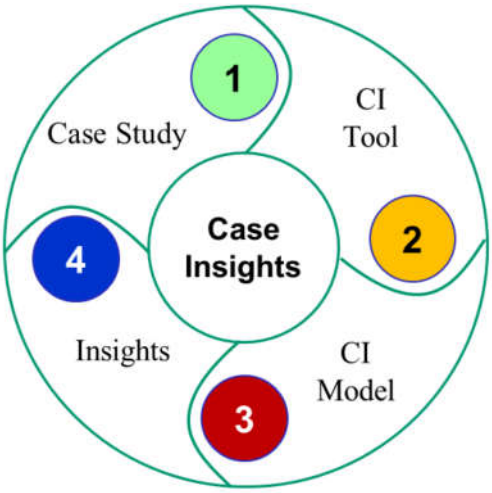

Knowledge Discovery in Case Studies

The Case Insight Method for Case-Based Problem Solving

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Knowledge Management and Collaboration (KMC)

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Thank you for the introduction, chairman!
Good afternoon and welcome to my presentation which deals with a new approach to Knowledge Discovery called “Case-Based Knowledge Discovery”, a technique for discovering knowledge in case studies.

Unlike the other research presented in this session, my research is not analytical but constructive. I'm an engineer, and as you know engineers love solving problems more than doing detailed analysis

Research Question

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- **Problem**: only a small part of case knowledge can be accessed through simple reading
- **Research question**: *How can we discover knowledge through case studies and make it usable for case-based problem-solving?*

Knowledge Discovery in Case Studies

Case studies contain a great deal of problem-solving knowledge, but only a small part of that knowledge can be accessed through simple reading.

So, the question is: *How can we discover knowledge through case studies and make it usable for case-based problem-solving?* This was the main research question that inspired this research about a new type of knowledge discovery.

Knowledge Discovery (KD)

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	"Huge" KD (established)	Case Based KD (new)
Volume of data	Large volumes of data	A carefully selected, small set of documents, easily managed and scanned through by a person
Typical task	Search only specific parts (concepts, entities, sentiments, etc.)	Full analysis dealing with the whole document (holistic)
Typical objects	A large collection of written resources (corpus)	Single, well-selected documents
Typical process	Computational, automatic, artificial intelligence process	Conscious reasoning process of natural intelligence ("reverse engineering")
Typical outcomes	Huge lists of similar parts found in a big corpus of many objects	A small set of holistic knowledge structures (models) for each task object

Knowledge Discovery in Case Studies

The established techniques of knowledge discovery – abbreviated by KD - like

- text mining, concept mining, natural language processing and knowledge discovery and data mining

are all focused on the **au**tomated processing of large volumes of data: we could call this the "Huge KD".

What you get from Huge KD are huge amounts of **knowledge fragments.**

For case-based problem-solving this is not very useful: we need **knowledge models** for the case. This is why for this research we have developed a new approach to knowledge discovery**: Case-Based KD**, which d**i**ffers from Huge KD in several aspects:

1. *Volume of data*: the number of case studies involved is such that it can be easily managed by a person.
2. *Typical task*: the performed analysis is holistic: it deals with the whole document, instead of focusing only on specific parts (concepts, entities, sentiments, etc.).
3. *Typical objects*: the task objects are single, well-selected documents, not a large collection of written resources (corpus).
4. *Typical process*: the text analysis process is a conscious reasoning process of n**a**tural intelligence, not a computational, automatic, artificial intelligence process.
5. *Typical outcomes*: the outputs are a small set of holistic knowledge structures (models), not huge amounts of **knowledge fragments** that have lost their context.

Case-Based KD: Definition

Case-based knowledge discovery (CBKD) is the process of

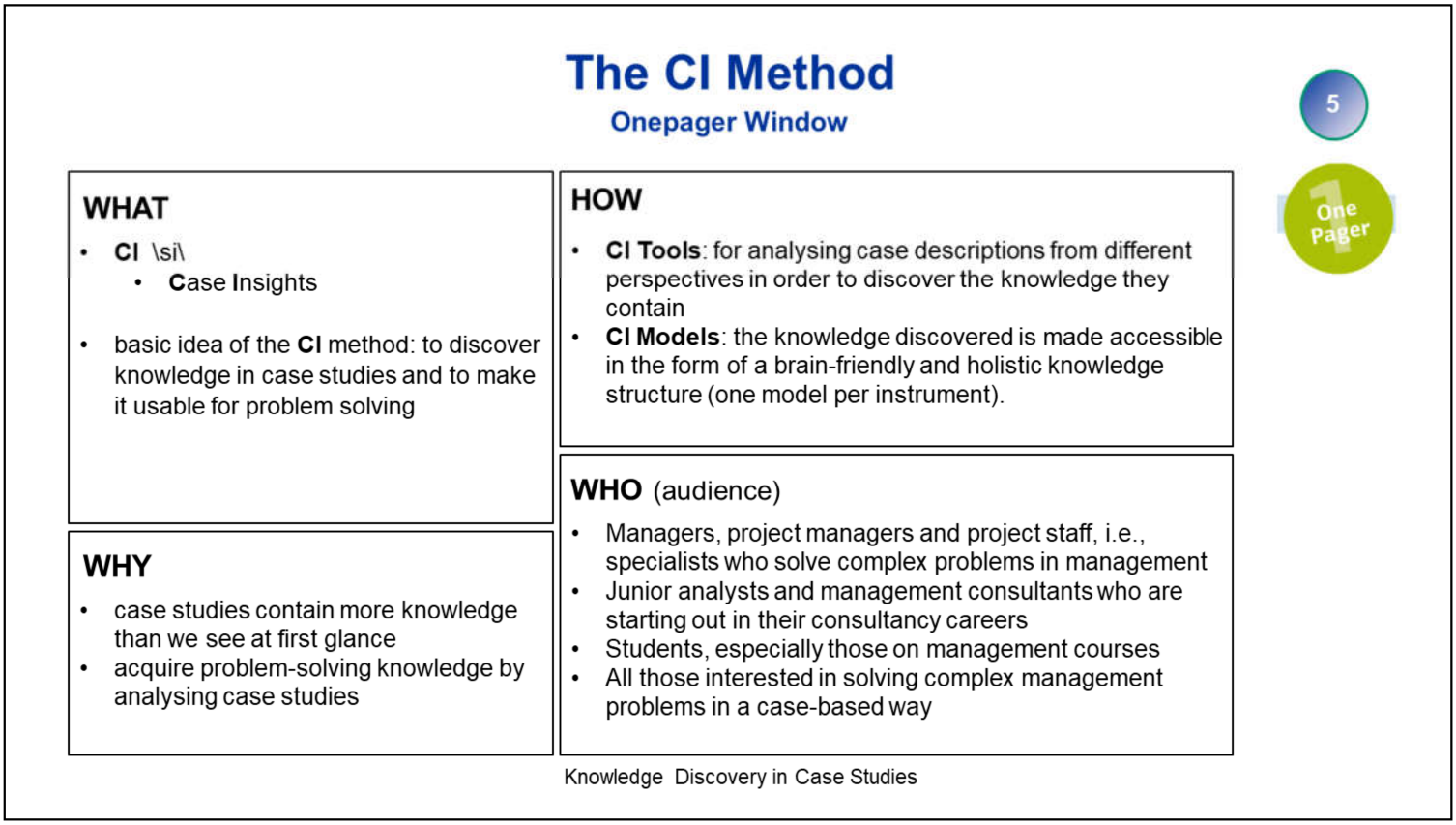
- *examining a case study by means of conscious, natural intelligence reasoning (similar to reverse engineering)*
- *that performs the task in a holistic way, dealing with the whole document*
- *and producing as the outcome a small set of holistic knowledge structures (models)*

Knowledge Discovery in Case Studies

The characteristics of this new approach to knowledge discovery are summarised in the following definition:

Case-based knowledge discovery (CBKD) is the process of

- *examining a case study by means of conscious, natural intelligence reasoning (similar to reverse engineering)*
- *that performs the task in a holistic way, dealing with the whole document*
- *and producing as the outcome a small set of holistic knowledge structures (models)*



In order to do this, we have developed a technique called “Case Insights”, abbreviated by CI \si\

- WHAT: the basic idea of the **CI** method is to discover knowledge in case studies and to make it usable for problem solving.
- WHY: we need the CI method because case studies contain more knowledge than we see at first glance, in particular problem-solving knowledge; **but this knowledge is often difficult to access** and the CI method enables to acquire it.
- HOW: case descriptions are analysed by means of **CI tools** and the knowledge discovered is made accessible in the form of **CI models**

Case-Based Problem-Solving

Knowledge Types

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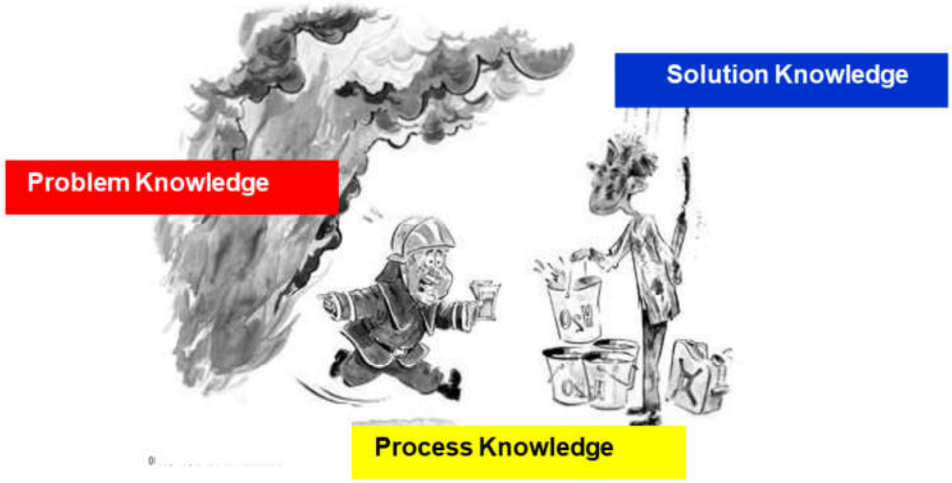

Image:
Paolo Calleri, Ulm, 2010

Knowledge Discovery in Case Studies

The problem-solving knowledge contained in case studies can be divided into 3 types of knowledge:

1. Problem knowledge. This is knowledge of the structure of the problem (parts and their connections);
2. Process knowledge. This is knowledge of the procedure, i.e. how to find the solution;
3. Solution knowledge. This is knowledge on which the implemented solution is based.

Why is problem-solving knowledge in case studies difficult to access? Two obstacles make knowledge discovery difficult.

Image: https://docplayer.org/19639510-B-wfs-p-problemwissen.html

Obstacles

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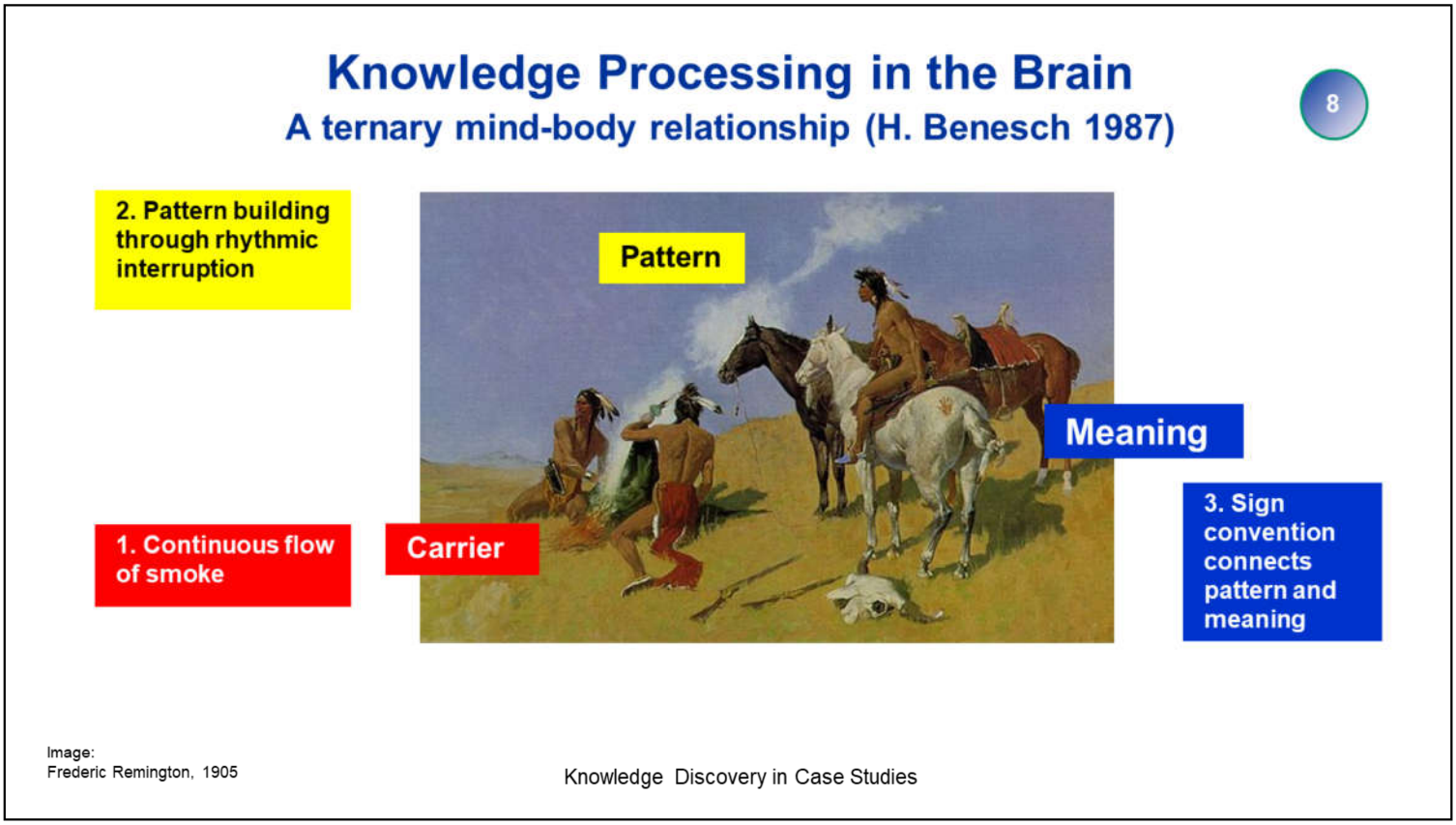
- **Obstacle 1**: case study texts are not or not sufficiently designed in a **brain-friendly** manner.
- **Obstacle 2**: Case descriptions are not or not sufficiently holistic: they do not sufficiently support **networked thinking** (pattern recognition).

Knowledge Discovery in Case Studies

Obstacle 1: case study texts are not or not sufficiently designed in a **brain-friendly** manner. For example, linear text is not brain-friendly: it is a chain, a succession of terms, in which each term has only two fixed connections, one with the previous term and one with the next term.

Obstacle 2: Case descriptions are not or not sufficiently **holistic**: they do not sufficiently support **networked (interconnected) thinking**, especially **pattern** recognition and **pattern** formation (the key of networked thinking).

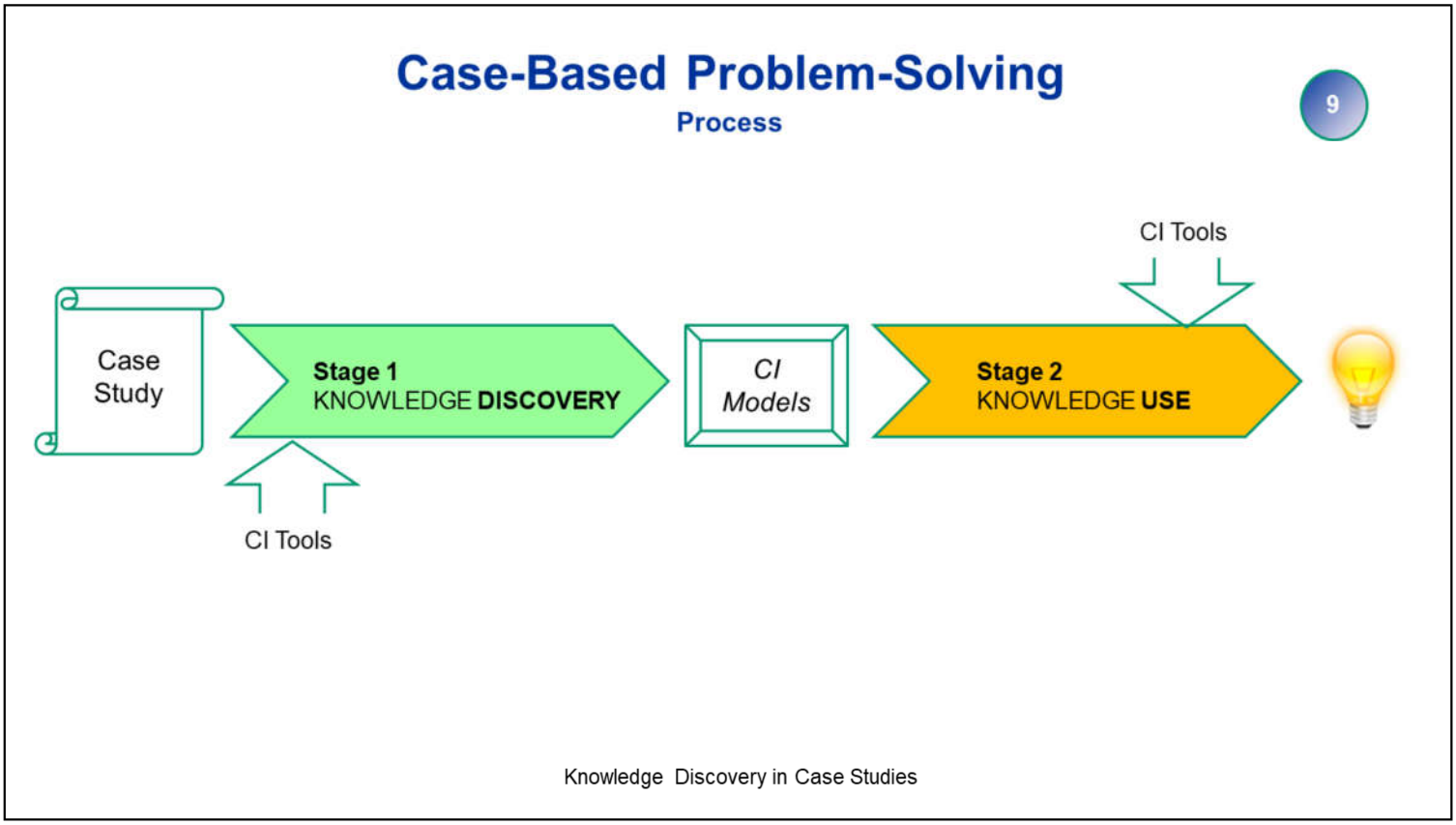


Regarding obstacle 1: When is a text "brain-friendly"?

According to G. Probst a description is “brain-friendly” if it is “***o****riented towards the processing mechanisms of the human brain*”, especially *knowledge* processing.

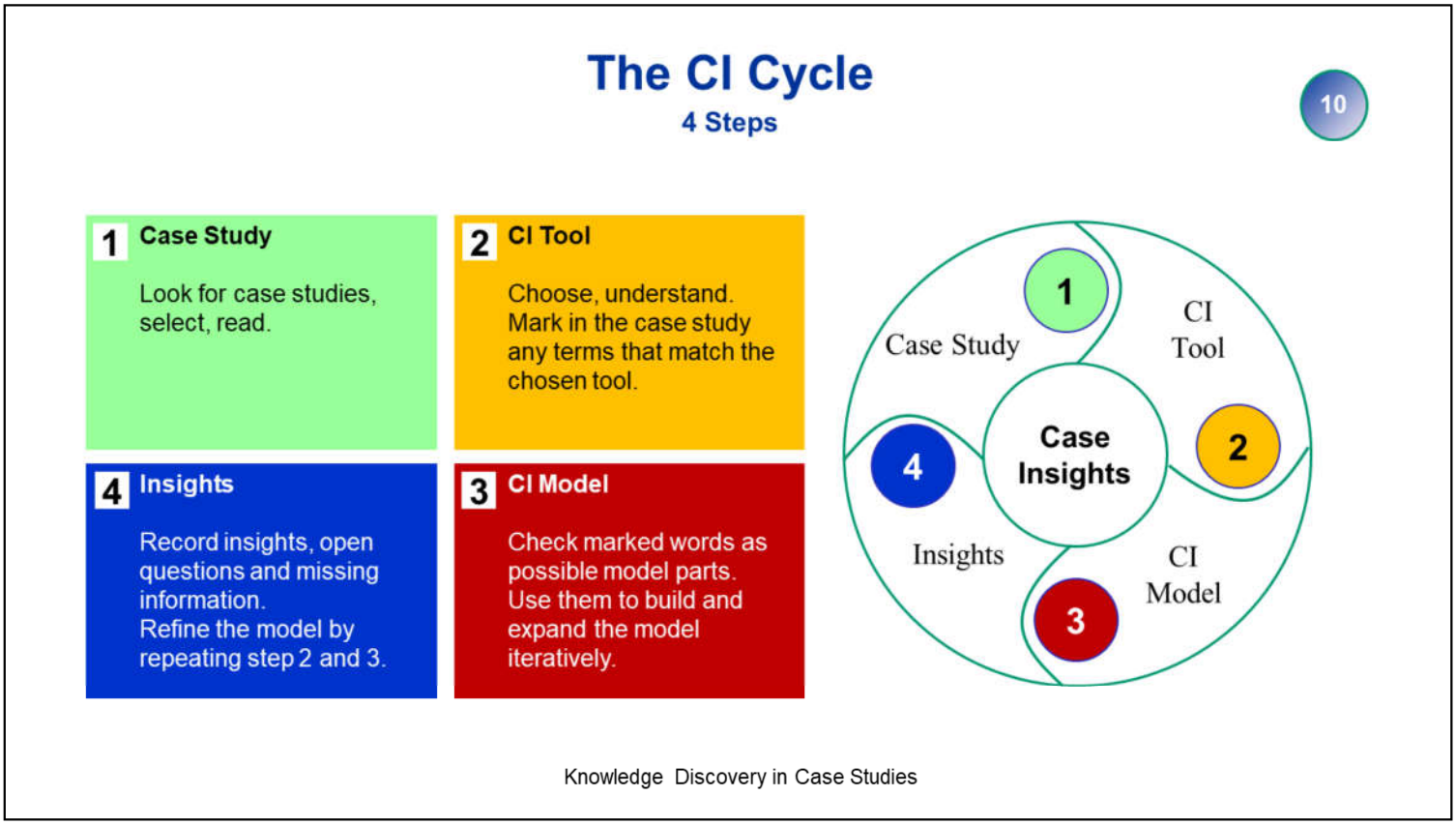
According to a principle by H. Benesch, at a basic level, knowledge processing in the brain should be investigated as a **ternary** mind-body **relationship** among:

1. **Carrier**: the processing is carried out by the nerve cells (neurons and others) which are extensively interlinked with one another.
2. **Pattern**: the activation of the neural networks creates time and space **patterns** (rhythm and figuration).
3. **Meaning (knowledge)**: figuration (structural **pattern** formation) generates and processes meaning



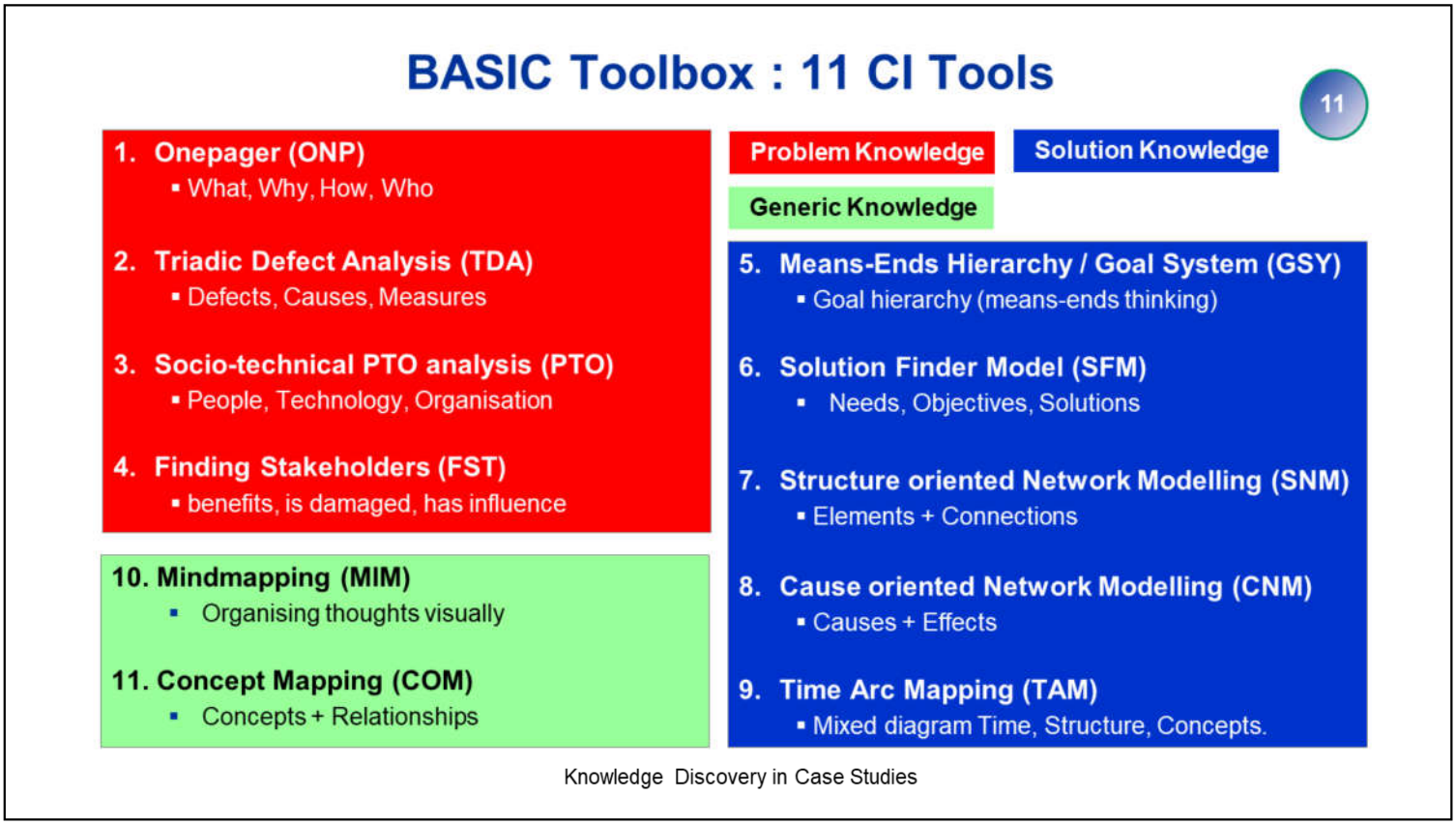
Case-based problem-solving in management is a two-stage process consisting of knowledge discovery (stage 1) and knowledge use (stage 2):

- *Knowledge Discovery*. This is where the CI method is applied: with the help of *CI tools*, knowledge from authentic case studies is analysed from different perspectives and the knowledge discovered is made visible and usable in the form of *CI models*, i.e. brain-friendly and holistic knowledge structures.
- *Knowledge Use*. The knowledge structures from stage 1 are adapted to the requirements of new problems and used together with the CI tools for problem-solving.



Knowledge discovery with CI consists of 4 steps; they are run through several times per tool and are therefore arranged as a circular process, the so-called CI cycle.

1. **Step 1**: Case study. The case study is at the beginning of the CI cycle. You have to look for case studies, define your own criteria for selection, collect suitable case descriptions, select the best one, read it and get a rough idea of the most important characteristics for you.
2. **Step 2**: CI tool. Depending on the characteristics that are important for you, you choose one of the tools. Then you need to make sure that you know the tool well. With this knowledge, you return to the case study and **apply the tool**: **identify** terms, concepts, ideas and **compare** them.
3. **Step 3**: CI model. Here you **connect** the text elements from step 2 into a **whole** thus building up and expanding the model iteratively; you also evaluate its suitability for modelling the related text sections.
4. **Step 4**: Insight. Finally, the created model is examined carefully and reflected on: what findings does it provide? What questions does it leave open? What information and links are still missing or are redundant? Etc



The basic toolbox for discovering case-based knowledge by means of the CI method consists of 11 tools, divided into 3 groups:
a) CI tools for problem knowledge b) CI tools for solution knowledge c) Generic tools: mind mapping and concept mapping.

Now I will show you four examples of models obtained from four of the tools in this toolbox:

- The **TDA chain**, the **PTO map,** the **Means-Ends Hierarchy** (see example) and the **Causal Network**.

KAPPA Case Study

Stocker & Tochtermann (2010), S. 188 ff

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Initial situation

- SME, 20 employees, 2 sites, consulting services, tourism industry
- Main goal: Avoid knowledge silos (improve knowledge work)
- Solution: Corporate Wiki + application scenarios + training (Wiki functions, Wiki practice)

Introducing the solution

- Product: MediaWiki
- Design: Administration, projects, methods and filing.
- Start: MS Office training with Wiki as storage for training contents

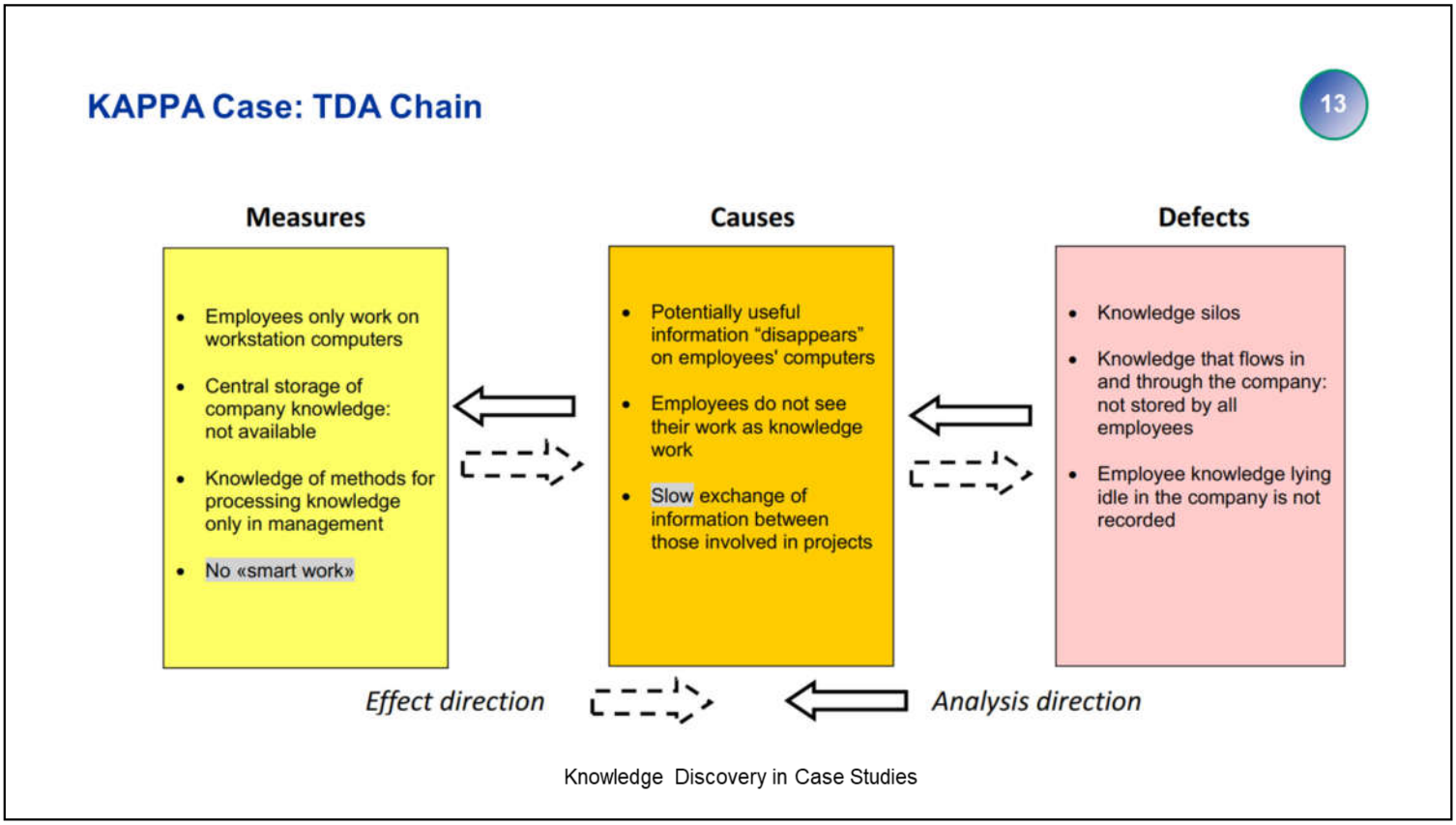
Results

- Half of the workforce use the Wiki very actively (regular contributions)
- Increased awareness of knowledge work in the company

Knowledge Discovery in Case Studies

I will now show you **four models** obtained by applying these CI tools to an authentic management case study, the KAPPA case study.

This case study describes the solution to a problem in the field of knowledge management by means of a corporate wiki.



The TDA Chain

… distinguishes Defects, Causes and Measures, connected from right to left by analysis and from left to reight by effects. It provides a kind of "bird's eye view" of the problem area, focusing on organisational provisions and their consequences, especially with regard to defects.

KAPPA case: PTO map

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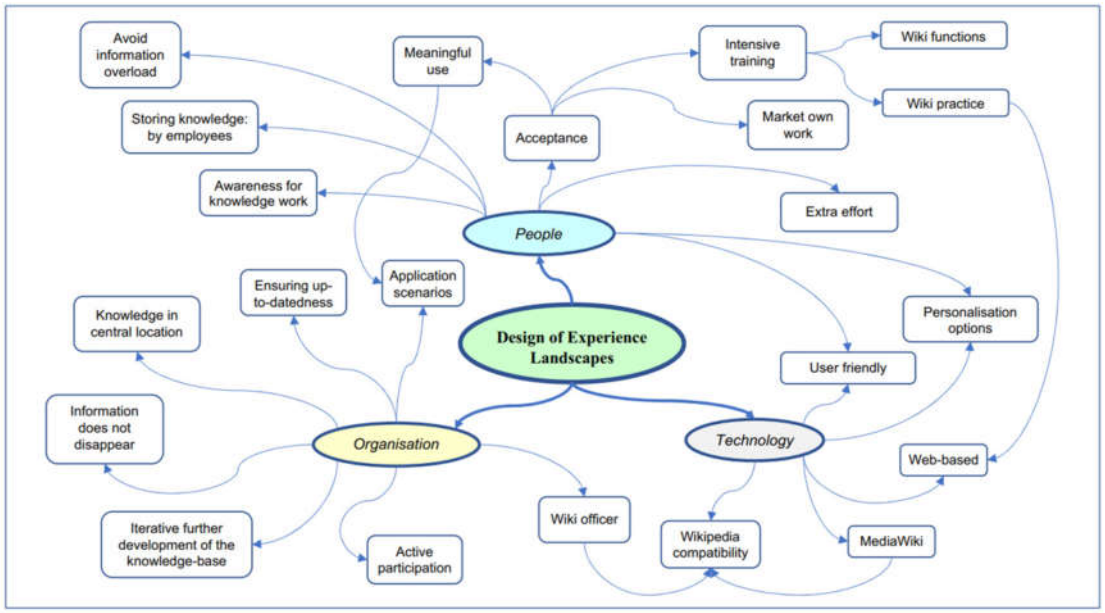

Knowledge Discovery in Case Studies

The PTO map

… distinguishes concepts (aspect) in the case study which are primarily human, technical or organisational and shows essential elements within these areas

KAPPA case: Means-Ends Hierarchy

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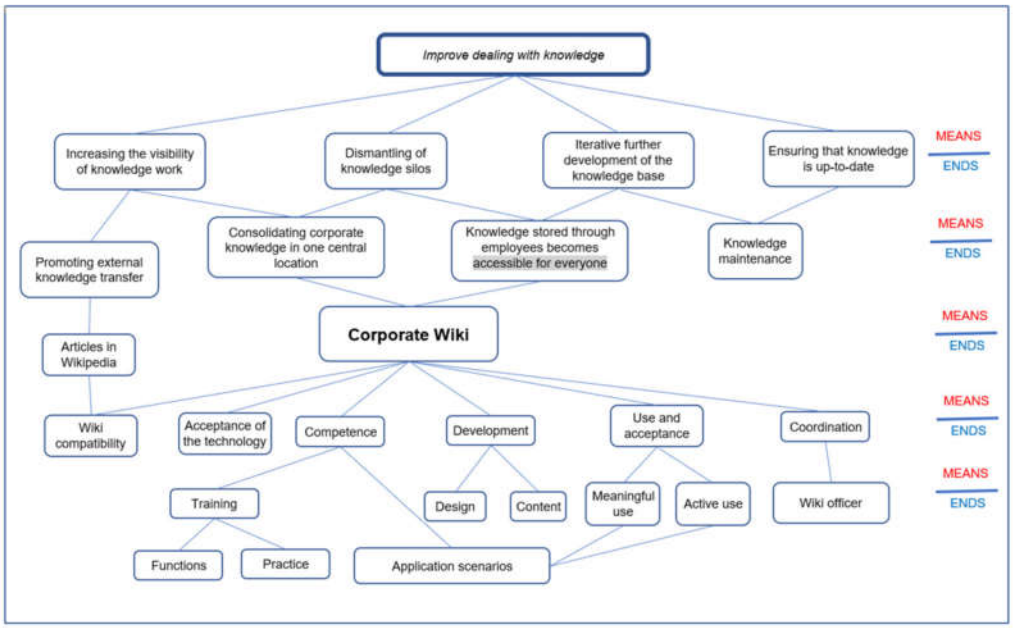

Knowledge Discovery in Case Studies

The Means-Ends Hierarchy

… makes it easier to oversee and reflect on project goals, especially with regard to weighting and complexity.

- By looking at the goals for a certain hierarchy level, you can see which goals have the same or a similar degree of abstraction;
- and when looking at all the sub-goals of a goal across different hierarchy levels, you can see, for example, the degree of complexity involved in achieving the goal.

KAPPA case: Causal Network

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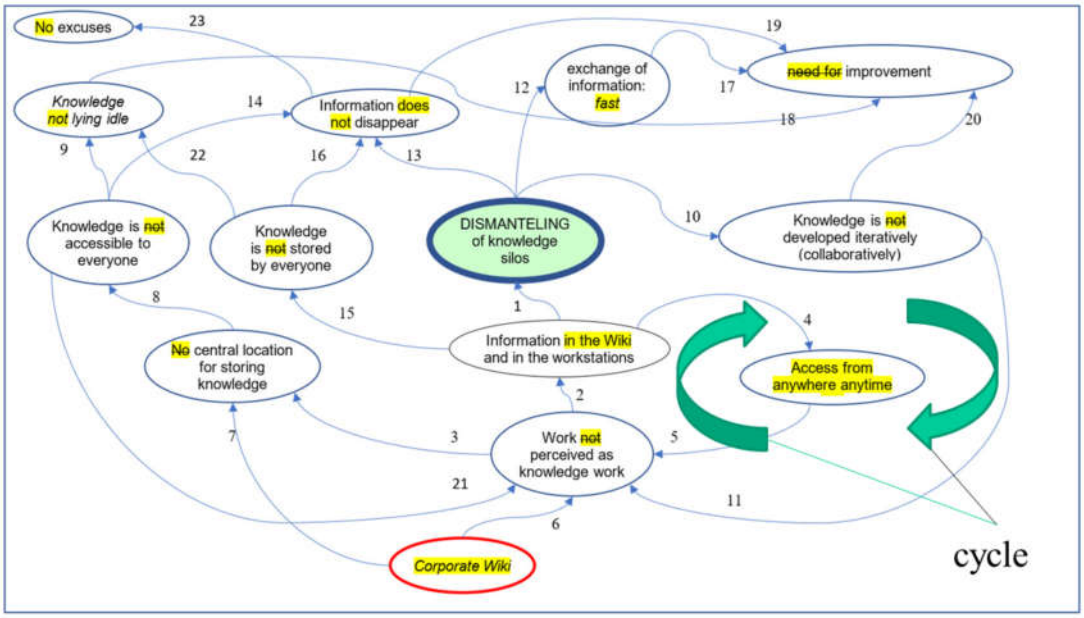

Knowledge Discovery in Case Studies

The Causal Network

… provides critical knowledge for understanding the mechanisms of action of the system under investigation.

In such a network special patterns become visible which are shaped as cycles.

Such cycles are like “motors” that drive what happens in the network.

What is Knowledge?

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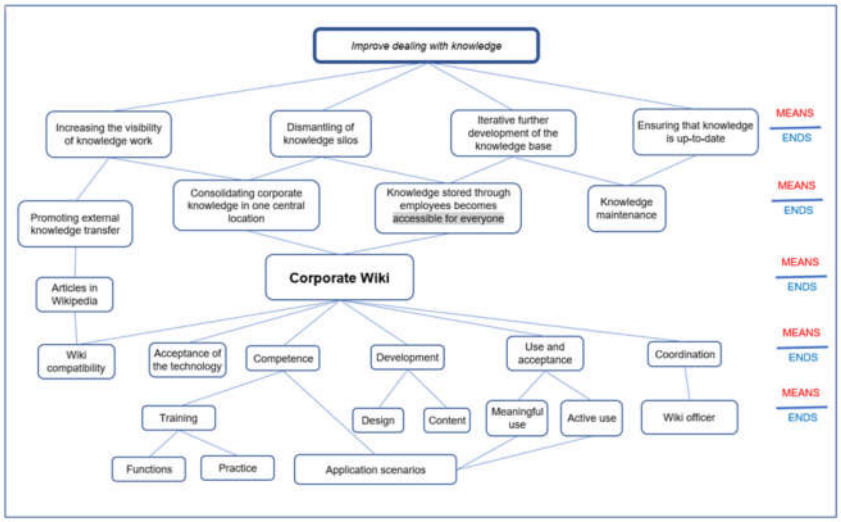
«… a whole made of compared and linked ideas …»

Immanuel Kant, 1781



KAPPA case: Means-Ends Hierarchy

Knowledge Discovery in Case Studies

We saw that CI is a method of knowledge discovery. But what is it, that is "discovered" in the process?

What is knowledge?

Immanuel Kant, the famous German philosopher who proposed an innovative theory of knowledge - which today is still revolutionary - wrote in his main work that knowledge is: “a whole made of compared and linked ideas”.

This is exactly what we do with every **CI tool**: we search for and discover (**tool** related) text elements in case studies (terms, concepts, ideas, etc.), **compare** them and **connect** them into a whole. This “whole” is precisely the CI model, a knowledge structure.

Case-Based Knowledge Discovery: Success Factors & Future Research

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Three aspects are crucial to a successful application of the CI method:

1. *collections of case studies need to be easily accessible*
2. *a large toolbox, extending the basic toolbox, perhaps even a big repository of tool*
3. *evaluation methods for supporting a critical examination of the knowledge discovered*

Knowledge Discovery in Case Studies

The successful application of the CI method presented in this paper depends on three conditions:

1) Easily available collections of high-quality case studies;
2) a repository of tools which is large enough to cover a big variety of case studies;
3) evaluation methods for supporting a critical examination of the knowledge discovered.

These are points on which future research should concentrate.