs in 1-3-1 Structure

- We live in interesting times.

- Though major global players still believe in the oil economy, we should earn all our energy demands from natural sources in 2030, because the technical progress in harvesting energy is so tremendously fast.

- Major global companies are fixed on the oil economy and fight against a methanole economy on the horizon. Also governments support their old-fashioned strategy.

- In 2030, however, we should harvest all our energy and store it in methane or methanole, because only the methanole economy can free the world from desastrous C02 pollution.

- A technical solution could be to use the political union with countries like Greece to buy their natural energy and transport it by long-distance DC-powerlines to central and northern Europe.

- We need to find "champions" who will invest into these golden times of natural energy harvesting.

Introductory Sentence → **POS Thesis Statement** → **Problem*** → **Objective*** → **Solution*** → **Message sentence**

1-3-1 Problem-Objective-Solution (POS) Paragraph (5 step)

Skeletons of Problem-Objective-Solution Sections

▶ The skeleton of a POS section is the sequence of all POS thesis statements of all paragraphs

▶ A problem section has unity if all problem theses of the paragraphs support its section problem thesis

▶ Problem sections may be positioned as section 2 or 3 of a paper
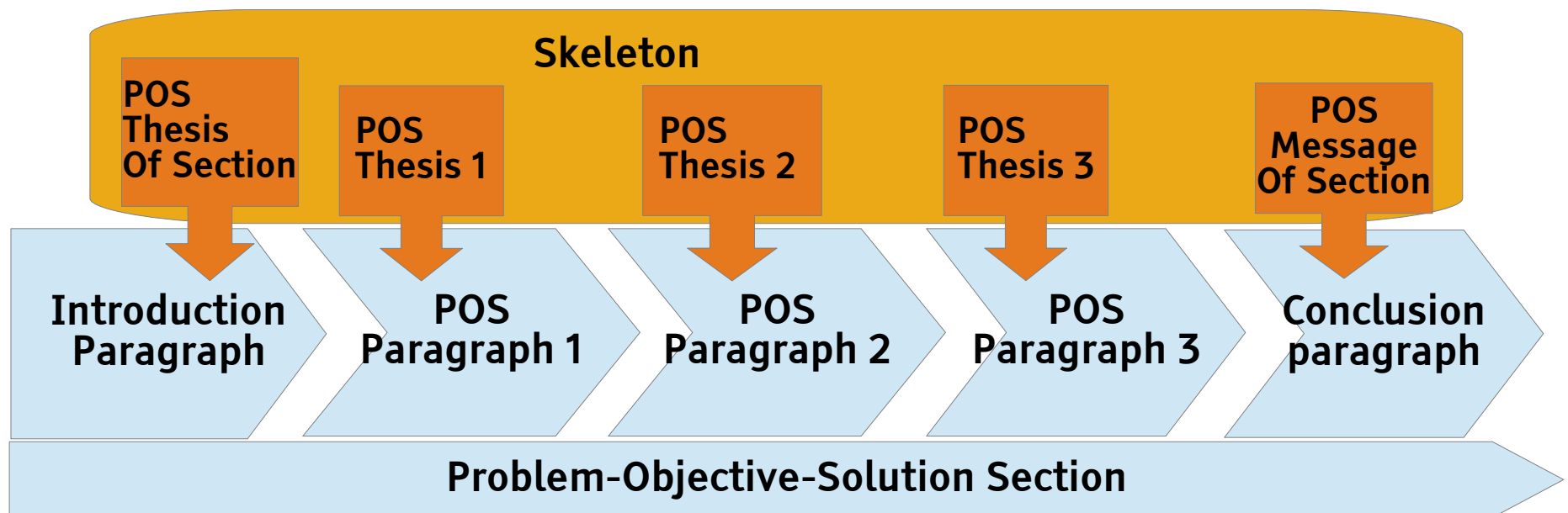
14.9 Writing Problem, Objective, Solution, Evaluation Papers (POSE papers)
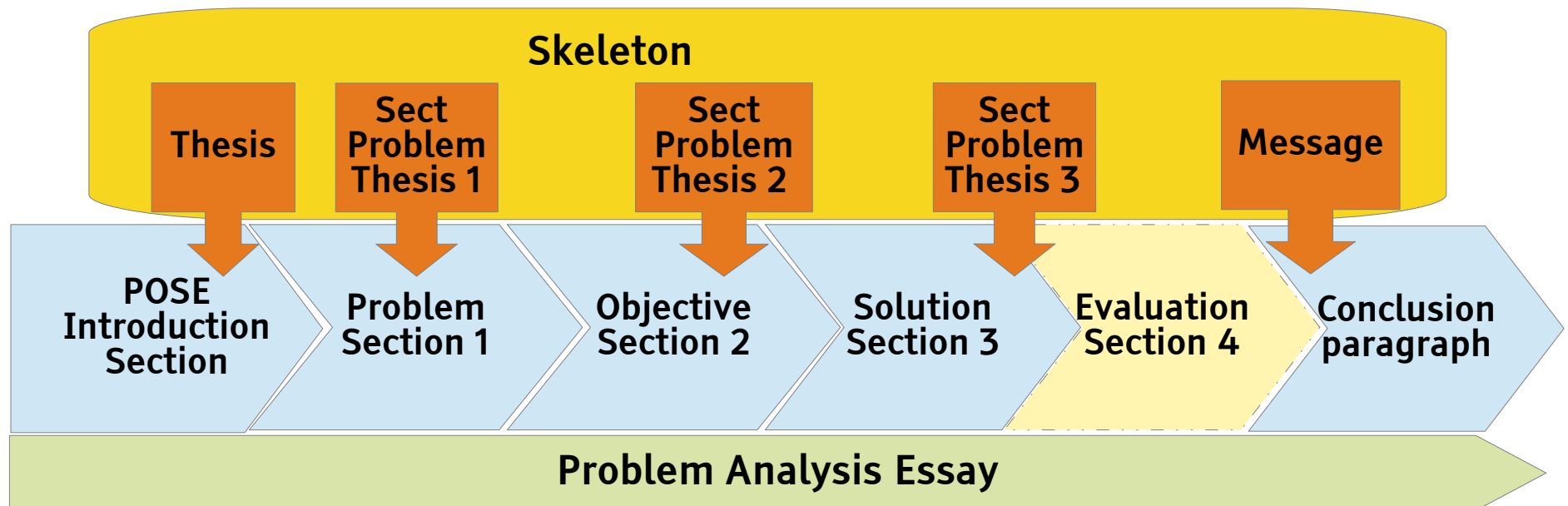
POSE Introduction Sections

▶ A **POSE (problem-objective-solution-evaluation)** section gives an overview over a paper (introduction section)

▶ The POSE section has unity if all theses of the POSE paragraphs support the section thesis

▶ Sometimes, evaluation is not available – then it becomes a POS introduction

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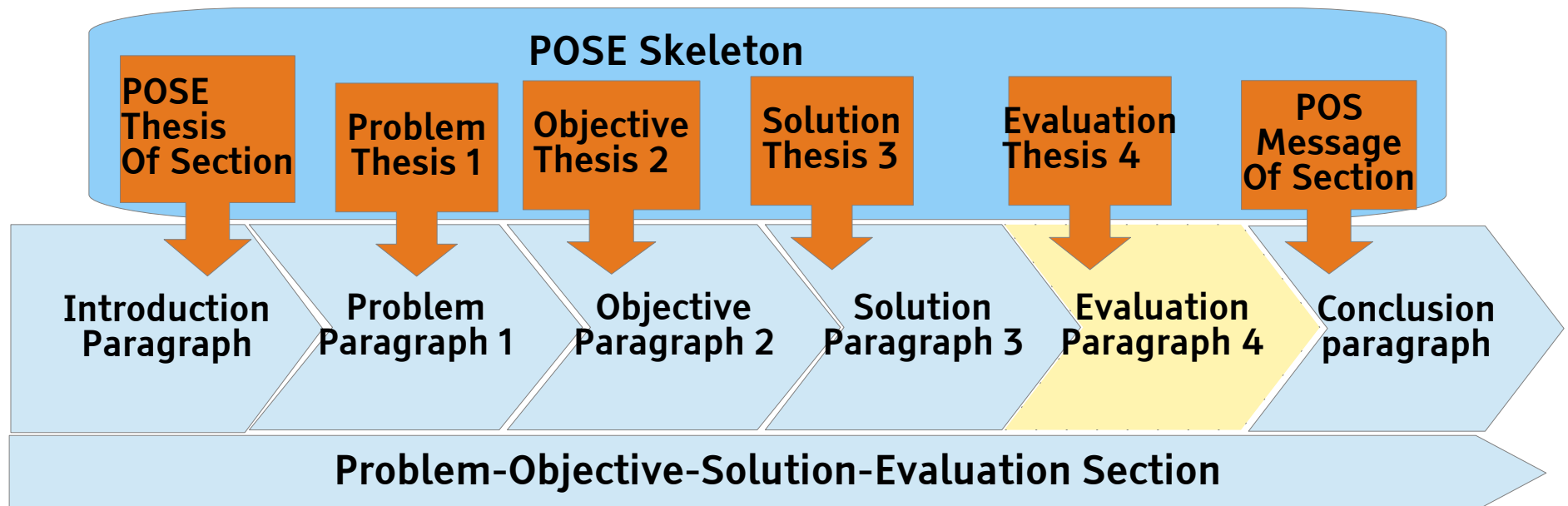
1-3-1-Problem-Objective-Solution-Evaluation Essay (POSE Paper)

▶ A POSE analysis essay discusses all aspects of a problem, an objective, and a way to a solution (and the evaluation)

▶ A problem-objective-solution-evaluation analysis research paper (POSE paper) discusses all aspects of a research problem

▶ A research exposé is a POS paper (to be written at the beginning of a thesis, usually without evaluation)

▶ Often, Problem and Objective Sections are merged

▶

Skeleton

| Thesis | Sect Problem Thesis 1 | Sect Problem Thesis 2 | Sect Problem Thesis 3 | Message |

| POSE Introduction Section | Problem Section 1 | Objective Section 2 | Solution Section 3 | Evaluation Section 4 | Conclusion paragraph |

Problem Analysis Essay

Why Do We Need Solution Design

- ▶ Every thesis needs a structured solution design method
- ▶ Many students loose time because they don't know any
- ▶ SPALTEN, DESIGN THINKING, ZOPP and other POPP methods are extremely valuable for YOUR thesis
  - ▪ to organize your thoughts
  - ▪ to write research exposés
  - ▪ to guide a reader through the work, or your defense talk
- ▶ Solution design processes organize your work systematically
  - ▪ make you much faster!
  - ▪ PAD-SAD-RAD is a 3-step schema for solution processes
- ▶ GAP is important for finding alternative and evaluating solution ideas
- ▶ Olympic and efficiency comparisons are very important for
  - ▪ comparing your work to others
  - ▪ selecting the best ideas
  - ▪ showing other people why they are best
- ▶ Knowing and using different classes of questions opens a discussion, an ideation process, or closes it

Exercises

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-POPP.

- 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-POPP an outline of a new essay, your own analysis.
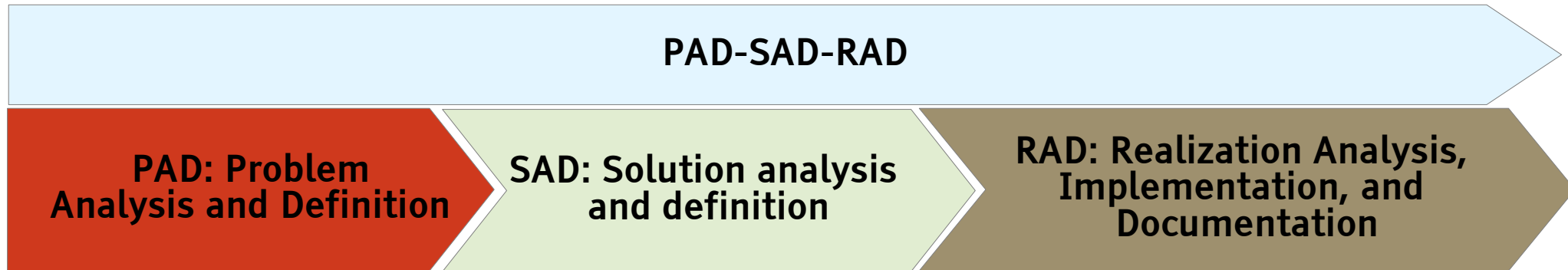
Homework – The Weekly Churchill

▶ 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-POPP yourself, ordering the problems and goals by decomposition and subordination. Find out blocking factors and success factors.

Writing POS Papers

- ▶ Write a POS 1-3-1 essay about the question
- ▶ "Why should Greece not leave the Euro?"
  - ▪ Define a skeleton
  - ▪ Define the POS thesis statements very carefully
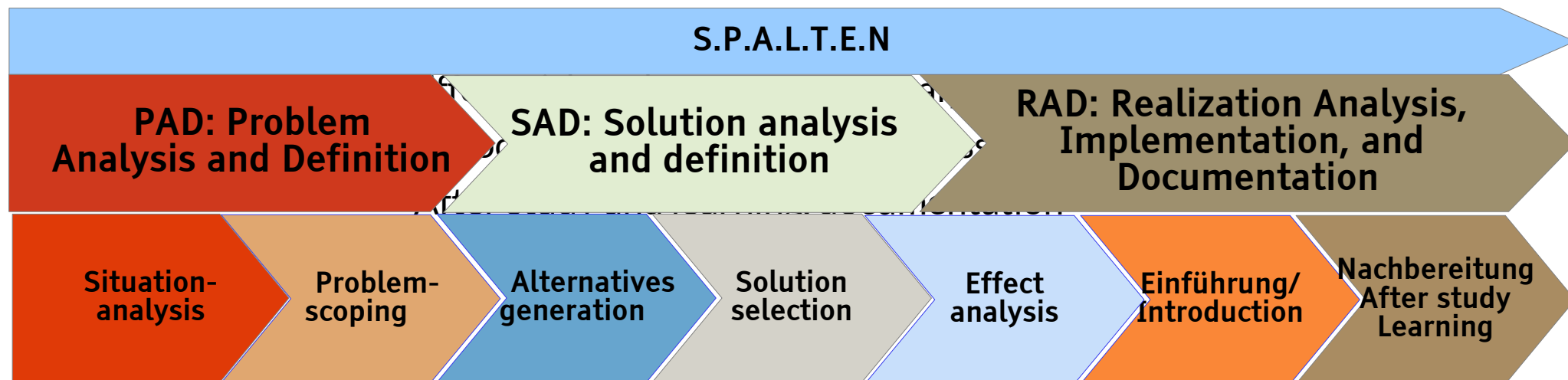 - ▪ Create unity for your POS essay!

Complete Solution Processes

▶ For your research (Master's thesis, paper, etc.), you need a complete solution process

▶ Most often, problem-solving processes are driven by a problem analysis

▶ In general, there are three steps

- PAD: Problem analysis and definition
- SAD: Solution analysis and design
- RAD: Realization Analysis, Implementation, and Documentation

▶ PARGESI, SPALTEN, and DesignThinking are fantastic solution processes for your Master's thesis

▶ For a PhD thesis, they have to be iterated several times

PAD-SAD-RAD

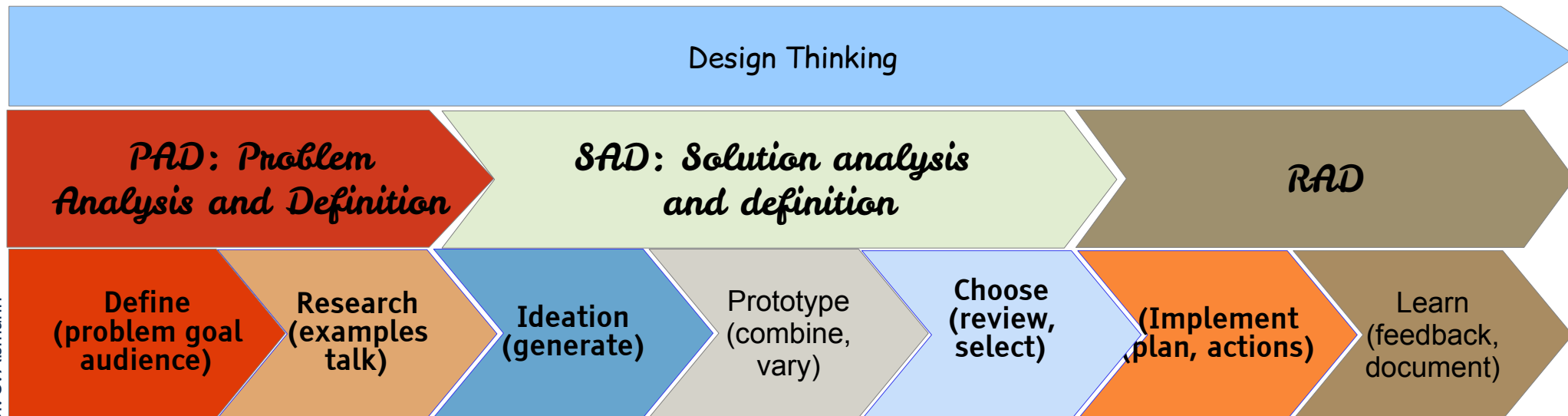| **PAD: Problem Analysis and Definition** | **SAD: Solution analysis and definition** | **RAD: Realization Analysis, Implementation, and Documentation** |

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

- ▶ SPALTEN is a problem solving process
- ▶ Steps: [Wikipedia/Problemlösen, Albers]
  - ▪ PAD: Problem analysis and definition:
    - · Situation analysis (Ist-Analyse, literature analysis)
    - · 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)

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S.P.A.L.T.E.N

PAD: Problem Analysis and Definition	SAD: Solution analysis and definition	RAD: Realization Analysis, Implementation, and Documentation

Situation-analysis	Problem-scoping	Alternatives generation	Solution selection	Effect analysis	Einführung/ Introduction	Nachbereitung After study Learning

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

▶ http://en.wikipedia.org/wiki/Design_thinking

▶ Similar to SPALTEN, but using prototyping to test and select ideas

▶ Used by D-School in Stanford and HPI in Potsdam

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Problem Solving with VanGundy Problem Solving Method PARGESI

▶ [VanGundy-ProblemSolving] contains a structured, very general process to solve structure problems: PARGESI

- Problem analysis and Redefinition: It is an experience that the first problem definition is not stable, but must be reiterated.

- Generating Ideas

- Assessment and Evaluation of Ideas

- Selection of ideas

- Implementation and Realization