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ABSTRACT

The orientation on the technical content of a reference model can increase the efficiency of processes in business engineering projects. Despite this, the use of reference models in the field of business engineering has not yet established itself in practice. The article at hand addresses this problem from a pragmatic perspective focusing on the designers‘ needs in specific modeling situations. Our work has revealed that we are in need of comprehensive infrastructures which provide various kinds of design support. Apart from methodological contributions, work in the fields of organizational and technological infrastructure design is needed. In order to illustrate and evaluate our approach, we will present a study which applies the findings for the set-up of an infrastructure that makes use of collaborative techniques. The infrastructure will be presented with respect to each building block, including the presentation of a prototype. This pragmatic approach thus, results in collaborative reference modeling and presents a way of using reference modeling for organizational change.

Keywords

Organizational design, business engineering, distributed modeling, reuse models, reference modeling, collaborative work.

INFRASTRUCTURES FOR REFERENCE MODELING AS A MEANS OF BUSINESS ENGINEERING

The Potentials of Reference Modeling for Business Engineering

The field of ‘business engineering‘ emerged at the start of the 1990ies as a management trend. It aims at enriching existing approaches with respect to both the development of operational information systems and business strategies for process design (Cornes 1990; Kruse et al. 1993; Österle 1995; Scheer 1994). From today‘s perspective, business engineering can be seen as a method and model-based design theory for businesses in the information age (Österle et al. 2003). Using the methods and models made available by business engineering, business information systems can be designed, implemented, and adapted according to specific business needs. At the same time, improvements to business operations made possible by innovations in information technology (IT) are also targeted. Thus, the goal of business engineering is to systematically align business applications and operations with the help of engineering principles.

Nowadays, business processes have established themselves as the organizational objects of design for business engineering (Davenport 1993; Hammer et al. 1993). Thus, with regard to corporate strategy, both the design of business processes and the analysis of the demands for their IT-support are of importance in business engineering projects. The design of business processes must follow a comprehensive approach encompassing the planning and the control, as well as the management of the operational workflows.

Information modeling has proved useful in supporting the systematic procedure in process design (Fowler 1997; Hay 2003; Kilov 2002; Wand et al. 2002). Modeling techniques such as, for example, the unified modeling language (UML) (Rumbaugh et al. 2004) or the event-driven process chain (EPC) (Keller et al. 1992), serve as methodological approaches for the construction of models. Software tools for business process modeling, such as IBM Rational or the ARIS-Toolset, can support the business engineer by way of system components for the collection, design, analysis, and simulation of business process models.

The extensive demand for information models in business engineering warrants the need for reference modeling concepts. The intention of reference modeling is to systematically reuse information models in systems reengineering (Thomas 2005; vom Brocke 2003). The approach is based on the finding that, despite various differences between design processes, general design patterns can be identified capable of solving design problems for a wide range of applications. Thus, the goal of reference models is to cover these general patterns in order to raise the efficiency and effectiveness of specific modeling processes (Becker et al. 2004a; Fettke et al. 2003; Mertins et al. 2006; Scheer et al. 2000).

To give a definition, a reference model is a special information model that can be reused in the design process of other business process models (vom Brocke 2003). Well-known examples of reference models in the scientific field are the reference model for industrial enterprises from Scheer (1994), as well as the SAP R/3-reference model resulting from commercial practice (Curran et al. 1998).

The Dilemma of Reference Modeling

One of the most important questions for the reference model constructor is what makes a reference model he has created a marketable product. If one abstracts from the argumentation of questions of quality, then the user of reference models will orient himself above all, on the effort required for its adaptation. A user will acknowledge the usefulness of a reference model when the effort needed for the construction of his specific model is considerably reduced by using the reference model. The constructor of a reference model is therefore urged to keep the adaptation needs of the reference model for his “customer” as low as possible. The effort needed for the adaptation of a reference model to an enterprise-specific situation is low when many of the use-case specifics are represented by the reference model. However, the more specific a reference model is, the fewer the enterprises are for which it can be applied—i. e. the potential demand for the reference model is lower. An increase in the demand for a reference model is, in turn only possible, by increasing the classes of use-cases to which it applies. This however, results in an increase in effort for the adaptation of the reference model by the respective user and this, in turn, reduces the usefulness of the reference model for the user.

Although the problem described above, referred to by Becker et al. as the “dilemma of reference modeling” (Becker et al. 2002, p. 26) is an abstracting argument, it does make clear that reference model developers are confronted with elementary problems in identifying a market for their products. Nevertheless, some authors consider this market to be just around the corner. Lang for example, sees a potential for the development of a market for the building blocks developed by him in his approach to designing business processes using such reference process building blocks. In his “Looking to the Future” (Lang 1997, p. 206) he presumes that service enterprises will concentrate on the creation and evolutionary advancement of reference process building block libraries according to uniform standards. Maicher is also of the opinion that the “development and management of […] reference models is becoming a competitive factor within the field of consulting” (Maicher 1999, p. 182).

The Need for Work on Infrastructures Supporting Reference Modeling in Practice

Findings indicate that one reason for the rare practical use of reference modeling in business engineering may lay in the fact that reference modeling is still in a rather early stage of development (vom Brocke 2003; Thomas et al. 2004; Becker et al. 2004a; Fettke et al. 2003). Most contributions focus on methodological aspects which may not suffice to put business engineers in the position of building and using reference models in operational design processes.

In order to increase the practical use of reference modeling, a pragmatic approach is required. This approach is characterized by focusing on the specific context situation of a modeling project from which a more holistic view, pertaining to the needs of the stakeholder involved in the design process, is derived. According to these needs, a comprehensive infrastructure is then built comprising helpful settings for the design and use of reference models in business engineering. Methodological aspects may also play an important role within this infrastructure. At the same time, however, the infrastructure is not only limited to these aspects. Further aspects may also be relevant and there might even be situations in which limitations in methodology may be compensated by the appropriate pragmatic arrangements.

These ideas will be examined in detail in the following section. We will identify the essential building blocks in a reference modeling environment which are then structured within a comprehensive framework.

The Building Blocks of an Infrastructure for Reference Modeling

An infrastructure for supporting business engineers in reusing conceptional models must be oriented towards the specific needs of a certain design situation. However, certain fields of action relevant for designing the infrastructure can be distinguished. A description of these fields within a framework can serve as a guideline for the implementation of specific infrastructures.

In order to derive relevant fields of action, a framework describing specific aspects for the implementation of design processes in information systems science can be applied (vom Brocke 2003). Figure 1 presents an overview of this framework along with the fields of action for building an infrastructure for the reuse of conceptional models in business engineering.

The framework emphasizes the fact that the implementation of design processes is an interdisciplinary task. Thus, the work calls for contributions from various perspectives which must be integrated according to specific requirements and opportunities. This model particularly shows, that apart from the methodological aspects of model design focused on in theory, contributions in the field of technological and organizational infrastructure are needed.

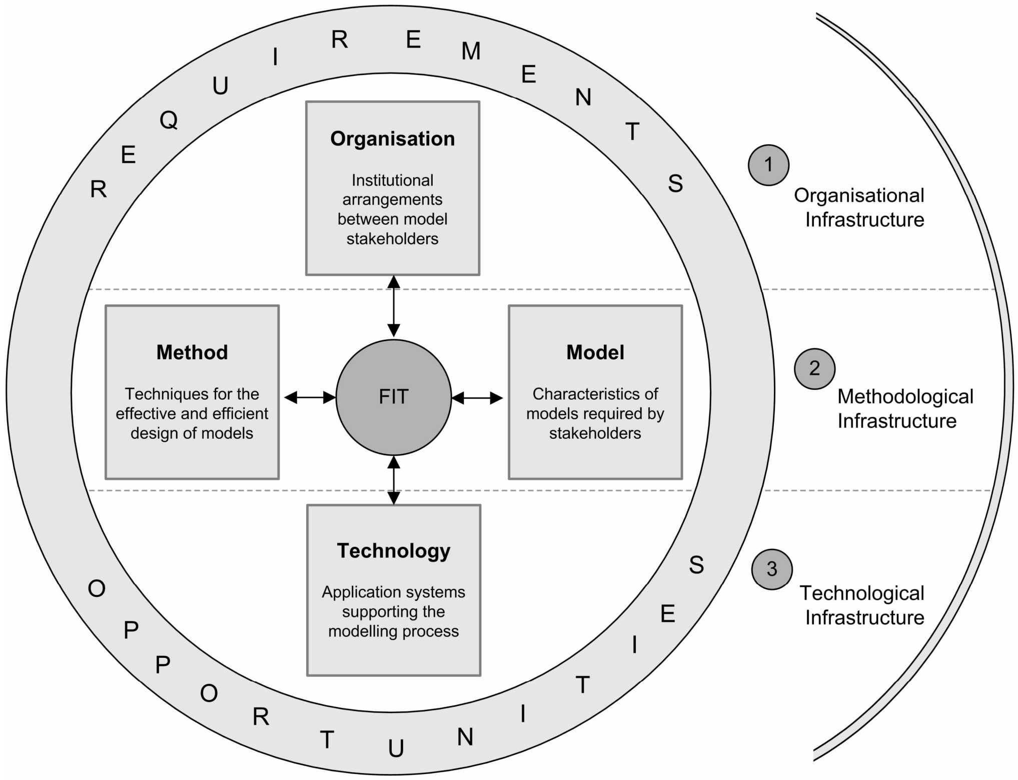

Figure 1. Framework for the Design of Infrastructures for Reference Modeling

Seen against the background of this framework, we can identify three fields of action for the design of an infrastructure for reference modeling:

- *Organizational Infrastructure:* Relevant stakeholders in a certain reference modeling situation must be identified and efficient ways of coordination between them established. In detail, this indicates the need to take into account the user‘s perspective at an early stage in the modeling process. Further stakeholders could for example be, business associates, scientific communities and shareholders.
- *Methodological Infrastructure:* Appropriate guidelines for describing business processes using models are needed. These guidelines should focus on certain characteristics which models should have in order to meet the requirements of certain modeling situations. Thus, rules are derived describing ways of building models accordingly.
- *Technological Infrastructure:* In order to make use of reference modeling in practice, application systems supporting the settings considered relevant within the other fields are needed. From a methodological perspective, it is mainly the functionality of case tools that is addressed. Thus, available tools must be examined and used accordingly. In addition, seen from an organizational perspective, systems supporting various ways of cooperation are needed. This, functionality which is typically provided by knowledge management systems, work group systems, or project management systems is important.

According to the model, the fields of action described above must be designed in view of specific modeling situations. These situations are characterized by certain requirements and opportunities which direct the settings in the fields. In order to meet the situation properly, various interdependencies between the settings in the different fields must be taken into account. For example, the technological conditions have an effect as an enabler or as a restriction for both organizational and technical settings. Thus, the design follows a balanced manner, aiming at a so-called ‘fit of design‘.

A study will be presented in the following section which analyzes the impact of the approach of building infrastructures for reference modeling support. This study was chosen to emphasize the special characteristics of the framework. Thus, the study particularly shows the impact of work in the field of organizational and technological design on the practicability of reference modeling.

A STUDY ON BUILDING AN INFRASTRUCTURE FOR REFERENCE MODELING APPLYING COLLABORATIVE TECHNIQUES FOR BUSINESS ENGINEERING

The Potentials of Collaborative Techniques for Reference Modeling in Business Engineering

The effects of the approach on reference modeling presented in this paper which aim at building a comprehensive infrastructure for special modeling situations can be illustrated by a concept called “collaborative reference modeling”. Within this concept, reference modeling is primarily addressed from an organizational perspective, deriving consecutive settings in the field of technological and methodological infrastructure.

The essential idea of collaborative reference modeling is to share models with a greater range of shareholders in order to both continuously check and improve them from various perspectives. Accordingly, the infrastructure should provide efficient ways of transferring and discussing modeling results during the entire life cycle of certain business areas. Given such an infrastructure, both a division of labor and an increase in model quality could be achieved. As a result, an essential contribution to business engineering could be achieved in practice.

In order to design an appropriate infrastructure for collaborative reference modeling, efficient means of collaboration from an organizational perspective must first be analyzed. These findings then set the main requirements for the design of the technical infrastructure which is then used to implement the organizational processes in practice. In addition, findings in the field of methodological infrastructures can be derived which make the collaborative design of reference models in practice easier. The following passage briefly introduces these perspectives.

Organizational Infrastructure: Networking of Stakeholders

For collaborative purposes, mechanisms of network organizations (Håkansson 1989; Klein 1993) can be applied in the organizational infrastructure of reference modeling. In particular, preliminary work in the field of organizing reuse-based engineering can be applied (Mili et al. 2002; Ommering 2002; Tracz 1995). According to the transaction cost theory, the arrangements may be carried out by hierarchy, market or hybrid forms of coordination (Coase 1937; Williamson 1985). A deeper analysis of the alternatives to reference modeling (vom Brocke et al. 2004) shows that the network organization, as a hybrid mode, is a promising means for reference modeling. On the one hand, it guarantees certain standardization necessary for developing shared mental models, while on the other, it leaves a critical degree of flexibility important for involving a wide range of stakeholders. On the basis of the AGIL-scheme (Klein 1993), a brief outline of the underlying mechanisms of the network organization in reference modeling can be given.

A strong impact on coordination comes from the individual return each stakeholder expects from his or her participation in the network. In particular, suppliers of reference models face a wide range of customers, whereas the customers themselves profit from transparency over a greater range of models. The design of reference models can focus on highly specialized solutions which significantly contributes to model quality.

Thanks to a stronger coupling compared to markets, people tend to establish a common understanding of their business in networks. In reference modeling, this gives way to the establishment of shared mental models pertaining to the semantic context of an application domain. Whereas the information system infrastructure provides a methodology for describing the semantic context, its design and application are carried out on an organizational level. This shared context is vital for efficient collaboration, because the understanding of models is strongly influenced by personal perception.

Due to the history of shared experiences, social relations evolve in networks. These relations are helpful in order in modeling projects. Assets, such as the reputation of stakeholders, give ground for vague requirements specifications which facilitate flexible responses in a dynamically changing environment. This way, both the quality and the efficiency of the design, are supported.

In addition, governing structures are also evident in networks. In software development for example, open source-communities represent an example of rather liberal and self-regulatory governing structures. In these arrangements the influence of single stakeholders results from their contribution to the network. In the practice of reference modeling however, collaboration might also be meaningful in projects with a restricted audience. Take, for example, development projects carried out by ERP-system providers involving various experts worldwide and a selected group of customers. In these applications, a more centralized governing structure could be established.

Technological Infrastructure: Collaborative Platforms

In order to start collaboration, we need information systems which support model sharing (Gomaa 1995). In particular, this means the support of processes for both exchanging and discussing models within a shared semantic context. The essential functionality is illustrated in Figure 2 with an example for a prototypical implementation (see www.herbie-group. de).

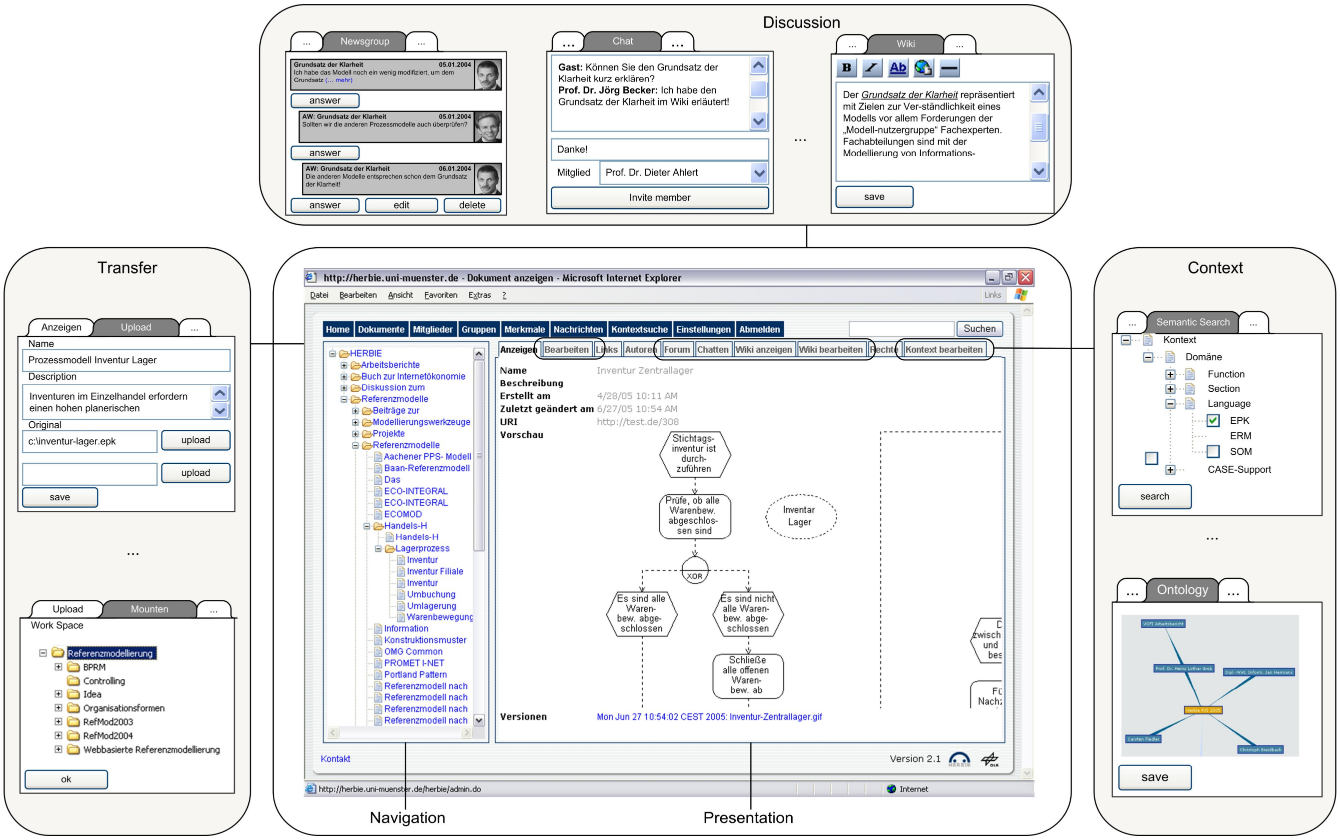

Figure 2: Elements of a Collaborative Platform for Reference Modeling

Features for exchanging models, i. e. the up and downloading of models on a shared repository, build the foundation for the collaborative design. Internet-technology offers promising means for accessing the repository in a flexible manner via a web-browser. On the basis of standard exchange-formats like XML, higher-level formats complying with the syntax of modeling languages are path leading. For the language of EPC for example, the format EPML is provided (Mendling et al. 2004). Standards like WebDAV make it possible to integrate the platform with local file-servers which facilitate the processes of model exchange.

Beyond the technical aspects, it is essential to capture the semantics of the models to be shared on the platform (Mili et al. 1995). For this purpose, feature-based techniques can be applied. Apart from the area of domain engineering (Kang et al. 1998), these techniques are subject to the field of knowledge management, especially information retrieval. In this field, quite a number of appropriate techniques are being developed, ranging from simple taxonomies to more complex anthologies (Daconta et al. 2003; Whitman et al. 2001). However, the appropriate application of these methods in practice still seems to be challenging.

Services for discussing models are needed in order to support the continuous improvement of the reference models disseminated on the platform. In contrast to conventional community platforms, these services should be made available in relation to each single model. In reference modeling, such a close connection is essential for directing the discussion towards special contributions and thereby, increasing the efficiency of the collaboration. Because the preferences for the topics of discussion differ from case to case, various channels of communication should be offered for each model, including newsgroups for asynchronous communication and chat rooms for synchronous communication.

Methodological Infrastructure: The Encapsulation of Models

In the study described in this paper, settings in the organizational field gave way to a new approach in reference modeling characterized by collaboration. As a technological basis to the approach, collaborative systems can be applied which offer special functionalities for sharing knowledge on the basis of conceptional models. Thus, the study mainly gives an example of the impact of the organizational and technological infrastructure, yet it also illustrates the fact that new methodological findings can be derived. In the study, for example, special requirements for the design of models can be gained in order to then easily share them in a collaborative manner.

Throughout the network of stakeholders, models represented in various modeling languages can be shared. For example, UML and EPC models can be distributed one by one. However, the efficiency of sharing the models could be increased by encapsulating them according to certain standards (vom Brocke 2003). An example of such a standard is shown in Figure 3. In the example, models for accounting in the procurement and distribution process of retail information systems (Becker et al. 2004b) are encapsulated in one component for ‘accounts payable‘.

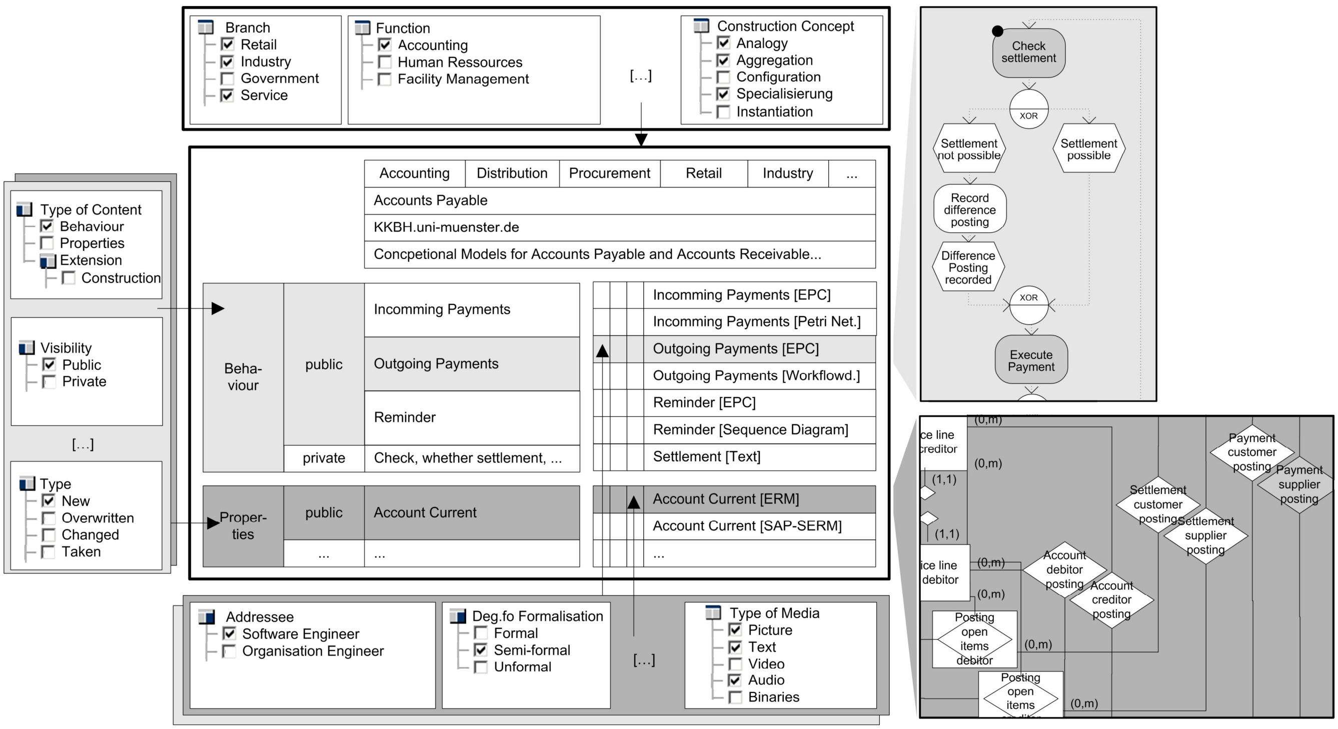

Figure 3. Encapsulating Reference Models as Components

The framework incorporates principles from component-based software engineering (Mili et al. 2002; Szyperski 1998). This essentially means that multiple models must be structured in such a way that a combination of them fulfils a certain modeling purpose. In addition, a description of the collection is given which serves to hide implementation details and to identify models by their essential semantic contribution. For this purpose, the framework provides interfaces on multiple layers: in detail, there are interfaces which specify the overall subject, the content provided to cover it and the representation available describing the content.

In the interface which specifies the subject, the overall contribution of the model is described on a pragmatic level. In addition to identifiers, the purpose of the collected models is characterized so that the component may be easily found by its contribution. For this purpose, both a textual and a taxonomy-based description are considered. The taxonomy-based description is especially helpful in large-scale networks because it builds the foundation for mechanisms of information retrieval (Mili et al. 2002). In particular, work on semantic descriptions carried out in the field of knowledge management can be applied for collaborative reference modeling. According to this type of specification, the component shown in Figure 3 is characterized by the framework to provide ‘Conceptional Models for Accounts Payable and Accounts Receivable…‘ which address companies in the branches of ‘Retail‘ and ‘Industry‘, as well as in the ‘Service‘ branch.

The content that is necessary for fulfilling the overall purpose of the component is specified by an additional interface on a more detailed layer. In this interface, items of the taxonomy serve to differentiate content regarding various views in information modeling. On the basis of systems-thinking, focusing on either the behavior or the properties of a described system can differentiate models. Further differentiations can be implemented by the taxonomy, including either a wider or a more detailed set of views. The component describing ‘accounts payable‘, for example, needs descriptions of behavioral aspects from the processing of ‘Incoming Payments‘ and ‘Outgoing Payments‘, as well as from ‘Reminders‘. As a foundation, properties described in the ‘Account Current‘ are needed.

In a collaborative environment, the content of each type can be represented in various modeling languages because stakeholders have different preferences. Therefore, a special interface must be created which specifies the representations available. The semantic description here serves to characterize the stockholder‘s perspective for which a representation is made. The ERM representing the ‘Account Current‘, for example, addresses ‘Software Engineers‘. Additional rules are required to support the integration of models in order to ensure a consistency in construction. A relationship-type named ‘Payment Supplier Posting‘ must be available which corresponds to the function ‘Post-Payment Supplier‘ as part of the behavioral design.

CONCLUSION AND FURTHER RESEARCH

This article presents an approach to reference modeling from a pragmatic perspective. Apart from focusing on methodological aspects, we recommend considering the type of modeling situation relevant. Thus, the overall aim is to provide business engineers with an infrastructure which facilitates the reuse of models in their daily work. Following this approach, a framework was introduced which illustrates major building blocks of such an infrastructure. Findings show that apart from methodological aspects, it is particularly the organizational and technological aspects which play a major role. In order to illustrate and evaluate the approach, a study applying the theoretical framework was presented. This study describes a design for an infrastructure for reference modeling which facilitates the collaboration of various stakeholders in business engineering. It is argued that such a collaborative setting, derived from organizational theory, can strongly contribute to the use of reference modeling in practice. For each building block in the infrastructure, a detailed description of relevant contributions is given. According to this study, which focuses on the potential for collaboration, further modeling situations must be analyzed. This way, a kind of reference guide for the infrastructure design can be given.

The rationale for further research work in the field of reference modeling lies in the fact that theory and practice have as yet not established an standardized reference modeling language. The reference modeling-specific extensions of established languages from information modeling developed primarily in the scientific world (for example, for ERM or EPC) were, up to now, hardly ever used in practice. Reference modeling research must balance between formal precision and pragmatic usability in the development of such a modeling language: if for example, modeling languages have a formal semantic, then they are suited to machine processing, however the interpretation of real-world coherences, can become complicated. In this context, research which deals with this conflict is highly desirable. Therefore, in the future, a central task in reference modeling research should be not only to show the consequences of results for the scientific world, but also for modeling practice.

Problematic in the construction of reference modeling languages is that they must be aimed not only at the creation, but also the use of reference models. The construction techniques used for the adaptation of a model by the user must thus be imbedded in the languages. The effort for developing such languages is however so high, that it often outweighs the benefits such reference model adaptations bring to modeling projects. Reference modeling research must therefore, also address questions of profitability in reference model use in the future.

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