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# ON THE APPROPRIATENESS OF EMPIRICAL RESEARCH STRATEGIES IN THE FIELD OF CONCEPTUAL MODELING

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## Research Goals of IS as an Academic Discipline

Each academic discipline is based on at least three constituents: (1) a subject, (2) research goals which refer to this subject, and (3) a set of theories, methods and procedures which are used to achieve these goals.

The subject of IS is denoted by the name of the discipline: Information systems in business and administration. In the following, we refer to an information system as the information processing subsystem of a business system [FeSi01]. The tasks of an information system are carried out by human and machine actors. Machine actors of information systems are called application systems. Thus, an application system is a component of a comprehensive information system.

The academic discipline IS deals with planning, development, implementation, operating, management and evaluation of information systems. From a more general viewpoint, the goals of IS refer to analysis and design of information systems. Here we have to keep in mind a major difference between IS and related sciences, e.g. social sciences. In contrast to societies, information systems and in particular application systems predominantly are artifacts. They do not evolve but have to be explicitly designed. Consequently, design goals play an important role within IS. In other words: IS is essentially an engineering discipline.

## Conceptual Modeling of Information Systems

Conceptual modeling isn't an end in itself. Conceptual models are for an information systems designer what engineering drawings are for a civil engineer or a mechanical engineer. Thus, conceptual models are the most powerful utilities to achieve the goals of IS. The purpose of a conceptual model is to facilitate analysis and design of complex information systems. Therefore, a comprehensive conceptual model must provide a multi-perspective, multi-view representation of the information system or subsystem under design. Relevant perspectives are e.g. the outside and the inside perspective. Views focus on specific characteristics from a given perspective, e.g. structure and behavior from the inside perspective of an information system.

The "basic tool kit" of conceptual modeling includes

- modeling languages (meta models) which define types of building blocks and relationships between building blocks as well as corresponding rules and constraints,
- process models to guide the execution of the modeling task, and
- software tools for computerized support of the modeling task.

A modeler who is equipped with heuristic knowledge and experience of how to map a certain real world issue into the schematic representation of a given modeling language is able to use such a methodology and to produce solid results, e.g. a conceptual data schema representing the data view on an information system.

Nevertheless, the basic tool kit is not sufficient for comprehensive modeling of information systems. In fact an "advanced tool kit" comprising additional tools is needed, e.g.:

- integrated meta models, based on powerful metaphors, allowing harmonized modeling of different perspectives and views on a complex information system,
- architecture models, which help to manage the complexity of models by dividing them into different layers, subsystems and views,
- reference models and patterns, providing reusable heuristic modeling knowledge,
- ontologies, which help to capture the semantics of building blocks and relationships.

Mastering an advanced methodology like this in order to develop a comprehensive conceptual model of a complex information system marks the level of "craftsmanship of conceptual modeling".

We all know that there is never the one and only right model. Rather there are more or less appropriate, more or less complex and more or less understandable models. This leads to the next level of modeling maturity, the "art of conceptual modeling" (analogous to DON KNUTH, The Art of Computer Programming [Knu97]). From the viewpoint of constructivism, a modeler perceives the real world, interprets the relevant part of the real world, separating it from its environment, and reconstructs the relevant parts of the real world and its environment in the form of a conceptual model using a given methodology. All this is subject to the modeler's understanding of the modeling goals and objectives as well as to his or her methodological knowledge and modeling experience.

## Research on Conceptual Modeling

In the last years, extensive research has been done on conceptual modeling. As recent academic conferences show, many questions meet ongoing interest and the list of research topics is even growing. Current themes include

- utilization of ontological concepts for conceptual modeling,
- meta-modeling,
- generic models,
- verification and validation of models,
- agile modeling and extreme modeling,
- model engineering,

- semantics-preserving model transformation,
- model-driven architecture, and
- automatic processing of models.

The examples show that conceptual modeling is a very agile field of research in IS. WAND and WEBER propose a research agenda on conceptual modeling in IS based on the question "How can we model the world to better facilitate our developing, implementing, using, and maintaining more valuable information systems?" [WaWe02].

## Empirical Research on Conceptual Modeling

The goal of empirical research is to observe, to describe, to analyze and to explain phenomena around the subject of investigation. The "tool kit of empirical research" comprises techniques like case study, action research, experiment, enquiry, interview, observation, field study etc. What can empirical research contribute to conceptual modeling in IS? Some examples for conceivable contributions are:

- Empirical research can look over the shoulder of a modeling craftsman or artist and help to identify best practices of modeling and thus encourage the improvement of model construction.
- Empirical research can observe users interpreting models and thus help on learning about clarity and understandability of models.
- Empirical research can help to compare different modeling methodologies in specific modeling scenarios.

As these examples show, empirical research can support the further development of conceptual modeling methodologies. Thereby it can unveil surprising results. BOWEN, O'FARRELL and ROHDE report on an experiment on the relationship between the level of ontological clarity of data structures and query performance. The results indicate that users of the ontologically clearer implementation of the data structure made significantly more semantic errors, took significantly more time to compose their queries, and were significantly less confident in the accuracy of their queries [BRF04].

Empirical research on conceptual modeling is both challenging and error-prone. One of the pitfalls is to underestimate the complexity of modeling scenarios. To give a negative example: investigating the proliferation of the different UML diagrams would produce only poor insight if methodology and context of the modeling scenarios are not considered sufficiently.

## Conclusion

Empirical research, facing the challenges and pitfalls, can provide valuable and complementary contributions to conceptual modeling in IS. However, an increasing focus on empirical research must not disregard research on the tool kits as well as the craftsmanship and the art of conceptual modeling.

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