Communicable Models for Cooperative Processes

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1 . INTRODUCTION

The design of systems to support (tele-)cooperative work, their introduction into organizations and their usage can be facilitated by modeling the cooperative processes. Developing these models as well as presenting and storing them can be based on the use of computers as assumed by the proposals made in the sections 2) to 4). Models of cooperative processes usually comprise several roles or organizational units. The complexity of cooperation in organizations requires graphically represented models with diagrams (including animation and pictures) and browsing mechanisms to inspect them.

In our notion, a model is the representation of an intentionally selected part of reality. This representation must support communication and reduce complexity in accordance with the specific aims it is intended to be used for. A model for cooperative processes can consist of several diagrams referring to each other and additional text. The diagrams are composed on the basis of a modeling notification, i.e. a set of symbols whose semantic is defined as well as the syntactical rules of possibilities to combine them. The following analysis provides proposals about how to design modeling notifications.

The predecessors of models for cooperative processes can be found in the context of software engineering, such as structured analysis [12], entity-relationship diagrams [1], object-oriented modeling [6]. CSCW research also offers specific modeling methods – in particular for workflows (e.g. [4]). There remain still some challenges to be met: unstructured fragments of processes must be representable, social (including ergonomical) aspects must be considered, and the models should be more communicable and easy to understand. We focus on the third aspect. The variety of elements of communicative processes is widely described [8] but should not be confused with requirements of how to make models more communicable.

We assume that models of cooperative processes can be used during the requirement analyses for groupware systems, that they support participatory design and that they help to improve the usage of already introduced systems or to improve organizational structures and processes in the context of groupware and telecooperation. The usage of modeling methods should not be limited to business process reengineering and workflow management, but should also be applicable to semi-structured cooperation depending on informal social relationships. Therefore the notification method should include indicators for incompleteness, uncertainty, vagueness, etc., because this is typical for social aspects. Besides symbols for objects and activities (or functions), the notification method should comprise roles which can represent a certain type of persons or organizational units. Furthermore it must be possible to show different types of relations between these basic elements as well as conditions (or events) and logical connectors.

To find possibilities for improving the communicability of models we use a theoretical and an empirical basis.

The communication theory is inspired by Ungeheuer [11] (a German communication theorist) and Maturana & Varela [3]. Consequently, communication is a non-deterministic process.

There is no "transport of content" metaphorically taking place between the communicators. The approach whereby the speaker encodes an idea which is decoded by the listener, is obsolete. By contrast, the speakers provide a kind of plan or guidance with their utterances to help the listeners construct another idea which might correlate with the speakers' idea. Several different plans, which might be useful to communicate the same idea, are called paraphrases (1). Paraphrases can also include ideas which have a metaphorical relation to the idea to be communicated. The selection of the appropriate plan depends on the pre-experience of the listeners as well as on the purpose and on the context of a communication process. The speaker's guidance expressed for the listener is always incomplete and shortened (2) because it would cause an endless stream of utterances to make explicit all implications of a single idea: maximal explicitness leads to minimal comprehensibility. Thus, context is used by the listener to complete the speaker's plan (3). Furthermore, context supports the detection of misunderstandings and by referring to context communicative conventions can be created or altered in the course of meta-communication. These basic ideas are used to structure the following analysis according to the numbers in parentheses.

The empirical basis of our propositions is given by some casestudies in the context of workflow modeling for different business processes, investigating various modeling methods for multimedia and groupware applications, and analyzing a huge set of models which were developed by students to describe the usage of information technology and its social implications. Although it was not the main aim of these activities to improve the communicability of models, we gathered a lot of experience which helped us to extract the following requirements.
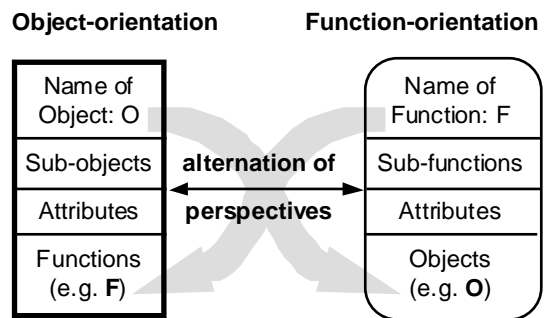

Figure 1. Alternation of perspectives

2. PARAPHRASES AND METAPHORS

Similar to the concept of paraphrases is the idea to offer different views or perspectives on the same modeled part of reality. A well known discussion deals with the question of whether models should be object-oriented or function-oriented. The left part of fig. 1) gives a more detailed description of an object by referring to its attributes and sub-objects whereas the right part is focused on the functionality, but can contain the object of the left side. We require a fluid transition between both perspectives. Some modeling methods, such as ARIS [7], provide a data-oriented view as well as a function-oriented and an additional view integrating parts of both perspectives. However, the extent of a detailed presentation of either object aspects or function aspects cannot be freely chosen. We propose that all details of both views should be integrated and incomplete models can be generated by selecting those details (objects and functions) which are a matter of interest in specific processes of communication.

Selection is an important means to produce different perspectives, such as showing all activities carried out by people versus those being supported by computer systems. It must be possible to start the inspection of a model by using an overview presentation and then to continue by selecting more and more details. The problem with selecting details is that it neglects context (see section 4). Another problem is illustrated by fig. 2). Nesting and aggregation can be used as paraphrases to express the same relationship, but they can also have different meanings (e.g., nesting might symbolize an encapsulation mechanism). Obviously, a computer based
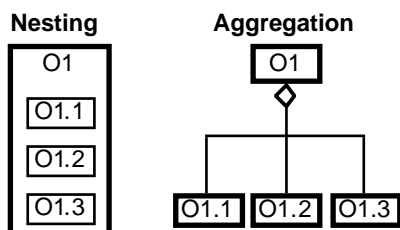

Figure 2. Nesting and Aggregation: Paraphrases or different meanings

modeling method should provide an indication of whether two different perspectives are meant as paraphrases or not.

Such a method should also provide concepts similar to metaphors. If a communication process might be disturbed because of the time needed to specify a certain part of a model, the modeler should be able to temporarily replace it by a similar, already specified part. If more than one specification of an element, for example an object, is sensible, 'pars pro toto' should be possible in combination with an appropriate indication. If it is questionable which one of a set of solutions is most reasonable, the modeler should be able to chose one as a variable or dummy and to express the uncertainty.

3. DIFFERENT KINDS OF INCOMPLETENESS

To make communication easy and to focus on the essential aspects it must be possible to indicate that the detailed description of a part of the model will be specified later or somewhere else but not in the current context. Computer support should offer buttons (as used in hypertext or WWW) which can be activated to provide a more detailed representation. The modeler should also be able to indicate that a more detailed description of a part of the model might be possible but is not in accordance with the purposes of communication and therefore is left out. This is a type of semantical and pragmatical incompleteness. Also syntactical incompleteness might be helpful. For example, Petri Nets require that a condition is always followed by an event and vice versa. This might lead to an overload of the diagrams which disturbs communication. Therefore incompleteness should be possible, although a conflict with formal consistency might be caused. It can be overcome by the requirement that syntactical incompleteness is only allowed if complete versions can be automatically reconstructed by exploiting context.

Context can also be used to be semantically incomplete and to allow a reduction of the number of different symbols being used by a modeling notification to achieve an easy handling. For example, arrows between objects and activities have another meaning than those between activities or between roles and activities. However, these different meanings can be expressed by only one single symbol for an arrow if the semantical definition is strictly related to the type of elements which are connected by the arrows and which therefore provide the relevant context.

The aspects described above are examples of intentional incompleteness. A modeling method must also provide symbols expressing types of incompleteness coerced by the reality itself; otherwise, the communicative process of developing a model would collapse if the modelers had no means at their disposal to represent incomplete structures. Modelers must differentiate between two cases: they might not know how to specify a certain element or they might not know whether a certain element is relevant or not. Modelers should have the possibility of introducing variables which can represent vague or uncertain values of attributes or to specify that a structure is only valid under certain conditions. Furthermore, they must be supported to deal with 'wicked problems' [5] or ill-structured problems [9]. These comprise loops not having a clearly specified stopping rule, structures without clear differentiation between cause and effect, cases where the process of problem definition and solving are integrated, problem spaces where the set of relevant objects or transitions is incomplete, or where external knowledge might have non-foreseeable influences.

Intentional or coerced incompleteness should not be confused with abbreviations. Abbreviations allow a dense presentation of information as it is needed to provide overviews. Abbreviations need not be self-explanatory but should support recalling of information. Names and descriptions as well as symbols and combinations of symbols can be abbreviated. Special abbreviations can be introduced to avoid a combinatorial explosion of diagrams. For example, loops can help to avoid the repeated representation of similar structures or a negation operator can be used if it is easier to represent what is impossible instead of showing all possible structures. Computer support must help to replace abbreviations by complete representations if necessary. The costs of providing overviews by using abbreviations are increased complexity. By

contrast, the idea behind intentional incompleteness is to conceal certain aspects instead of representing them by abbreviations. Thus, incompleteness improves the comprehensibility of models by achieving less complexity. Apparently, a tradeoff between both concepts has to be found in every process of developing models.

4. REPRESENTATION OF CONTEXT

The number of rules and basic symbols of the modeling notification should be as small as possible. The availability of context supports this aim as we have already outlined above with the example of arrows between different kinds of elements. In some cases it can be assumed that the users of models are aware of the context needed to reconstruct the meaning of the employed symbols; however, this assumption is mostly inappropriate. Therefore it is necessary to make the context explicit. The left side of fig. 3) shows an example with only a rough contextual reference which is indicated by the numbering system as it is used in the case of structured analysis [12]. By contrast, the right side of fig. 3) gives an example of how context can be represented more explicitly by employing the concept of nesting and the possibility of intentional incompleteness (expressed by three points in parentheses).

In some cases it might be overlooked that different contexts are given and therefore it is sensible to emphasize these differences, for example by giving the arrows mentioned above a different shape or by emphasizing different textual descriptions (e.g., whether an object is represented electronically or on paper) with the help of different icons. Modelers should have the possibility to freely introduce these kinds of redundancies if they determine them in a way which allows an automatic transformation to the basic symbols of the modeling method.
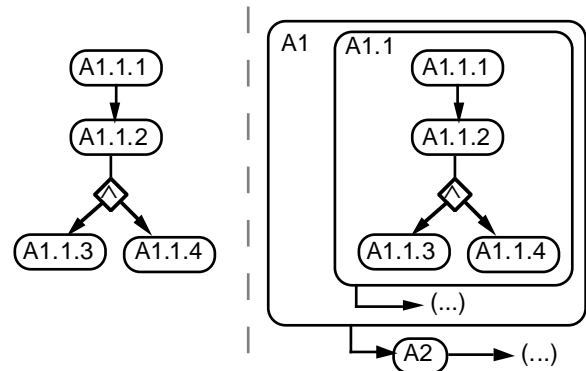
Figure 3. Representation of context

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