Multi-perspectivity in Information Systems modeling and 'The blind men and the elephant'

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Abstract: *The exemplary story of 'The blind men and the elephant' is used as a pedagogic illustration for mono- and multi-perspectivity. In Chapter 1, two starting points for the discussion of this epistemological phenomenon are introduced: the view of computer science / information systems and the view of literary studies with its description framework. Chapter 2 deals with the generalization of the exemplary story and its application to epistemological questions in general. Chapter 3 applies it to IS modeling in particular. The aspects of multiple mono-perspectivity and conflicting partial models in IS modeling are analyzed and approaches to a well-reasoned and conscious treatment of their integration and harmonization are demonstrated. The main result is that the problem of inconsistencies between different perspectives (partial models) of an enterprise cannot be solved, but the model designers' awareness is the best method to avoid undesired consequences. This paper is a brief excerpt of a detailed research study (see bibliography).*

Keywords: *multi-perspectivity, modeling perspectives, model balancing, IS modeling, epistemology, cognitive strategy, intermodel errors, pedagogic approach, exemplary story, literary studies*

1. Introduction

1.1 Exemplary stories used by computer science and information systems

Since the 1960s, many attempts have been made to structure software development projects with the help of ever new phase concepts and to facilitate modeling with the help of ever new modeling notations. This process seems to be a never-ending story: in spite of the efforts made, however, we are still far from having reached the desired success, namely a sustainably better project time management and, as a consequence, the considerable reduction of project costs.

From this situation, it is obvious that a great deal of the difficulties encountered in information systems (IS) modeling cannot be explained completely and definitively by computer science (CS) itself. One must go beyond its boundaries and consult other disciplines: ergonomics, human resources psychology, sociology, epistemology. Nevertheless, CS and IS have up until now only rarely been regarded from these aspects, least of all from the aspect of epistemology. This is due to the fact that research in this field requires quite a bit of project experience, a good background in the humanities and familiarity with epistemological approaches, particularly those from the natural sciences.

Epistemology is the branch of philosophy which deals with the acquisition, nature and limits of knowledge, especially scientific knowledge, such as the formal models necessary for implementing enterprise IS on computers. One of the authors (AH) calls the corresponding branch of CS / IS *epistemology-based IS modeling* or, more generally, *epistemology-based software engineering* (cf. Holl, 1999a). Our considerations in this paper focus on an epistemological question of IS modeling.

Teaching CS and IS students the fundamentals of this subject remains a difficult pedagogic challenge. As in other sciences, the teacher should combine dry theoretic results with suitable illustrative examples. Where from can a teacher take the latter? Only from a wide project experience which students cannot be expected to have: most of the examples chosen would allude to this experience and thus miss the didactic purpose intended. Therefore, small, comprehensible and retainable examples for epistemology-based IS modeling are rare. AH has been facing this pedagogic problem for more than a decade.

There is, however, another way of giving illustrations: not to take them from IS, but to resort to an old didactic and rhetorical tradition and to use brief, exemplary stories for illustration and demonstration. This strategy is known in CS and IS, even if it is not widespread. For instance, Wilhelm Steinmüller makes use of a story when explaining the question of multi-perspectivity and its consequences: “An ant state launched a research project about an elephant. One research group investigated the trunk, the other one the hoof. When the results were compared, a quarrel broke out between all the persons involved ... The government decided to stop the project due to unsolvable differences in the scientists’ opinions” (Steinmüller, 1993: 51 translated by AH).

Traditionally, this exemplary story appears in the form of ‘The blind men and the elephant’, such as the following version from India:

> There lived in a village four blind men, who had often heard an elephant talked of, and wondered greatly what it could possibly be like. So, when one day an elephant was passing through the village, they begged of the rider to give them an opportunity of knowing it by touch. The rider allowed them to do so, and the four blind men were right glad to be led near to the animal, and to feel its stupendous body with their hands.
>
> The elephant was soon on the move again, and one of the blind men began to talk of his sensational experience thus: “What a huge thing an elephant is! It is just like a pillar, or a thick round log.”
>
> “You are mistaken, my friend,” said another blind man, “you must have felt a pillar and not an elephant. The elephant is like a thick rope with hair at the end.”
>
> “Both of you are deceived,” said the third blind man, “You must surely have felt something else than an elephant, which is surely like a fan.”
>
> “My dear friends,” said the fourth blind man, “all of you are quite wrong. How on earth could you feel an elephant if you describe it like that? It is neither a log, nor a rope, nor a fan, but a vast mass of flesh without shape or size, and without beginning or end.”
>
> “Yours is the most delusive idea,” said the first blind man. “Never has a person described an elephant as being endless.”
>
> Thus they had a serious dispute among themselves. None would yield to the other.
>
> (Shyama Shankar, 1924: 153 f.)

Already at first glance, indeed, the epistemological situation of the blind men reminds us of multi-perspectivity in modeling, an important epistemological aspect of IS modeling: a team of model designers tries to describe a real open system in an enterprise from different modeling aspects, such as an information flow model, a business process model, an entity-relationship model, a class model, etc. They have to eliminate the inconsistencies arising during the modeling process and – if they become aware of them at all – ... start wrangling ... which costs a lot of time and often does not lead to any solution.

This at least two-thousand-year-old Asian exemplary story was not systematically taken into consideration by the research of the past five decades. We, however, consider it an excellent illustrative example for the undesired effects of multi-perspectivity, both for the purpose of better understanding and of better teaching IS modeling. This is the reason for the cooperation of a researcher in the field of cultural and literary studies, including the Middle Ages (EF), and an IS expert and linguist (AH), who both have a deep and strong research interest in epistemological questions. Neither of us is an Orientalist, but nevertheless we have become fascinated by the development of this exemplary story and its multi-perspective interpretations against different cultural backgrounds in different ages.

It is worth having a closer look at this type of text in the context of CS / IS.

1.2 Exemplary stories examined and explained by literary studies

In order to establish a constant template and a consistent terminology for the description of the versions of our exemplary story, we have to introduce fundamentals from literary studies with regard to exemplary stories in general, the related types of text and their function.

An exemplary story is a brief, instructive and convincing story (partly reminiscent of a caricature or an experiment in a laboratory) which always serves two purposes: it is intended to teach (benefit) and please (Horace's *prodesse et delectare*), even more, to intensify its teaching force by its entertaining value. Its didactic range (or potential) can be derived from a judgment of (interpretation of, evaluation of, statement about or consequences from) the situation and behavior presented in the story. If this judgment is implicit - but obvious - or explicitly stated at the end or somewhere in the context, the combination of an exemplary story and its

judgment is called an **exemplum** using a *terminus technicus* from literary studies.

The **internal moral**[1], as we call this judgment, has not yet to do with an analogical transfer to an application area ('moral' in everyday language or more exactly 'external moral', see below); it merely provides the possibility for this transfer. In our case, the cognitive behavior of the blind men, that is, to consider mono-perspective, incomplete views of one and the same elephant as complete, absolute knowledge about it, is judged as stupid. A good example of an explicit wording of an internal moral can be found in the version from India quoted above; a wise man is introduced who formulates it:

> A wise man was standing hard by, listening to the hot dispute with keen interest. When the disputants became wild with fury and came to blows, he approached them and begged them to be quiet.
>
> "Hold, brothers," he exclaimed. "Do not quarrel but listen to me. You all are right and you all are wrong. When the first man says that the elephant is like a log, he means only the leg of the animal, the second man's rope represents its tail, the fan of the third man answers to its ear, and the fourth man is evidently describing its body. So you see you have had only the knowledge of *parts*, but you are disputing about the *whole*.
>
> (Shyama Shankar, 1924: 153 f.)

In everyday language, the term *exemplum* is not common, but often replaced by the term *fable* for a subtype as *pars pro toto*. A **fable** is defined as an exemplum with an exemplary story, where animals act like humans (e.g. the ants in Steinmüller's story). Beyond this special subtype, however, most exemplary stories do not present acting animals (e.g. the blind men in the traditional version of our story). That is why the umbrella term *exemplum* is necessary. One and the same motif complex can be dressed as a fable or as a general exemplum. Incompatible views of an elephant appear in the form of a fable, as in Steinmüller's version, or in the form of a general exemplum, as in the traditional version. Note that the elephant itself is only an object, it does not act; the traditional version is not a fable, as humans are the actors. This type of exemplum, where animals play a role in a story determined by humans, was rather popular in the Middle Ages.

The exemplum is a functional text category which always serves a didactic purpose. The recipients are intended to learn something. Therefore, an

[1] The term *moral* means instruction or interpretation and does not aim at 'morality'.

exemplary story is applied to some **application area**, e.g. a statement to be confirmed or a situation in human real-life to be judged. This works with analogical transfer, which is only possible if the exemplary story and the compared application area are obviously and undeniably similar (= comparable). Only in this case, it is possible - using analogical transfer - to establish an **external moral**, which is analogous to the internal moral and can be applied to the application area intended.

The external moral in the version quoted is told by the wise man:

> "Anyhow, you teach me a grand lesson: We are all blind in matters of religious truths, yet we would seek to lead others in realising the Grand Mysterious Being."
>
> (Shyama Shankar, 1924: 153 f.)

In the final result, exemplum and application are entirely analogous, as their two parts, exemplary story and application area, as well as internal moral and external moral, are analogous.

In order to go into more detail, we have to explain the background of similarity and analogy (cf. Holl, 2003). Two objects of cognition (e.g. situations, physical objects, mathematical concepts, etc.) are similar if and only if they coincide in some features[2]. These common features *inductively* constitute a type which can be designated by an umbrella term and which is the 'basis / linkage of comparison', traditionally called *tertium comparationis*. This type can be *deductively* applied to other similar objects (classification, pattern recognition). Comparative or analogical thinking is a special form of abstracting thinking, as the *tertium comparationis* is a common abstraction, a generalization, of all of the compared objects, as it comprises less features than they themselves. This shall now be illustrated with some examples: you can compare an ostrich and a swan on the basis of the underlying type 'bird' (*tertium comparationis*) which comprises common features, such as oviparous vertebrate with wings and feathers, etc.; but you can also compare a red book and a red chair because they are 'red office supplies', or a red bird and a red pen because they are just 'red physical objects'. What we have explained for two similar objects of cognition, applies also for sets of similar objects.

[2] Similarity is of course not an immanent property of objects of cognition, but one which is assigned to them in a *constructivist* way by humans who decide upon which features are considered as important!

In order to represent these abstraction levels of analogical thinking unequivocally, we introduce a special terminology. We call the *tertium comparationis* of an exemplum and its possible applications the **generalization of an exemplum**. It consists of a *generalized story* and a *generalized moral.*

A **generalized story** is the *tertium comparationis* of an exemplary story and its possible application areas. It is a lot more complex than the examples above; it comprises an abstract motif complex, that is, abstractions of properties, persons, objects, courses of events, modes of behavior, etc. In our case, one would abstract from the blind men to humans in general and from the elephant to an object of cognition in general (see 2. for details).

A **generalized moral** is the *tertium comparationis* of an internal moral and its possible external morals. As it is wider, more comprehensive and more general than any concrete external moral given to an exemplary story in its history, it determines the range or potential of all its possible external morals. In our case, one would say that to consider mono-perspective, incomplete views of one and the same object of cognition as complete, absolute knowledge about it is stupid (see 2. for details).

We summarize our terminology:

On the same lower abstraction level, we define two parallels linked by analogical transfer:

- **Exemplum: exemplary story and internal moral**
- **Application of an exemplum: application area and external moral (often just 'moral')**

On a high abstraction level, we define:

- **Generalization of an exemplum: generalized story and generalized moral**

These aspects of an exemplum can again be found in the structure of the paper.

2. The epistemological potential of the elephant exemplum

Using the terminology defined in the introduction (1.2), we will now carve the generalization of the elephant exemplum out of the versions mentioned. This will be done in two steps.

- First, we will reduce the different stories to their common motif complex, which we call the core of the story.
- In the second step, we will abstract from the blind men and the elephant to humans and an object of cognition in general.

Both of the abstraction levels are important for further and deeper epistemological considerations.

For the first step, some basic set theory is required, which is intuitively used in everyday life. We regard each version of our exemplary story as a set of motifs (features). The intersection of these motif sets leads to their common motif set, or common motif complex. Uncommon motifs are considered as accidental. They are left out, for example, whether the examination of the elephant by the blind men is due to their own desire or due to an order. Common motifs are regarded as essential. They are quoted. The core of the story thus figured out is as follows:

Some blind men touch different parts of an elephant's body. Each of them gets an individual impression, which he considers as absolute. Once the blind men have been confronted with the others' opinions and have learned that they are different, each one insists on his own opinion, rejects the other ones as wrong and all of the blind men start quarrelling.

Reducing our exemplary story in this way, its corresponding internal moral does not change: the cognitive behavior of the blind men is judged as epistemologically stupid.

The second step leads us to the generalization of the elephant exemplum, its *tertium comparationis* to possible applications. It contains its generalized story and its generalized moral, which determines the potential of all of its possible external morals. In order to find this generalization, we generalize each essential motif (feature) from the core of the story. The frequent philosophical and theological morals of the elephant exemplum are only mentioned to show the relation to the versions of that kind.

- The elephant can be abstracted to an unknown object of cognition in general. In versions in a theological context, we find an analogical transfer to God or essential philosophical questions.
- Touching only one part of the elephant stands for (the restriction to) mono-perspective cognition, a defective, inadequate strategy of cognition. Theological contexts refer to the defects of one-sided intellectual, mental, rational and sensory cognition, in opposition to comprehensive mystic cognition, which leads to all-encompassing knowledge.
- The property of blindness means that the blind men (the subjects of cognition) are not aware of the mono-perspectivity of their strategy of cognition. They do not reflect the conditions of cognition. It is important to state that blindness does not represent mere mono-perspectivity, but unnoticed mono-perspectivity.
- The individual impressions considered as absolute can be generalized to partial knowledge considered as complete and absolute knowledge of an object of cognition. Theological contexts allude to logically inconsistent, one-sided doctrines, which are regarded as the final truth.
- This conviction does not become obvious before the individual opinions are uttered – in statements such as “The elephant is like a pillar” – and communicated to other persons who have different opinions of their own. When the individual statements thus come into contact with one another, their collection turns out to be incompatible and contradictory. Even when the persons are confronted with the existence of different opinions, they do not change their conviction, but rather insist on their own impressions and reject the other views as wrong. Communication is the prerequisite for the manifestation of the contradictions and of the conviction that one’s own knowledge is complete and absolute.
- The final disputing, arguing and quarrelling shows that partial knowledge (such as mono-perspective views) taken as complete and absolute is useless and even detrimental, as it does not lead to more precise and deeper knowledge.

On the basis of the preceding discussion, we outline the generalization of the elephant exemplum.

The generalized story can be formulated as follows:

Independently of each other, some persons acquire individual partial knowledge about an object of cognition and consider it as

complete and absolute knowledge. Even when they are confronted with different opinions, each one insists on his own opinion, rejects the other ones as wrong and all of the persons start quarrelling.

The generalized moral can be summarized as follows:

To consider incompatible opinions (partial knowledge), which are based on (unnoticed) mono-perspective, incomplete cognition, as complete and absolute knowledge is detrimental.

As the generalization of the elephant exemplum, its *tertium comparationis*, does not restrict the type of the object of cognition, it opens a wide range of applications which spans from theological questions to modeling information systems.

3. Multi-perspective modeling in information systems

Multi-perspectivity is a well-known phenomenon in different areas. Already in ancient Roman mythology, Janus, the god of gates and doorways, is depicted with two faces looking in opposite directions. A modern example from the natural sciences is the wave-particle dualism in physics; that is, a subatomic particle can behave as a particle or a wave, depending on the experiment executed. From perceptional psychology, we know that the recording of information is only one part of perception. The other part is a selection of information or even a completion of information. When people look at the same object, everyone 'sees' something different (interpersonal multi-perspectivity). Mental-psychical predispositions, such as interest, motivation, attitude, foreknowledge, etc., lead to the effect that some features dominate, some are neglected during perception.

In spite of widespread knowledge on multi-perspectivity outside computer science and information systems, both sciences hardly took any notice of it. In a recent Ph.D. thesis from the University of Crete (Theodorakis, 2001), Nikos Kazantzakis's version of the elephant exemplum is used with regard to knowledge representation in order to illustrate that definitions are only meaningful within a certain context: they can be overlapping, complementary or contradictory.

In computer science, the first reference we know can be found in Yourdon, 1989, 276-277 under the keyword 'model balancing'. It is true that Yourdon

recognizes the great impact of multi-perspectivity on software development: “But many of the more difficult and insidious errors are intermodel errors, that is, inconsistencies between one model and another” (Yourdon, 1989, 277). But he confines himself to its syntactic aspect, which he considers the only important one, and omits the rest: “The balancing rules ... can be automated” (Yourdon, 1989, 284). This ‘tool view’ is very narrow (cf. 3.2.2).

A later reference in applied computer science is given by the German computational jurist Wilhelm Steinmüller. He uses a new version in the form of a fable to illustrate the issue of cognition of objective truth (Steinmüller, 1993: 51 f.), as already mentioned in the Introduction. His version is closely related to project management, which plays an important role in IT projects as well as in other fields.

There is a fascinating group-psychological experiment which illustrates Steinmüller’s issue under the aspect of communication. The members of a group get written information about a problem. They are asked to find a solution to it within the limited time of half an hour, but they are not told that the texts are different. The solution to the problem, however, can only be found if all the group members realize that they got overlapping and complementary information and put their knowledge together. It is amazing to observe how many groups do not even realize that the information given to each person is different, let alone that they reach the state of adding it up.

Our focus is not on project management and communication, but on IS modeling. Although both form the framework of IS modeling as well, there are epistemological problems in addition to the communicational ones, which show up in any form of teamwork. The former lie deeper and cannot be solved by better communication alone. In the following two chapters, we will analyze the phenomenon of multi-perspectivity in IS modeling (3.1) and demonstrate approaches to a well-reasoned and conscious treatment of it (3.2).

3.1 Analysis of multi-perspectivity in IS

With regard to IS, we have to consider both types of conflicting opinions: the interpersonal ones explicitly mentioned in the elephant exemplum (between different model designers: multiple mono- / oligo-perspectivity) and the intrapersonal ones only implicitly alluded to in the elephant exemplum (within one and the same model designer: oligo-perspectivity). As illustrated in the elephant exemplum, the human mind possesses a built-in logical consistency checking mechanism. Contradictory opinions are not tolerated

when they come into contact with one another. This mechanism, however, works only roughly, detecting only obvious logical contradictions. It overlooks or tolerates weak and hidden logical inconsistencies.

Therefore, humans are able to live with several non-disturbing inconsistencies. IT systems cannot do that: they are formal-logical machines, the reactions of which are detrimental if they contain logical contradictions (if they can at all). Formal logic and machines based on it are not tolerant towards logical contradictions, which everyday life can handle up to some degree. Therefore, IS model designers should construct models which are logically consistent.

Models cannot be represented in large coherent representations, but due to reduction of complexity and a better understandability, in many mono-perspective small partial models (3.1.1). They are based on intrapersonally and interpersonally mono-perspective views (3.1.2) of model designers. These get their information on a company in the form of mono-perspective opinions from different employees on different management levels (3.1.3). Each type of mono-perspectivity concerned is a source of logical inconsistencies.

3.1.1 Different modeling aspects: multi-aspectuality

Models are only usable if documented, that is, if they are represented verbally in textual descriptions and / or graphically in diagrams. This is done with model representation languages, e.g. graphic notations. Only then can models be communicated to and discussed by other persons. It is a fundamental epistemological problem that enterprises and their departments cannot be described in one small diagram only, without losing lots of information; neither can they be described in one huge, all-encompassing, coherent diagram, without losing the overview. This is due to the complexity of reality on the one hand and to the limited power of human perception on the other, which cannot understand arbitrarily large diagrams. As a result, (the representation of) a model has to be split up – decomposed – into several small partial models, which in turn are represented in small, perceivable diagrams. Decomposition is done in two orthogonal dimensions, the necessity of which is not eliminated by modern notations, such as the Unified Modeling Language.

- Vertical or hierarchical decomposition corresponds to a top-down design of a model, starting with a very coarse overview and proceeding to more and more detailed views of an enterprise. Partial models are

constructed on different abstraction levels. This technique is well known in IS, when information flow diagrams and control flow diagrams are designed. It is also used for module-based software development.

- Horizontal (multi-aspectual) decomposition is used to describe different aspects of an enterprise, such as the data aspect or the process aspect. It is important to distinguish modeling aspects from model notations, that is, representation languages. The four traditional, but still valid basic modeling aspects in IS are outlined in the table below, which also shows examples of corresponding notations. Of course, there are not any hard boundaries between the four cells of the table. Each aspect covers also parts of the neighboring aspects, for example, business process models often contain references to data, and special notations can be assigned to two aspects at the same time, such as HIPO (Hierarchical Input Process Output) to information flow and control flow.

	Static models	Dynamic models
Data models	data (structure) models: data structure diagrams, entity-relationship models (ERM), UML class diagrams	information flow models: data flow charts, Structured Analysis (SA) diagrams, UML use case diagrams
Function models	function structure models: compositional function trees, Jackson trees	control flow models: Nassi-Shneiderman diagrams, block diagrams, event-driven (business) process chains, UML activity diagrams

***Table 1**. Multi-aspectuality*

Considering both types of decompositions, you look at the same object of cognition from different points of view and with different degrees of exactness. This is just an example for multiple mono-perspectivity.

Each partial model, however, is related to and overlaps with several other partial models. They cannot merely be added on a

higher level of cognition as in the elephant exemplum! As IT systems are formal machines, all the mono-perspective partial models derived from vertical and horizontal decomposition have to be coordinated, harmonized and made compatible; that is, logical contradictions have to be eliminated. The aim is a coordinated multi-perspective view of the enterprise (see 3.2).

3.1.2 Different model designers: multi-personality

Two cases have to be distinguished: one single model designer is responsible for the model construction or a team of them.

If there is only one model designer, one might assume that the partial models designed by him are automatically harmonized and cannot contain any logical contradictions. This, however, is not true due to two facts:

- The human consistency verifier (checking mechanism) does not work perfectly. Even within the same person, logically inconsistent opinions are not excluded at all. Every person can have several intrapersonal mono-perspective views (oligo-perspectivity).
- The consistency verifier is overcharged. The high complexity of an enterprise does not allow comprehending all of its details at the same time. One and the same object of cognition (enterprise) has to be regarded from different sides and under different aspects. At the end of a modeling process, there can be so many partial models that it is impossible to keep all the interdependencies between them in mind[3].

One of us (AH) experienced very often that a project report or a master thesis written by a single student can contain numerous contradictions (cf. Holl, 1999a: 192, 202-203). Therefore, to have one responsible model designer only is not a guarantee against inconsistencies, except when a very small and very simple segment of reality is modeled under one aspect only.

When model designers work together as a team, they can model

- one and the same aspect of an enterprise: each designer establishes an alternative model. In order to compare them, they have to be harmonized. They need some parts in common, some overlap, a basis of comparison, so that parallels and differences between them become obvious.

[3] Albert Einstein is reported to have been an exception when he renounced to sign the American constitution as he found too many contradictions in it.

- different aspects of an enterprise (3.1.1): each designer deals with one aspect or several designers investigate one aspect or there can be model designers who work on different aspects.

Each of the model designers has at least one personal mono-perspective view, normally several, that is an oligo-perspective view. The coordination effort of their different views does not increase linearly, but binomially, as the number of coordination possibilities between *n* model designers corresponds to the number of sides and diagonals in an *n*-polygon.

3.1.3 Different opinions of different employees

Model designers base their models on generic or reference models on the one hand and on interviews with employees of a company on the other. Employees have mono-perspective opinions and attitudes, as they are subject to the same epistemological conditions as model designers. All-encompassing, harmonized multi-perspective views of enterprises are rare. Most companies do not possess them. Each of the management levels has its own mono-perspective opinion, attitude or image, different employees can have different mono-perspective opinions and, even in the same mind, slightly contradictory mono-perspective opinions can have their place (oligo-perspectivity). All these smaller or bigger logical inconsistencies can coexist and survive, if they are not too evident and if they do not cause any obvious damage.

Most of the employees are not aware of this situation, especially not with regard to the hard requirements of logical consistency which need to be met when deploying IT systems. Model designers have to face this multiple oligo-perspective mixture of a variety of images of an enterprise when they base their model construction on interviews as usually done. As their distance to the enterprise is larger, they will find more inconsistencies than the employees themselves.

Ulrich Frank examined the issue of multi-perspective enterprise modeling in Frank, 1994. He distinguishes the IS perspective (from model designers to system administrators), the organizational perspective and the strategic perspective.

3.1.4 Conclusion

The different perspectives outlined in 3.1.1/2 can be summarized in a table:

	One model aspect	Several model aspects
One model designer: intrapersonal mono- / oligo-perspectivity	–	multi-aspectual
Several model designers: interpersonal multiple mono- / oligo-perspectivity	multi-personal, alternative models	multi-personal and multi-aspectual

***Table 2**. Multi-aspectuality and multi-personality*

It is easy to see that the usual situation of several model designers working on many model aspects at the same time leads to an exploding effort of harmonization. Different model designers have different previous knowledge and different psychic-mental-intellectual-social dispositions. They can use the same words with different meanings (see 3.2.2). Even one model designer often has difficulties to keep his variety of mono-aspectual partial models consistent.

Human thinking is **oligo-perspective**, that is, it can only handle a few perspectives at the same time, and **not perfectly logically harmonizing**, that is, the human logical-consistency verifier tolerates superficially undisturbing contradictions. It is not suitable for the formal-logical needs of IT deployment and not suitable for consistently modeling complex socio-technical systems, such as enterprises, from many different perspectives. Therefore

- inconsistent points of view between different model designers and
- contradictions and incompatibilities between partial models

are normal and cannot be avoided.

We have to take into consideration that the problem of inter- and intrapersonal multi-perspectivity and the hence following need to

harmonize different perspectives with regard to IT is natural. That is, problems related to it are usual in IT projects, although not systematically dealt with. It is a great exception if undesired consequences of multi-perspectivity do not show up. Methods to reduce them will be discussed in the next and last section.

3.2 Approaches to a conscious treatment of multi-perspectivity in IS

The way out of mono-perspectivity is the one via aware mono-perspectivity to coordinated multi-perspectivity, that is, the conscious treatment and coordination of many mono-perspective views of an object of cognition. Knowing, however, that enterprises are complex socio-technical systems, the question arises whether logically consistent formal models of them are possible at all. Can all the small mono-perspective partial models necessary to describe an enterprise be harmonized, so that the outcome is a coordinated multi-perspective view of the enterprise, a comprehensive, consistent formal model, and not an uncoordinated multiple mono-perspective view, a collection of uncoordinated partial models?

Above all, IS experts have to remember that a complete model of any segment of reality is impossible. Enterprises are human artifacts, which contain two main components: more or less formal business structures, and human employees, who are not accessible to formalization. What we can describe in formal models are only the formal traits of reality. Every enterprise comprises lots of formal structures, which can be used for the construction of a formal model, which does of course not cover every feature of the enterprise.

In the light of this background (and only with this background), one of us (AH) can state his long-term personal experience: yes, partial enterprise models can be harmonized! The reality of enterprises is such that logically consistent models are possible. AH has only seen contradictions due to bad observation and interviewing, due to a lack of coordination between partial models and due to contradictory implicit pre-conditions. AH formulates this experiential result as his “hypothesis of consistency” (Holl, 1999a: 192).

Therefore, it is necessary to have a closer look at methods to handle external (3.2.1) and to avoid internal (3.2.2) inconsistencies. The main method will be outlined in 3.2.3.

3.2.1 Methods to treat external inconsistencies

As outlined in 3.1.3, IS experts are confronted with a variety of mono-perspective views of a company which are uttered by the employees during the interviews.

The first requirement for IS experts is that they use efficient communication and interviewing techniques, such as linguistics-based and psychology-based Requirements Engineering (cf. Rupp, 2001), in order to record the employees' opinions as completely as possible. This, however, is not our focus in this paper.

During this process, logically well-trained IS experts will find a lot of contradictions, which can be treated in standard ways. Alternatives can be discussed, with results like:

- selection of the predominant perspective
- pragmatic selection of the best looking perspective
- selection by order, that is, some responsible person in the enterprise decides which one of two inconsistent perspectives has to be chosen for IS modeling.

If a contradiction still turns out to be unsolvable, it can be excluded from modeling or, in extreme cases, the project has to be stopped.

Thus, as soon as an inconsistency becomes obvious and all the persons involved are aware of it, some solution can be found. This kind of inconsistencies is not the core problem.

There are two more difficult types:

- Hidden inconsistencies in the company, which remain undetected during the interview process: besides excellent Requirements Engineering techniques, an aware treatment of the second type will help to considerably reduce them.
- Home-made inconsistencies, which are produced by the inevitable splitting (vertical and horizontal decomposition) into small partial models: techniques to avoid them are discussed in the next section.

3.2.2 Methods to treat internal 'home-made' inconsistencies

In spite of their mathematical training, IS experts cannot neglect that their in-built consistency checker is limited and not perfect. They cannot easily handle the complexity of a model which is split into dozens of partial models

(cf. 3.1.1 and 3.1.4). This fact becomes obvious not only in model designer teams, but also in individual model designers.

The first aid is given by compatibility checking tools, e.g., it can be checked in data flow diagrams that all data flows from and to a function have to occur again when it is vertically decomposed into partial functions. This kind of decomposition turns out to be less difficult.

Bigger problems arise in the coordination of horizontally decomposed models, that is, in the case of multi-aspectuality. Tools can, of course, check that you use the same label for a function in a data flow diagram and in a related process diagram, but they cannot check that you use the label in both diagrams with the same meaning.

As background, an IS expert should know that every linguistic sign possesses two sides:

- the form, that is the sequence of letters or sounds and
- the meaning, that is its semantic reference.

Therefore, there are two common situations in natural languages:

- homonymy (or polysemy): one form, several meanings
- synonymy: several forms, one meaning

Both phenomena do not disturb us in natural languages. The context and the human knowledge about the world determine how a word should be understood. In the field of formal models, however, IS experts have to obey the conditions of formal language, that is, a one-to-one correspondence between form and meaning. Synonymies are already detrimental, but homonymies are disastrous. No IT system is able to use one and the same description for two meanings, except in situations with formally well-defined contexts. Therefore, terminological harmonization is indispensable.

Compatibility checking tools can only check the form, but not the meaning in which a model designer uses a word. This can only be done by humans with a very extensive modeling background. AH has often experienced models of one or more persons, where the same word, e.g. the name of a function, was used with two different meanings in two partial models belonging to two different model aspects. Homonymy also becomes obvious in discussions where a couple of model designers start arguing – just as the blind men in the elephant exemplum – not realizing that they use the same word with different meanings, that they relate different images to the same word.

It is always very difficult to deal with such semantic problems. They are not solvable, although one can do a lot to minimize their undesired effects. There are important methods to successfully treat multi-perspectivity within IS modeling:

- Any model has two sources: reference or generic models and immediate observation and interviews. The former are used for the standard structures of a company, the latter for its individual, particular structures. According to these two sources, terminology has to be treated in two different ways. For the standard structures, you should use standard terms from business, which are common and do not need any further explanations. With regard to the individual structures, the terminology used in the model has to be defined as exactly as possible and as 'richly' as possible, so that each definition becomes transparent to other model designers, but also to the defining designer himself, as it discharges his memory. IT tools can support this **glossary of company-specific terminology**.
- The second method concerns the sequence you use to establish partial models. Always try to attach a partial model to its neighbors. Not every partial model is related to every other one, e.g., level 3 is not directly related to level 1 in the hierarchical decomposition of a process, but only to levels 2 and 4. Try to organize your modeling sequence so that you treat related, neighbored partial models in parallel. It will be easier to cope with the complexity of an enterprise if you use an **iterative, successive integration of neighbored perspectives** (partial models).

3.2.3 The main method to treat inconsistencies: the model designer's awareness

The human cognitive strategies cannot be changed fundamentally. Therefore, it is a basic epistemological demand that humans learn more and more how their cognitive strategies work and consciously deal with their consequences, in order to avoid their undesired effects. With regard to IS modeling, this was already shown

- for analogical thinking in Holl, 2003,
- for gestalt-theoretical principles of thinking in Holl, 2000 and
- for thinking in mayeutic cycles in Holl, 1999b.

With regard to multi-perspectivity, we repeat the result from 3.1.4: we have to face the fact that human thinking normally is **oligo-perspective**, that is, it can only deal with a few perspectives at the same time, and **not perfectly formal-logically harmonizing**, that is, the human logical-consistency verifier tolerates superficially undisturbing contradictions as well as homonymies and synonymies in natural languages.

The coordination of many perspectives in a model is a difficult task for humans. Up to some degree, it can be supported by IT tools, but as it is not solvable, **the model designers' awareness** is the best method to successfully fulfill this task.

Within IT instruction, the exemplum of the blind men and the elephant can be used for the demonstration and illustration of the problem field of multi-perspective thinking. It serves as an excellent pedagogic means to make model designers aware of it.

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