

MODEL TYPE CONSTRUCTION

—AN APPROACH FOR ACHIEVING SCIENTIFIC COGNITION

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ABSTRACT

In Business Informatics, research objectives can be classified in the two groups „cognition objectives“ and „design objectives“. The former postulate the wish to understand given and observed facts, the latter constitute the aim to design new facts. Model type construction can be seen as an approach for achieving scientific cognition, since model types are helpful in the research process as well as a result type in research processes. Efficiency in the research design is reached, when certain requirements are observed. These requirements include the necessity to explicate the epistemological point of view, the research objective and the explanatory statement for the chosen research method.

1 INTRODUCTION

In this paper we discuss, to what extent the construction of models is able to contribute to scientific cognition. Our research is focusing on business informatics—a research field covering both information management and computer science in German speaking countries. In this discipline, models are of central relevance in research, and the type of outcome in research frequently is a model. First, we describe our understanding of the relevant terminology and the related work in this context. The next section discusses the relevant philosophies of science in general, which we apply for business informatics. In section four we deal with the central question of this paper and discuss the feasibility of creating models in the process of gaining scientific cognition. In this paper, we focus on a central European point of view regarding the philosophy of science and the roles and functions of models. Where appropriate, we link to other systems of terminology.

2 MODELS: TERMINOLOGY AND RELATED WORK

In a first definition, a model is an illustration of real or imaginary circumstances in a simplified and use-adequate matter (e.g. Busse von Colbe & Laßmann, 1991; Heinrich & Roithmayr, 1995; Schwaninger, 2002; Winter, 2003). Models are ubiquitous in most scientific disciplines as well as in daily life. The process of modeling is a process of abstraction. By modeling we reduce our observation in the given problem sphere to the relevant perceptions. By using formal descriptive languages, symbols etc. we classify the perceptions. Both make it necessary to first reflect about the purpose of the model, because abstraction is possible only in relationship to the purpose of the model (Hars, 1994). Hence, a model can be defined only related to its reference object and its purpose (Grochla, 1974). The literature contains a wide variety of definitions about models in the different sciences (Spinner, 1969), reflecting different understandings about the philosophy of a model. One class of interpretations defines a model as an inter-subjectively understandable extract from a reality (image-related understanding of a model). Another class sees models as subjective entities designed by modelers, which can not be measured at an objective reality (constructivist understanding of a model) (Dresbach, 1996). Furthermore the term „model“ is used on two different levels of abstraction: On one side, it describes the set of language elements, which is used for a representation in a given application context. On the other side, also concrete applications of modeling are described as a model. In our context, we will call the abstract view on a model, the set of language elements, the model type. We can develop and construct model types in the process of gaining scientific cognition. Model type construction is independent of the planned aims of the model types. Modeling or model construction is the application of a model type on a given problem. Result of modeling is the model. So, the model is always related to a certain application context, either to analyze or to design something, either for a single situation or with a claim to be valid in a generalized context.

3 SCIENTIFIC COGNITION AND BUSINESS INFORMATICS

Cognition can be defined as knowledge about objects with objects being part of a reality or being imaginary only. Depending on the epistemological point of view, knowledge about objects can be derived inductive from experience or deductive from existing knowledge (Becker, Holten, Knackstedt, & Niehaves, 2003). Depending on the number of persons gaining cognition there has to be differentiated, whether a real world does exist, or does not exist or is at least assumed to exist or not. If a real world exists or is assumed to exist, there has to be differentiated, whether there is an objective cognition or not. When assuming the existence of a reality (epistemological realism), the cognition of reality is subject independent. If objective cognition of a reality is impossible (constructivism), each subject has its own individual cognition of reality, which may not be congruent with other's cognition of the same issue. The moderate constructivism assumes that each cognition is subject-dependent, but between two or more subjects a common assumption about the cognition can be agreed on (common understanding) (Becker et al., 2003). In this paper the moderate constructivist position is assumed.

To be scientific cognition, a common understanding of this cognition has to be achieved. This depends on satisfying some requirements. (Becker et al., 2003) see the creation of a language community as the constituting difference between pre-scientific and scientific cognition. This can be done by documenting the research process in a way that within this language community a consensus of experts on the common understanding of this process can be achieved (e.g. König, 2004). (Becker et al., 2003) developed a requirements list, which is to be met to establish a consensus on the scientific process. These requirements are: (a) *Completeness of the explication of the evaluation basis*. (b) *Documentation of research results* in a way that they can be understood by "a well-informed and willing one" (Becker et al., 2003). (c) *Selection of a research methodology*. (d) *Application of the research methodology*, i.e. correctness of the application of the methodology. (e) *Research goal* resp. discussing the achievement of the objectives. (f) *Overall assurance of consistency concerning the chosen epistemological and ontological positions*. A common understanding is given, when accepted processes were applied. The acceptance is a result of the ongoing discourse of experts within the language community. These requirements are the skeleton for the research methodology and—based on this—for the research design, which is used as a synonym of the overall approach of cognition.

Since the mid-nineties the cognitive objectives of business informatics are debated. Experts were interviewed in two delphi studies in 1994 und 1999 (Heinzl, König, & Hack, 2001; König, Heinzl, & von Poblitzki, 1995). The long term objectives were described as the increase of knowledge about (a) taming complexity in information and communication systems, (b) net and virtual markets, and (c) the design ("Gestaltung") of the human-computer-interface. In the previous study research methodologies and core theories of business informatics were asked for. Concerning research methodologies constructivist and empirical methodologies were distinguished. Concerning theories pragmatic and theoretic objectives were differentiated. In the end, the research objectives can be reduced to "Why?" (theoretic approach) and "How?" (pragmatic approach).

	Cognitive objective	Design objective
Methodological tasks	Understanding methods and techniques of information system design	Development of methods and techniques of information system design
Functional tasks	Understanding of information systems and their applications in practice	Supply of IS reference models for individual companies or whole industries

Table 1: Research tasks and objectives in business informatics (Becker et al., 2003)

According to this the research objectives to be defined within the research design of (Becker et al., 2003) can be differentiated in cognitive objectives and design objectives (see table 1). Both objectives can be differentiated furthermore. (Becker et al., 2003) differentiate between methodological and functional tasks. The methodological tasks can be distinguished between the understanding of suitable methods and techniques of information system design (cognitive objective) and the development of these methods and techniques (design objective). Accordingly the functional tasks can be differentiated in understanding information systems and their applications in practice (cognitive objective) and supplying IS reference models for individual companies or whole industries (design objective).

4 MODEL TYPE CONSTRUCTION AS SCIENTIFIC COGNITION

After introducing the basic terms of both models and scientific cognition in the previous sections, now we can try to challenge model type construction as an approach of scientific cognition. First the relevance of model construction in research processes is shown. After this requirements are presented, which have to be met by model types and by their construction to constitute a scientific research process.

In section 3 was shown, that a common understanding is a particular characteristic of scientific cognition. To enable this, a distinct and well-defined language is required. With this language cognition can be communicated unambiguously. Natural language doesn't perform well on this matter because of its fuzziness. Formal languages are more suitable. They have a clear, well-defined semantic of the words, are temporal invariant, and the sentences build are unambiguous because of the defined syntax (Holl, 1999). These properties apply for model types as well. I.e. models types are a language required to establish a common understanding of cognitions. Therefore the construction of model types is an approach of building scientific cognition. With respect to the methodological research tasks and the corresponding research objectives of business informatics (see table 1) this can be stated both (a) functional (indirect) and (b) as regards content (direct): (a) By pursuing cognitive objectives existing model types are used as the medium to document and communicate research processes and results. The result is the cognition, not a new model type. (b) By pursuing design objectives model types are themselves results of a research process. Independent of the suitability of model type construction for achieving scientific objectives the question comes up, how certain model types and the process of their construction satisfy the scientific requirements.

Model type requirements address the question of suitable formalization and granularity. In literature there are two positions. On the one hand representatives of the critical rationalism are demanding that all scientific predicates must be falsifiable (Popper, 1994). This leads to the requirement of unambiguous formulations and consequently to the requirement of formal model types (Frank, 1999). Finally it depends on the research strategy (research objective, methodology and underlying theories) (Heinzl et al., 2001) giving arguments in favor of or against a certain degree of formalization. More important seems to be to give reasons why a certain model type and its granularity have been chosen or constructed in the context of the chosen research strategy.

For the discussion of a suitable construction process the requirements of a scientific research process in business informatics introduced in the third section can be used: (a) Completeness of explication of evaluation criteria: In business informatics the basic positions concerning research theory are heavily discussed. Representatives of constructivist positions (Schütte, 1998) as well as of rationalist positions (Gadenne, 1998) can easily be identified. To have a sufficient foundation of both the model type and its construction process, the position occupied has to be made explicit and to be reasoned. Any research results achieved (i.e. the quality of the model type constructed) have to be evaluated concerning this foundation. (b) Completeness of documentation: To assure a common understanding on a constructed model type a complete documentation of the model type itself and of the construction process is absolutely necessary. (c) Selection of research methodology: Which research methodology is suitable for a specific research problem is discussed intensely in business informatics as well. Representatives of critical rationalism demand a stronger empirical foundation, whereas others are in favor of a more pragmatic-constructivist approach (Heinzl, 2001; Heinzl et al., 2001; König et al., 1995). Following the empirical approach—and staying close to the understanding of models as mappings of reality—model types result from carefully observation and subsequent design of models (model types) and their formalization (Holl, 1999). The other approach has a constructivist understanding of models. For them (Dresbach, 1999) defined nine rules of a structured construction process. To avoid criticism concerning methodology it is necessary to justify the selection made with reference to the theoretic position (and the research objectives) thoroughly. (d) Application of research methodology (Becker et al., 2003): When applying the research methodology every step in the process and its correctness is to be made explicit and well documented. The result of model type construction is a language, having elements defined without cycles and their semantics and syntax defined (Holten, 2000). (e) Research objective: The research objective pursuit by constructing the model type has to be explained. Here the differentiation in models for description, explanation, forecasting, and decision as described in section 2 is useful. Explaining the objectives is an additional means of assuring consistency with theoretic positions and the research methodology chosen. Representatives of a moderate constructivist position can use a variety of research methodologies and subsequently a wealth of model types and construction processes to achieve their research objectives and scientific cognition (methodology pluralism), as long as the requirements stated before are met. Representatives of a more fundamentalist position (radical-constructivist or pure positivism)

have to choose suitable methodologies, model types and model type construction more carefully and against the background of their special position only. Therefore the variety they can use is shorter.

5 CONCLUSION

The construction of model types is a valid means of scientific cognition in business informatics. There is no fundamental difference to other disciplines—at least in German speaking countries. Controversial is what can be a model type and how model types can be designed. There is no general answer to this question, satisfying all fundamental research positions equally. All the more it is important to be systematic in the model type construction process and to make it explicit and well documented. The six requirements discussed may be helpful to achieve this objective.

6 REFERENCES

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