GI-Edition

Lecture Notes in Informatics

Stefanie Betz, Ulrich Reimer (Hrsg.)

Modellierung 2016

Workshopband

2.–4. März 2016
Karlsruhe

Proceedings

255

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband

Stefanie Betz,
Ulrich Reimer (Hrsg.)

Modellierung 2016
Workshopband

2. – 4. März 2016
Karlsruhe, Deutschland

Gesellschaft für Informatik e.V. (GI)

Lecture Notes in Informatics (LNI) – Proceedings
Series of the Gesellschaft für Informatik (GI)

Volume P-255

ISBN978-3-88579-649-7 ISSN 1617-5468

Volume Editors

Dr. Stefanie Betz
Karlsruher Institut für Technologie
Institut für Angewandte Informatik und Formale Beschreibungsverfahren (AIFB)
Kaiserstraße 89, 76133 Karlsruhe, Deutschland
E-Mail: stefanie.betz@kit.edu

Prof. Dr. Ulrich Reimer
FHS St. Gallen Hochschule für Angewandte Wissenschaften
Institut für Informations- und Prozessmanagement
Rosenbergstrasse 59, 9001 St. Gallen, Schweiz
E-Mail: ulrich.reimer@fhsg.ch

Series Editorial Board

printed by Köllen Druck+Verlag GmbH, Bonn

Vorwort

Die Tagungsreihe „Modellierung“ wird vom Querschnittsfachausschuss Modellierung der Gesellschaft für Informatik getragen. Das Tagungsformat sieht traditionell die Organisation von Workshops vor, wo Themen aus dem Kontext der Modellierung vertieft diskutiert werden. Auf der Tagung Modellierung 2016 finden sieben Workshops statt, die ein breites Themenspektrum abdecken. Der vorliegende Band umfasst die Beiträge von drei dieser Workshops. Zum ersten Mal wurde im Rahmen der Modellierung 2016 auch ein Track „Werkzeug-präsentation“ organisiert. Die Leitung für diesen Track haben PD Dr. Hans-Georg Fill und PD Dr. Agnes Koschmider übernommen. Vorgestellt werden sechs Modellierungs-werkzeuge, die im wissenschaftlichen Umfeld entwickelt wurden und werden. Diese Beiträge finden sich ebenfalls in diesem Band. Die Workshops, deren Beiträge hier veröffentlicht sind, seien im Folgenden kurz beschrieben. Die Beiträge der übrigen vier Workshops sind separat veröffentlicht.

Workshop *Adequacy of Modeling Methods*: Die Konzeption von Modellierungsmethoden hat eine Reihe ganz unterschiedlicher Aspekte zu berücksichtigen. Dazu zählen primär die Anforderungen der betreffenden Anwendungsdomäne sowie der Modellierungszweck, aber auch Aspekte, wie das Retrieval von Modellelementen und deren Visualisierung. Der Einfluss dieser Aspekte auf den (adäquaten) Entwurf von Modellierungsmethoden ist Gegenstand dieses Workshops.

Workshop *Modellierung in der Hochschullehre*: Modellierungsthemen werden in der Hochschullehre nach wie vor weitgehend klassisch durch eine Kombination von Frontalunterricht und praktischen Übungen vermittelt. Alternative Lehrformen, wo die Studierenden im Zentrum stehen und eine aktivere Rolle einnehmen, werden zunehmend gefordert und auch vereinzelt praktiziert. Der Workshop befasst sich mit solchen alternativen Lehransätze.

Workshop *Requirements Engineering & Business Process Management*: Anforderungsanalyse und Geschäftsprozessmanagement sind eng miteinander verknüpft, da Anforderungen an Informationssysteme in aller Regel auch die Geschäfts-prozesse betreffen, in welche die Informationssysteme eingebettet sind. Umgekehrt führt eine Analyse von Geschäftsprozessen oft zur Betrachtung der Anforderungen der involvierten Informationssysteme. Die Querbezüge zwischen beiden Domänen sind Gegen-stand dieses Workshops.

An dieser Stelle sei allen Personen gedankt, welche zu der Realisierung der Workshops sowie des Tracks „Werkzeugpräsentation“ beigetragen haben. Hier sind die Workshop- und Track-Organisatoren zu nennen, die Autoren der eingereichten Beiträge und die Gutachter. Nicht zuletzt geht der Dank auch an die Organisatoren der Modellierung 2016, welche die notwendigen Rahmenbedingungen überhaupt erst geschaffen haben.

Karlsruhe, St. Gallen, im März 2016

Stefanie Betz, Ulrich Reimer

Sponsoren

Andrena
www.andrena.de

Promatis
www.promatis.de

PPI AG
www.ppi.de

TWT GmbH
www.twt-gmbh.de

Partner

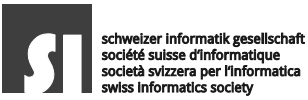
Karlsruher Institut für Technologie
www.kit.edu

FZI Forschungszentrum Karlsruhe
www.fzi.de

Gesellschaft für Informatik
www.gi.de

Österreichische Computer Gesellschaft
www.ocg.at

Schweizer Informatik Gesellschaft
www.s-i.ch



Workshops

1st International Workshop on Adequacy of Modelling Methods (AQEMO'2016)

Organizers:

Hans-Georg Fill (corresponding), University of Vienna, Austria
Heinrich C. Mayr, Alpen-Adria-Universität Klagenfurt, Austria
Andreas Oberweis, Karlsruhe Institute of Technology, Germany
Bernhard Thalheim, University of Kiel, Germany

Modellierung in der Hochschullehre (MoHoL)

Organisatoren:

Andreas Schoknecht, Karlsruher Institut für Technologie, Deutschland
Meike Ullrich, Karlsruher Institut für Technologie, Deutschland
Michael Fellmann, Universität Rostock, Deutschland

Requirements Engineering & Business Process Management (REBPM) – Konkurrenz oder Symbiose?

Organisatoren:

Robert Heinrich, Karlsruher Institut für Technologie, Deutschland
Rüdiger Weißbach, Hochschule für Angewandte Wissenschaften Hamburg, Deutschland

Werkzeugpräsentation

Organisatoren:

Univ.-Prof. Dr. Hans-Georg Fill, Universität Wien
PD Dr. Agnes Koschmider, Karlsruher Institut für Technologie

Querschnittsfachausschuss Modellierung

Die Modellierung 2016 ist eine Arbeitstagung des Querschnittsfachausschusses Modellierung (www.gi-modellierung.de), in dem folgende GI-Fachgliederungen vertreten sind:

ARC (Architekturen)

ASE (Automotive Software Engineering)

EMISA (Entwicklungsmethoden für Informationssysteme und deren Anwendung)

FoMSESS (Formale Methoden und Software Engineering für Sichere Systeme)

ILLS (Intelligente Lehr- und Lernsysteme)

MMB (Messung, Modellierung und Bewertung von Rechensystemen)

MobIS (Modellierung betrieblicher Informationssysteme)

PN (Petrinetze)

RE (Requirements Engineering)

ST (Softwaretechnik)

WI-VM (Vorgehensmodelle für die betriebliche Anwendungsentwicklung)

WM (Wissensmanagement)

Inhalt

1st International Workshop on Adequacy of Modelling Methods (AQEMO '2016)

Modellierung in der Hochschullehre (MoHoL)

Requirements Engineering & Business Process Management (REBPM) – Konkurrenz oder Symbiose?

Werkzeugpräsentationen

1st International Workshop on the Adequacy of Modeling Methods (AQEMO'2016)

When designing a modeling method various aspects need to be taken into account in order to ensure the method's adequacy for the envisaged modeling scenarios. Specific requirements of the given application domain and its different target user groups are examples for such aspects, as well as the intended purpose of the modeling method to be designed like communication, analysis, simulation, processing or code generation etc. Likewise, persistency aspects, i.e. how models are to be stored for ensuring the efficient processing of algorithms, and the retrieval of model information have to be considered. Another aspect concerns the choice and design of the graphical notation for ensuring an intuitive understanding. All these aspects have direct implications on the conceptualization of the modeling method: on the modeling language including its syntax, semantics, notation, on the modeling procedures and algorithms, as well as on the choice of the actual implementation environment.

The Workshop on the Adequacy of Modeling Methods aims at establishing a platform for interested researchers and practitioners to exchange ideas and reveal co-operation opportunities. For the first instance of AQEMO we received four submissions which were peer reviewed by three experts each. Out of these three papers were accepted, two of them after intensive revision.

Together, these papers form a good basis to start the discussion on how to design adequate modeling methods: Jannaber et al. (*Invigorating Event-driven Process Chains – Towards an integrated meta model for EPC standardization*) take up the topic of standardization of modeling languages and discuss how the integration of meta model variants of event-driven process chains can serve as a foundation for a standardized modeling language. Koç and Sandkuhl (*Evolution and Evaluation of a Component-based Context Modelling Method*) focus on the conceptualization process of modeling methods. In particular they report on the development and evaluation steps during the method conceptualization and the experiences gained from this process. In the third paper, Braun (*Towards a Multi-Faceted Framework for Semantics in Enterprise Modeling Languages*) discusses the aspects of semantics of enterprise modeling languages and proposes a framework for the multi-faceted analysis of semantics.

AQEMO would not have become reality without the support of a number of people. First, we are very grateful to the authors for their intensive work. Second, we would like to thank the program committee members and additional reviewers for providing timely and thorough assessments. Furthermore, our thanks go to the Modellierung 2016 organizers for hosting this workshop.

Karlsruhe, March 2016

Hans-Georg Fill, Heinrich C. Mayr, Andreas Oberweis, and Bernhard Thalheim

Invigorating Event-driven Process Chains – Towards an integrated meta model for EPC standardization

Sven Jannaber[1], Arne Karhof[1], Dennis M. Riehle[2], Oliver Thomas[1], Patrick Delfmann[2], Jörg Becker[3]

Abstract: When deciding about appropriate modelling languages, the degree of standardization often represents an important decision criterion. Although the EPC is commonly used for process modelling in the last decades, the absence of an official standard leads more and more to its non-consideration. A coherent meta model is a pillar for the specification of process modelling languages. Accordingly, this work builds the basis for further standardization by providing an integrated meta model for the EPC. The resulting meta model therefore supports the invigoration of the EPC by impelling the future standardization effort.

Keywords: EPC, meta model, model integration, process modelling language specification

1 Meta modelling as a key factor for EPC standardization

In the area of business process management, various modelling languages have emerged over time, exemplary the Business Process Modelling Language or the Unified Modelling Language. In order to facilitate model exchange, the communication between model stakeholders and the reduction of transaction costs, many of these languages have been standardised by respective standard development organizations. Standardization has been identified as relevant both for successful business process modelling [In09, RB10] and for rather specialized criteria like reducing outsourcing risks [WW07]. Hence, standardization can be emphasized as pertinent to the design and choice of an adequate modelling language in terms of graphical representation, syntax and semantic.

The event-driven process chain (EPC) represents a possible option when deciding about an appropriate modelling language. It is well recognised in research as well as in practice [Aa99, DKK14, MA07, MN06]. However, in contrast to its maturity, the EPC still lacks an official standard. Therefore, this paper aims to establish a basis for a successful EPC standardization by providing an integrated EPC meta model. In addition to other relevant language components such as the specification of an exchange format, a grounded meta model is a vital pillar for standardization. In order to address this issue, the paper is structured as follows. Section 2 introduces theoretical background with special focus on

[1] University of Osnabrück, Institute for Information Management and Information Systems, Katharinenstraße 3, 49069, Osnabrück, arne.karhof@uni-osnabrueck.de, sven.jannaber@uni-osnabrueck.de, oliver.thomas@uni-osnabrueck.de
[2] University of Koblenz-Landau, Institute for Information Systems Research, Universitätsstraße 1, 56016, Koblenz, riehle@uni-koblenz.de, delfmann@uni-koblenz.de
[3] University of Münster, European Research Center for Information Systems, Leonardo Campus 3, 48149, Münster, becker@ercis.uni-muenster.de

the EPC and meta modelling. In section 3, the underlying research method is presented. In section 4, we discuss prior EPC research and agree on a mutual understanding of a basis EPC meta model. Subsequently, section 5 provides an overview of relevant EPC literature dealing with meta models and language variants. Consequently, section 6 underlies the significance of a meta model for EPC standardization. Finally, we discuss the relevance of our results for standardization purposes in section 7.

2 Theoretical background and related work

Initially, the EPC emerged from a collaboration between the Institute for Information Systems in Saarbrücken and SAP [KNS92]. Since then, many proposals regarding an extension or alteration of the basic EPC have been made. In order to formalize the respective suggestions, many authors applied their own developed meta models. However, meta models in business process management are not only be used for describing modelling languages, but also facilitate the verification of the syntax and therefore partly the correctness of the whole model [Be00].

A comprehensive consolidation of existing EPC meta models has not been conducted to date. [Th09] presents a consolidated meta model, but as the work does not focus on meta model integration it only considers two models and does not explicitly describe the consolidation steps. [HKM06] do not merge EPC, but XPDL and BPEL meta models. The applied integration process builds the basis for our upcoming integration methodology. Other consolidation approaches, such as [LK06], develop a generic meta model for modelling languages in general, inter alia the EPC, but negate proposed extensions and only concern the basic EPC. Furthermore, there are approaches in literature in the field of the EPC that have to agree on a common EPC basis. For example, [MN06] develop a XML-based interchange format for the EPC, but do not previously consolidate existing extensions. Instead, they agree upon one formal definition of the EPC (in this case [NR02]), which in turn is based on the extended EPC [GS94, HKS93, KT97]. Furthermore, [Ri16] has listed different variants of the EPC language and evaluates them for potential EPC standardization. Similarly, [Ka16] analyses the implementation of EPC concepts in BPM modelling tools.

3 Heading for an integrated model

To establish the foundation for a meaningful development of an integrated EPC meta model, a systematic approach is applied throughout the presented work. Starting point is a baseline EPC meta model that represents essential constructs of the EPC and eEPC and serves as a basis for further enhancement and refinement. The development of an integrated EPC meta model is conducted by taking two primary data sources into account. First, EPC extensions that have been proposed over the last decades are considered for a possible consolidation. Second, multiple authors have already created meta models describing the EPC language. Those existing meta models are evaluated

against a potential integration as well. To acquire both sources, a structured, keyword-driven literature review based on [WW02] and [Br13] is carried out. The search phrases "event-driven process chain" and "Ereignisgesteuerte Prozesskette" have been kept rather general on purpose in order to ensure a broad coverage of EPC literature. The phrases have been used to query the scientific databases SpringerLink and ScienceDirect. Additionally, the proceedings of the EPC workshop from 2002 to 2009 as well as the working paper series of the University of Saarbrücken, Institute of Information Systems, have been considered. All results have been analyzed whether they specifically address EPC extensions or meta models. To further reduce the number of findings, we considered the scientific impact of each publication, hence the amount of citations when conducting a forward search. This was done in line with steps outlined in [Ri16]. To acquire an integrated EPC meta model the consolidation of results adheres to the steps proposed in [HKM06]: Regarding schema preparation, all identified models and variants are transformed into Entity-Relationship (ER) models first to ensure comparability. For schema matching, the models are analyzed in terms of similarities and differences. Subsequently, schema merging takes place by enhancing the baseline EPC meta model with additional concepts and constructs identified in the final results. Ultimately, schema refactoring omits model redundancies and yields an integrated EPC meta model, which is able to sufficiently unify the EPC language.

4 The (extended) EPC language

The initial EPC as presented by [KNS92] consists of functions, events and connectors. Functions represent activities performed in a business process, events present a current state and the connectors AND, OR and XOR can be used to split or join the control flow. Functions and events need to be alternating and processes have to start and end with an event. Although functions, events and connectors are sufficient to model simple business processes, the EPC language lacks information on resources to this point. With an early publication, [HKS93] suggested to annotate resources to functions, which over the years has led to an understanding of event-driven process chains often referred to as "extended EPC" (eEPC) in literature (see e.g. [HKS93], [GS94], [Ro96] or [KT97] for definitions).

The eEPC offers different types of resources to be annotated to functions, for example organizational units, which represent the responsibility to perform the respective function, or IT and application systems that are utilized during the execution of a function. Additionally, the eEPC offers process refinements, which enables the embedding of sub-processes for greater reusability of (partial) process models.

While there exist several meta models for the eEPC in literature (e.g. [HS94], [Be03], [SV05] or [STA05]), we selected the meta model proposed in [Be03] as a base for our work (see Fig. 1) for two reasons: First, the meta model presented by [Be03] follows closely the initial definition of the eEPC, whereas other identified models add model-specific characteristics. Second, the selected model is kept rather simple and intuitive. Hence, we consider the model by [Be03] best suited for model enhancement. The model

is created via the Enhanced Entity-Relationship Diagram notation (see e.g. [Ho93] or [Ta00]), which uses minimum and maximum cardinalities as specified by [SS83] and constraints for specializations, which can be disjoint (D) or non-disjoint (N) and incomplete / partial (P) or total (T).

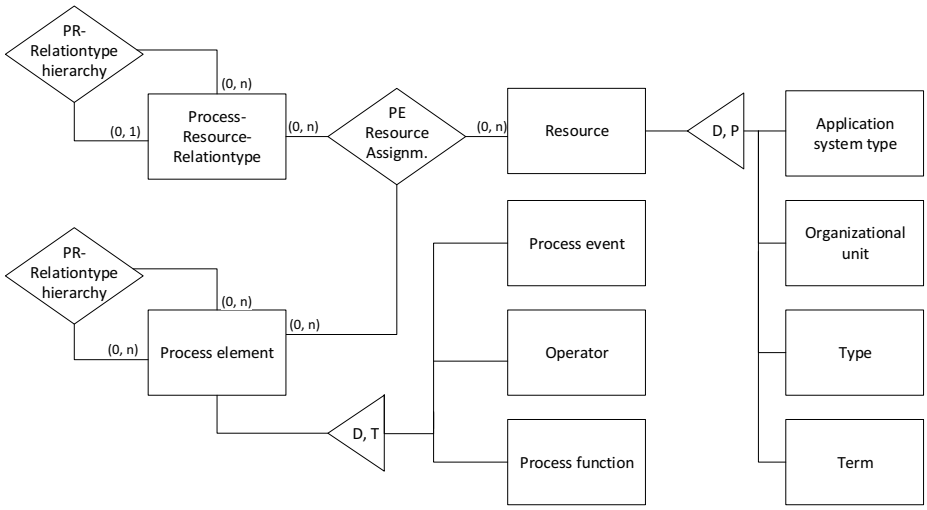


Figure 1: eEPC meta model according to [Be03]

In the chosen EPC baseline meta model process elements are used as an abstract representation of either functions, events or operators. Process elements are related to each other, which reflects the control flow throughout the process. Resources represent a generalization of different resource types. For each resource, its relationship to a process element is specified. Additionally, the model allows for relationship type hierarchy [cf. Be03]. The ternary relation between resource, process element and process-resource-relationship type assigns the resource to the process element using the determined relationship type.

5 Overview of EPC meta models and variants

Following the applied methodology as carried out in section 3, the results of the structured literature review are presented in Table 1. During our research, we identified 14 different EPC variants. Four of those are considered as highly relevant according to their impact factor. Similarly, we found 16 contributions that dealt with process meta models. For a final consolidation, only eight of them are considered as relevant, since they specifically deal with EPCs.

In terms of EPC variants, we consider the basic EPC as specified in [KNS92] for a potential consolidation. In their work, [KNS92] establish the foundations of the EPC language. The contribution introduces basic constructs like information objects, events,

functions and connectors (AND, XOR, OR). The previously mentioned eEPC adds resources, organizational structures and process refinements. A refinement towards risk modelling is conducted by [RM05] and [RW08]. In their work, the EPC language is extended by risk-based constructs. Exemplarily, [RM05] use a risk element which can be attached to EPC functions in order to distinguish between different risk types. In [RW08], the basic EPC is extended by i.e. risk events and corresponding ways to manage risks within a business process. One of the most popular EPC variants in literature is the configurable EPC (C-EPC). Core concept of this EPC variant is the configurability of EPC process elements, which allows the creation of multiple process instances out of a single EPC process model, each of them tailored for different purposes [RA07, Re05]. To achieve this, functions, events and connectors of an EPC model are assigned with an additional attribute altering the visibility of the respective element.

Findings	References	Type (EPC)
EPC	[KNS92]	Variant
Extended EPC (eEPC)	[HKS93] [GS94] [KT97]	Variant
Risk EPC extended	[RM05] [RW08]	Variant; Meta model
Configurable EPC (C-EPC)	[RA07] [Re05]	Variant
EPC/eEPC meta model	[HS94]	Meta model
Process meta model	[Be02]	Meta model
ARIS meta model	[STA05]	Meta model
eEPC meta model	[SV05]	Meta model
EPC meta model	[BDK07]	Meta model
Integrated EPC meta model	[Th09]	Meta model

Table 1: Literature review results

Whereas presented EPC variants are different by nature, most EPC meta models identified during our review share common characteristics. One of the first meta-model based specifications has been proposed by [HS94]. Despite its early stage, the meta model includes most major EPC elements. Additionally, eEPC elements are considered in the presented model. However, differences with regard to other meta models primarily lay in the detailed specification of element attributes and primary keys. In addition, the model refrains from recognizing connector types and instead emphasises on rather unspecific conjunction groups. In [Be02], a generic process meta model is proposed. Although not specifically designed for representing the EPC language, it resembles to a large degree the overall structure of common EPC meta models in literature. Besides EPC core elements, the model focuses on resources, since it introduces e.g. roles, competencies or knowledge on top of common EPC resources. A distinguishing characteristic is the differentiation between function (general functional activity that can be reused in multiple process models) and process function (actual modelling element) [Be02]. Another way of EPC-related meta modelling is carried out by [STA05], who introduce the ARIS business process meta model. This model does not contain most of the element relationships and the syntactical structure known from previous models. Instead, main concern of the contribution is the EPC function and its relationship to process resources. In contrast to other propositions that lay a specific focus on resources,

[STA05] additionally detail the type of each resource relation in terms of visualization and semantic. [SV05] present a meta model that appears very similar to the meta model presented by [Be03], which serves as the baseline meta-model in this paper. Main differences lay within the way resources are treated in the model. In fact, the meta model proposed by [SV05] is the only one identified that relates resources specifically to functions instead of generic process elements. Furthermore, the model by [SV05] enables a resource hierarchy, e.g. for cases where organizational units are aligned in a reporting structure. Similarly, the model found in [BDK07] already strongly resembles the identified baseline meta-model. Again, differences can be noticed in the splitting of the function element (cf. [Be02]) and additional resources (e.g. Entity type). An integrative approach has been facilitated in work by [Th09], who refers to both [Be02] and [BDK07] in order to establish an EPC meta model to serve as a basis for the introduction of the Fuzzy EPC. Subsequently, the model encompasses basis EPC constructs and structures known from previous models, such as the relationship between resources and process elements, rather than between resources and functions. The meta model by [Th09] mainly sets itself apart by explicitly covering all three EPC connector types (AND, XOR, OR) in the meta model.

6 Developing an integrated EPC meta model

Based on the results, this section presents the consolidated meta model. Initially, each meta model and extension from our result set has been compared to the underlying meta model by [Be03]. Thereby deviations have been highlighted. In order to ensure a coherent result, the deviations have been subsequently inspected whether commonalities can be found. For this purpose, also homonyms, synonyms and other linguistic discrepancies had to be dissolved. Figure 2 presents the consolidated meta model as an enhanced ER-model.

Additional elements to [Be03] in Figure 2 are emphasized by a hatched shape. Accordingly, blank shapes illustrate the original set of meta model elements. We relinquish the description of these elements at this point, as it is already carried out in section 4. One striking commonality between EPC meta models is the entity *Process model* or *Process* [BDK07, Be02, HS94, RW08, SV05, Th09]. One process may contain an unlimited number of elements, but a process element is always linked to a specific process. Therefore, we added the *Process* entity with (1,1) and (1,n) cardinalities. Additionally, another specialisation to *Process element* has been added with the *Process Interface* entity [BDK07, Be02, HS94, RW08, SV05]. Furthermore, we adopted the annotation for the predecessor/successor relation, as we assume the possibility to determine the exact cardinalities of process element relations as highly relevant. Due to the lack of space, the elaboration of cardinalities using formal algebra will not take place in this paper. Related work can be found in [Be02, De06]. If a process contains an interface, it is always linked to one specific process and represents a refinement of a “normal” function with a (1,1) cardinality. Surprisingly, just a few meta models from literature concretize the specialisation of the *Operator* entity [HS94, Th09]. In order to

gain a holistic consolidation, we included the respective items. Moreover, it has to be decided which specific resource elements should be appended on the meta model. Considering the meta models from literature, a highly extensive set of suggestions can be retrieved. Especially [Be02] and [RW08] propose many possible extensions. With the purpose of retrieving a consensus between a holistic and simultaneously comprehensive meta model, the manifold proposals from literature have been derived to the rather abstract entity *Data object*. Furthermore, despite the fact that they are only included in one meta model respectively, the elements *Relation Type* and *Process Element Relation Type* have been added. The *Relation Type* entity in conjunction with the *Resource Structure* relationship enables the EPC process to handle the relations among e.g. organizational units. These relations might be of the type "reports to" or "is responsible for" [SV05].

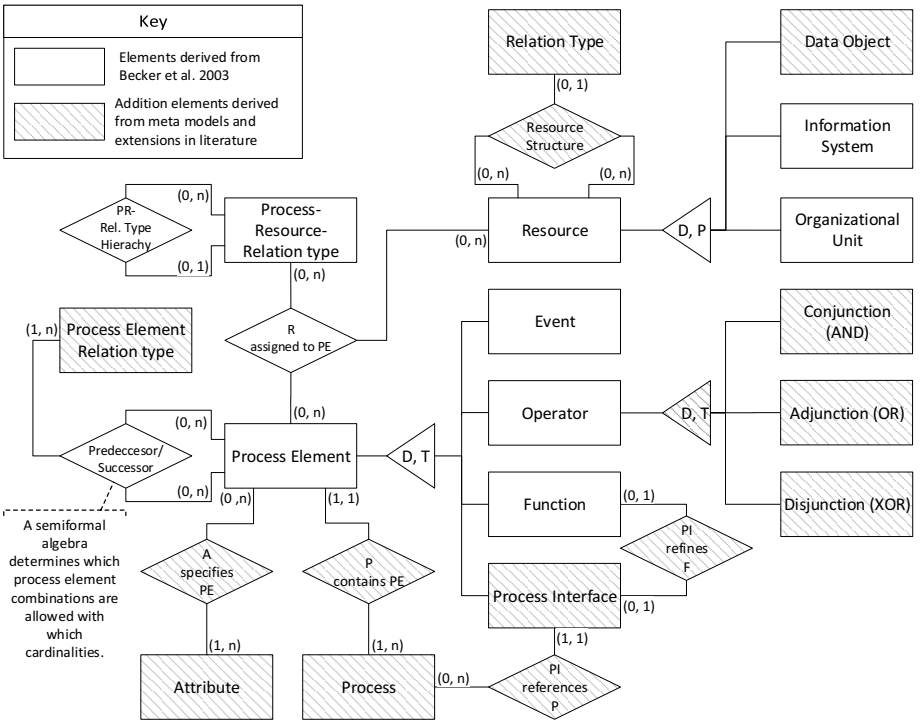


Figure 2: Consolidated EPC meta model

In the above described consolidation steps, we only considered basic EPC and eEPC meta models or their respective parts in exceeding meta models [cf. RW08]. Beyond that, the risk EPC extended and the C-EPC elements have to be taken into account as they also have been identified as significant in our research. While there is no meta model for the C-EPC in literature yet, [RW08] proposed a comprehensive meta model for the risk EPC extended. Therefore, additional C-EPC elements had to be derived from

textual and figurative descriptions. Overall, there was a total set of over 20 additional elements that can be included in our consolidated meta model in terms of conformity with the C-EPC and the risk EPC. Considering the comprehensive-holistic ratio, we decided not to integrate all these elements but instead adding the entity *Attribute* to our meta model to meet basic requirements of both extensions. As a result of this, the main concept behind the risk EPC and the C-EPC can be added to the EPC process model by linking a specific attribute to the respective process elements. Since an attribute can specify more than one process element and a process element can be specified by more than one attribute, we applied (0,n) and (1,n) cardinalities. Exemplary, the attribute "configurative" can be linked to any connectors or functions and therefore mark them as a configurable element in accordance to the C-EPC. Referring to the risk EPC, e.g. an attribute "risk event" may be linked to an event and thus cast it to a risk event. By specifying the attributes' text even more, the risk event can also be differentiated between a "beforehand deterministic risk event", a "direct apparent risk event" and an "delayed apparent risk event", as proposed in [RW08]. A downside is that our approach eliminates the specific figurative representation of additional extension elements like the thick lines of configurative elements [Re05] or the completely new designed break operator [RW08]. However, in order to integrate as many elements as possible without creating an unintelligible, specialized meta model, our approach strikes a balance.

7 Towards EPC standardization

A comprehensive meta model is an integral part of every process modelling language and therefore represents an essential component for the standardization of each respective language. In our work, we have identified relevant literature dealing with meta models concerning the EPC language using a structured literature review. In addition, popular EPC variants have been taken into account for model refinement. Ultimately, the paper at hand establishes an integrated meta model that consolidates existing models and variants. Although each consolidation process implies a certain degree of generalization, hence the omission of rather specialized elements and constructs, the resulting model is able to represent a unified EPC meta model that strives for meeting the requirements of previous EPC research. Subsequently, the proposed model is able to serve as a foundation for successful EPC standard-making.

In future work, the integrated EPC meta model can be used as a blueprint for further language specification, since a holistic standardization requires a detailed definition not only of the language elements as specified by the model, but also of syntactical and semantical aspects that are based on element relationships determined in the meta model.

Acknowledgement: The research presented in this paper is part of the SPEAK project and is funded by the Federal Ministry for Economic Affairs and Energy (BMWi) under grant number 01FS14030.

References

[Aa99] Aalst, W.M.P. van der.: Formalization and verification of event-driven process chains. Information and Software Technology 41, pp. 639–650. 1999.

[BDK07] Becker, J., Delfmann, P., Knackstedt, R.: Adaptive Reference Modeling: Integrating Configurative and Generic Adaption Techniques for Information Models. In: J. Becker, P. Delfmann (eds.) Reference Modeling. pp. 27–58. Physica-Verlag HD, 2007.

[Be00] Becker, J., Rosemann, M., Uthmann, C. von, Uthmann, C. Von.: Guidelines of Business Process Modeling. Business Process Management 1806, pp. 241–262. 2000.

[Be02] Becker, J., Delfmann, P., Knackstedt, R., Kuropka, D.: Konfigurative Referenzmodellierung. Wissensmanagement mit Referenzmodellen. Konzepte für die Anwendungssystem- und Organisationsgestaltung. pp. 25–144. 2002.

[Be03] Becker, J., Delfmann, P., Falk, T., Knackstedt, R.: Multiperspektivische ereignisgesteuerte Prozessketten. In: EPK 2003. 2. Workshop der Gesellschaft für Informatik e.V. (GI) und Treffen ihres Arbeitkreises "Geschäftsprozessmanagement mit Ereignisgesteuerten Prozessketten (WI-EPK), pp. 45–60. Bamberg 2003.

[Br13] Brocke, J.M. vom, Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., Cleven, A.: Reconstructing the giant: On the importance of rigour in documenting the literature search process. In: 17th European Conference on Information Systems, pp. 1–13. Verona, Italy 2013.

[De06] Delfmann, P.: Adaptive Referenzmodellierung. Methodische Konzepte zur Konstruktion und Anwendung wiederverwendungsorientierter Informationsmodelle. Advances in information systems and management science 25, pp. 266. 2006.

[DKK14] Drawehn, J., Kochanowski, M., Kötter, F.: Business Process Management Tools 2014. Stuttgart, Germany 2014.

[GS94] Galler, J., Scheer, A.-W.: Workflow-Management - Die ARIS-Architektur als Basis eines multimedialen Workflow-Systems. In: Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), No. 108, Universität des Saarlandes 1994.

[HKM06] Hornung, T., Koschmider, A., Mendling, J.: Integration of heterogeneous BPM Schemas: The Case of XPDL and BPEL. In: Advanced Information Systems Engineering, 18th International Conference, CAiSE 2006, 2006.

[HKS93] Hoffmann, W., Kirsch, J., Scheer, A.-W.: Modellierung mit Ereignisgesteuerten Prozeßketten. In: Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), No. 101, Universität des Saarlandes 1993.

[Ho93] Hohenstein, U.: Formale Semantik eines erweiterten Entity-Relationship-Modells. Teubner, Wiesbaden, Germany 1993.

[HS94] Hirschmann, P., Scheer, A.-W.: Konzeption einer DV-Unterstützung für das überbetriebliche Prozessmanagement. Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), Universität des Saarlandes 1994.

[In09] Indulska, M., Recker, J., Rosemann, M., Green, P.: Business Process Modeling: Current Issues and Future Challenges. Advanced information systems engineering, pp. 501–514. 2009.

[Ka16] Karhof, A., Jannaber, S., Riehle, D.M., Thomas, O., Delfmann, P., Becker, J.: On the de-facto Standard of Event-driven Process Chains: Reviewing EPC Implementations in Process Modelling Tools. In: Proceedings of the Modellierung 2016, Karlsruhe, Germany 2016.

[KNS92] Keller, G., Nüttgens, M., Scheer, A.-W.: Semantische Prozeßmodellierung auf der Grundlage “Ereignisgesteuerter Prozeßketten (EPK).” In: Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), No. 89, Universität des Saarlandes 1992.

[KT97] Keller, G., Teufel, T.: SAP R/3 prozeßorientiert anwenden. Addison-Wesley, Bonn 1997.

[LK06] List, B., Korherr, B.: An Evaluation of Conceptual Business Process Modelling Languages. 2006 ACM symposium on Applied computing, pp. 1532–1539. 2006.

[MA07] Mendling, J., Aalst, W.M.P. van der.: Formalization and Verification of EPCs with OR-Joins Based on State and Context. Proceedings of the 19th International Conference on Advanced Information Systems Engineering (CAiSE'07) 4495, pp. 439–453. 2007.

[MN06] Mendling, J., Nüttgens, M.: EPC markup language (EPML): An XML-based interchange format for event-driven process chains (EPC). Information Systems and e-Business Management 4, pp. 245–263. 2006.

[NR02] Nüttgens, M., Rump, F.J.: Syntax und Semantik Ereignisgesteuerter Prozessketten (EPK). Prozessorientierte Methoden und Werkzeuge für die Entwicklung von Informationssystemen P-21, pp. 64–77. 2002.

[RA07] Rosemann, M., Aalst, W.M.P. van der.: A configurable reference modelling language. Information Systems 32, pp. 1–23. 2007.

[RB10] Rosemann, M., Brocke, J. vom.: The Six Core Elements of Business Process Management. In: J. Brocke, M. Rosemann (eds.) Handbook on Business Process Management 1 SE - 5. pp. 107–122. Springer Berlin Heidelberg, 2010.

[Re05] Recker, J.C., Rosemann, M., Aalst, W.M.P. van der, Mendling, J.: On the Syntax of Reference Model Configuration – Transforming the C-EPC into Lawful EPC Models. In: Business Process Management Workshops: BPM 2005 International Workshops, BPI, BPD, ENEI, BPRM, WSCOBPM, BPS, pp. 60–75. Nancy, France 2005.

[Ri16] Riehle, D.M., Jannaber, S., Karhof, A., Thomas, O., Delfmann, P., Becker, J.: On the de-facto Standard of Event-driven Process Chains: How EPC is defined in Literature. In: Proceedings of the Modellierung 2016, Karlsruhe, Germany 2016.

[RM05] Rosemann, M., Muehlen, M. zur.: Integrating Risks in Business Process Models. Australasian Conference on Information Systems (ACIS), pp. 62–72. 2005.

[Ro96] Rosemann, M.: Komplexitätsmanagement in Prozeßmodellen. Gabler, Wiesbaden 1996.

[RW08] Rieke, T., Winkelmann, A.: Modellierung und Management von Risiken. Ein prozessorientierter Risikomanagement-Ansatz zur Identifikation und Behandlung von Risiken in Geschäftsprozessen. Wirtschaftsinformatik 50, pp. 346–356. 2008.

[SS83] Schlageter, G., Stucky, W.: Datenbanksysteme - Konzepte und Modelle. Stuttgart, Germany 1983.

[STA05] Scheer, A.W., Thomas, O., Adam, O.: Process Modeling using Event-Driven Process Chains. 2005.

[SV05] Seel, C., Vanderhaeghen, D.: Meta-Model based Extensions of the EPC for Inter-organisational Process Modelling. In: EPK 2005. 4. Workshop der Gesellschaft für Informatik e.V. (GI) und Treffen ihres Arbeitkreises "Geschäftsprozessmanagement mit Ereignisgesteuerten Prozessketten (WI-EPK), pp. 117–136. Hamburg 2005.

[Ta00] Talheim, B.: Entity-Relationship Modeling. Springer, Berlin/Heidelberg, Germany 2000.

[Th09] Thomas, O.: Fuzzy Process Engineering. Gabler Verlag, Wiesbaden 2009.

[WW02] Webster, J., Watson, R.: Analyzing the past to prepare for the future: writing a literature review. Management Information Systems Quarterly 26, pp. 8–13. 2002.

[WW07] Wüllenweber, K., Weitzel, T.: An empirical exploration of how process standardization reduces outsourcing risks. Proceedings of the Annual Hawaii International Conference on System Sciences 2007.

Development and Evaluation of a Component-based Context Modelling Method

Hasan Koç[1], Kurt Sandkuhl[1]

Abstract: In very general terms, a method describes a systematic procedure for problem solving including the required aids and resources. This paper is a continuation of our earlier work that reported on the practices and experiences in the development of a component-based context modelling method in the area of information systems development. The contributions of the paper are (1) the detailed development process of the context modelling method, with a particular focus on artefact evaluation by means of the Framework for Evaluation in Design Science Research (FEDS) (2) additional experiences and lessons learned from the method engineering and application process.

Keywords: method component, method engineering, context modelling, method evaluation, FEDS

1 Introduction

Enterprises should easily adapt to the changes in the regulations, customer demands and advances in the technology to secure a competitive advantage and to improve their chances of survival. The shift towards a service-oriented economy makes it even more important for enterprises to be agile to fulfill the changing requirements. A recent EU-FP7 project Capability as a Service in Digital Enterprises (CaaS) addresses these aspects and proposes to design a business service explicitly considering its delivery context. To this end, the project will deliver the Capability Driven Development (CDD) method. An integral part of the CDD is the context modelling method, which allows for eliciting and designing the service application context.

Method engineering is a complex process since methods have to be grounded in solid experiences, elaborated with an adequate level of detail and ideally validated in many application cases in order to reach a sufficient maturity level. This paper is a continuation of our earlier work that reported on the practices and experiences in the development of a component-based context modelling method in the area of information systems development [SK14]. The contributions of the paper are (1) the detailed development process of the context modelling method, with a particular focus on artefact evaluation by means of the Framework for Evaluation in Design Science Research (FEDS) [Jo14] and (2) additional experiences and lessons learned from the method engineering and application process.

[1] The University of Rostock, Institute of Computer Science, Chair Business Information Systems, Albert-Einstein-Str. 22, 18059 Rostock, Germany, {hasan.koc, kurt.sandkuhl@uni-rostock.de}

The remaining part of the paper is structured as follows: the background for the work from CDD and previous findings from the earlier work are briefly introduced in section 2. Section 3 presents the overall method development process constituting the frame for this research. Section 4 focuses on the development and evolution of the context modelling method and discusses the different phases of the process with experiences and lessons learned. Conclusions and future work are discussed in section 5.

2 Background

2.1 Capability as a Service (CaaS)

Work in this paper is based on the method development which is a part of the EU-FP7 project "Capability as-a-Service in Digital Enterprises" (CaaS). The main goal of the CaaS project is to facilitate a shift from the service-oriented paradigm to a capability delivery paradigm by applying the CDD approach. Based on the capability meta-model proposed in [Bē15], capability in CaaS is defined as the ability and capacity that enable an enterprise to reach a business goal in a certain context. Context in this case would be any information characterizing the situation of the capability [De01].

The CDD approach includes five top-level method components for capability modelling, a Capability Development Tool (CDT) and a Capability Navigation Application (CNA) to monitor and adjust the service delivery according to the context at runtime. In order to ease adaptation of business services to new delivery contexts, the CDD explicitly defines (a) the potential delivery context of a business service and (b) the potential variants of the business service for the delivery context. This requires development of a new methodical framework supporting business context modelling in the three industrial cases in CaaS, which is the main focus of this work. Method engineering in CaaS was a use case-driven, iterative process. The three use cases contributing to the method development and involved in method evaluation were from e-government, energy industries and insurance. More detailed descriptions of the use cases are available in [Bē15] and [KS15].

2.2 Experience Reports in Method Engineering

Reflecting on the practices of method application and presenting the experiences gained in the projects is a decisive and necessary activity. In the literature, there are only a few publications reporting from the topics of method engineering experiences, such as method application, realized business value, stakeholders of the method as well as the development process of the method itself.

Addressing this gap, our previous work indicated recommendations and lessons learned in method engineering based on the development of the context modelling method

component [SK14]. First, in a distributed team of developers, the previous work strongly recommended to treat the method development task like a project and define clear role and task structures. The roles needed are the overall method development responsible and the responsible actors for different method components, which in project management could be considered as project manager and work package managers. Furthermore, there should be an expert for the selected method conceptualization supporting the method component development and the developers as such. Second, to develop a method documentation template and define it as mandatory for all method component also proved valuable, which should be complemented with additional training for all method developers on the application of the method conceptualization. In this respect, the method conceptualization by Goldkuhl et al [GLS98] proved to be suitable and applicable. Yet, extensions to the method conceptualization had to be done and some concepts were renamed to further operationalize the method use. Third and last, Moody´s principles [Mo09] were used to evaluate the visual notation, whereas they did not help when constructing it, which was rather a creative process. Also, one important missing aspect in the evaluation was the implementability of the visual notation within the modelling environment, which could be crucial for the projects applying the notation in the industrial setting.

This paper contributes to this findings by elaborating the method development process, with a particular focus on artefact evaluation by means of the Framework for Evaluation in Design Science Research (FEDS) [Jo14] as well as the gained experiences from the method engineering and application.

3 Overall Method Development Process

The process for development of the top-level CDD method components roughly followed the general phases of an engineering process: scope setting, requirements analysis, design, implementation and test - with several iterations included in these phases. However, all these phases were adapted to the specific needs of the application case and heavily influenced by the method conceptualization used. The produced output is used in the context modelling method development process (cf. section 4).

The process was started with organizational and technical preparations. The organizational preparations included formation of the development team, defining the responsibilities of the team members, agreeing on schedule and clarifying available resources. The technical preparations were directed to identifying and agreeing on frame conditions, such as the purpose of the method as a whole, a set of requirements and the capability meta-model, which were a result of the previously completed requirements work package. The main principles were defined as i) the creation of a component-oriented method to support different ways of working, ii) the update of the meta-model that should serve as a common basis for all method components and iii) development of a ready to use reference methods with links to the proprietary methods.

After these preparations, the actual work on the method started with discussing different method conceptualizations and agreeing on one conceptualization to use. The way methods and method components are applied within CDD is an extension of the method conceptualization proposed by [GLS98]. A method component consists of *concepts, procedures* and a *notation*. The *concepts* specify which aspects of reality are important and what should be captured in a model. The *procedures* describe in concrete terms how to identify the relevant concepts in a method component and the *notation* specifies how the result of the procedure should be documented. The method components are related to each other with *method framework*, i.e. which components are to be used and under what conditions, as well as the sequence of the method components (if any). The *perspective* defines what the procedures should achieve and finally, forms of cooperation represents the necessary skills to apply the method. In line with the project needs, we replaced the terms *framework* and *perspective* by *overview to method components* and *purpose* respectively. Moreover, the procedures are refined with additional elements such as *steps* with certain *inputs*, *outputs* and *tool support*.

The development process for the different method components happened in different parallel activities performed by different groups from the method development team. This paper will focus on the development process for the context modelling component only, which is introduced in the next chapter. Before that, it should be noted that the overall method development process introduced in this chapter was not entirely sequential but rather iterative and incremental (e.g. the change in the frame conditions were also reflected in the resource planning). The overall process worked smoothly for the CaaS project, yet we lack other use cases and projects that might help to generalize the procedure and create good practices.

4 Context Modelling Method: Development Steps

The development of the context modelling method followed the problem explication, requirements elicitation, solution investigation, method design and method evaluation steps. The output created from the overall method development process was integrated after the first iteration of the method design step. The feedback gained in each evaluation cycle triggered the design of a new method version. Moreover, as the use cases and stakeholder goals evolved, changes were observed in the requirements, which were again reflected in the following method versions. This section focuses on this highly iterative context modelling method development process.

4.1 Problem Explication

This step investigated the problems experienced by the enterprises when increasing flexibility of the service delivery in changing environments. The first activity was to define the problem precisely. Based on the overall CDD method objectives, the problem was refined as “the digital enterprises need more support towards offering flexible digital

services, which should be adapted to the changing requirements of the environment". In the second activity, the problem is positioned in the practice, within which it occurs, i.e. surveys and semi-structured interviews with stakeholders from practice were conducted to demonstrate general interest, action research and observation techniques are applied to give depth to the problem. Finally, the last activity analyzed the root causes of the main problem. The output of this step was a precisely explicated problem, with its root causes [JP14].

4.2 Requirements Elicitation and Investigation of Possible Solutions

Different from the main principles produced in the overall development process (cf. section 3), this step elicited additional requirements that should guide the design of the context modelling method. For this purposes, focus groups including the researchers and the practitioners were created. To mitigate the risk that one person dominates such groups, participative approaches were used, upon which the requirements were derived from the enterprise goals regarding a context-aware service delivery. The result was a set of requirements of functional and non-functional nature that the method should fulfill.

Based on the requirements, systematic literature analyses in the areas of context modelling and capability modelling with a particular focus on method engineering were conducted. The state of the art analysis showed that context modelling and context-based systems are a popular topic in contemporary research with a lot of different context definitions and application examples existing. Most work focused on the conceptualization of context and a method for context modelling, showing what steps to take and how to identify relevant context elements, has not been proposed yet. The gained knowledge during the analysis was applied in the next step, when designing the method. To exemplify, the six parameters of the context proposed in [BB05] was used as an inspiration, namely constraint, influence, behavior, nature, structure and system. Moreover, amongst the categories, we selected "situational context" as the most relevant classification for CaaS, since developments in this category focus on information characterizing the state or situation of a person, object or location. Regarding the capability modelling methods, we observed that the term "method" is used synonymously with "process, procedure" or "step". Also, it was not possible to identify an off-the-shelf method related to enterprise models and stakeholder goals or an approach consisting of actors, notations, important concepts and activities to be executed when modelling capabilities.

4.3 Design of the 1st Method Version

This step presents the first iteration of the context modelling method development. The requirements enriched in the prior step are used here to express the purpose of the method, which were formulated as questions that the method should be able to answer. Following that, important concepts derived both from the literature work and the

industrial use cases were selected to find a right balance between the theory and practice. Based on these concepts, generic procedures are created that help to identify them. During the first design iteration, the overall method development process introduced in chapter 3 were still being executed. In particular, there was no agreement on the method framework to be used, hence the documentation template could not be created. Yet, solely from the context modelling method point of view, the problem explication, requirements analysis and solution investigation steps could be carried out, which established the foundations of the context modelling method.

The first iteration resulted in a fairly immature artefact, which had to be further developed in accordance with the output from the overall development process and the evaluation results. Specifically, the evaluation cycles provided the most important input for designing the next method version, leading to a close relation between the design and evaluation steps. The following section details the interplay between these two steps.

4.4 Selecting the Right Strategy for the Evaluation

The design process of the context modelling method is iterative, i.e. the design of the artefact produces method versions, which is then evaluated in different settings. For evaluating the method version(s), Framework for Evaluation in Design Science Research (FEDS) proposed by Venable and colleagues [Jo14] is applied. Each evaluation result feeds the loop back to the design method step, i.e. the evaluation activities executed after each method version contributed to the refinement of the procedures, concepts and notation of the following method versions.

Following the FEDS approach, first an evaluation strategy should be selected that is based on the resources and the evaluation criteria. Here we explicated the main goals as ensuring the efficacy (*the positive outcome is due to the artefact*) and effectiveness (*the method works in real settings*) of the artefact. Furthermore, since we develop a socio-technical artefact, we aimed to minimize the social/ user oriented design risks related to whether the design fulfils a need or solves a problem. The evaluation of an artefact in its natural context is a resource-consuming task, hence existing research projects that the method engineers work in as well as the student assignments should be used to minimize the costs. As identified in the previous steps, there was a general lack of proposals about the context modelling methods. Thus, the development would be of exploratory nature and the initial design described in section 4.3 could have minor flaws, which had to be taken into account in the strategy selection.

Consequently, we selected the “Human Risk & Effectiveness” evaluation strategy, i.e. evaluation methods that produce empirically-based interpretations to improve the characteristics of the artefact (*formative evaluation*) should be applied in artificial settings, which allows for a few false starts. Then, the evaluation should be scaled up rather fast to the more realistic settings (*naturalistic evaluation*) in the upcoming method versions to create shared meanings of the artefact in different contexts (*summative evaluation*) [Jo14]. To obtain the utility of the artefact, four main properties derived

from the non-functional requirements should be evaluated, namely "perceived usefulness, perceived ease of use, fit with the organization and ease of learning". Finally, the individual episodes required to evaluate the artefact were planned, which are elaborated in the following section.

4.5 Evaluation Cycles and Method Versions

The evaluation of the 1st method version (1st evaluation) has a formative-artificial character and adopts the criteria-based method. The enterprise modelling experts discussed the 1st method version and checked whether it fulfils the requirements. In line with the 1st evaluation, the context modelling method is updated (see Fig. 1). The important concepts that the method user needs to be acquainted with had to be aligned with the capability meta-model to have an ontological commitment to the terms. Based on the classes in the capability meta-model important concepts in the procedures are highlighted and explained. Here we also used the results of the literature reviews to use additional concepts such as "variation aspect" or "variation point", which were then added to the meta-model. In order to represent such concepts, a notation was developed and then evaluated based on Moody´s principles [Mo09]. To define the relationship between the concepts, the associations in the meta-model were used. Moreover, the tools are introduced, which the method user needs to model the context. The generic procedures are refined as *steps*, which comprise of the activities, input(s), objective(s) and output(s), tool support required to execute the steps is added to the method.

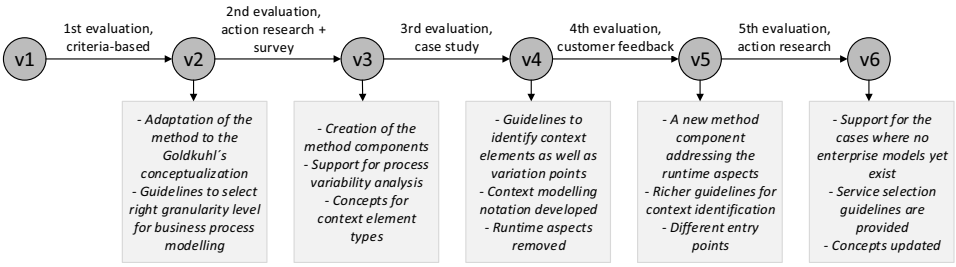


Fig. 1: Evaluation Cycles and Contributions to the Method Versions

The activities to update the method to v2 included two researchers, an enterprise architect and a knowledge worker. This helped to clarify the concepts that the method uses and to identify initial skills required when applying the method. Also, by observing the modelling activities of the business stakeholders in the participatory modelling sessions, the researchers could propose guidelines on how to develop enterprise models. Examples of this were the produced goal models, mostly with ambiguous and hardly measurable objectives and business process models with various granularity levels.

The 2nd evaluation used both formative-naturalistic and summative-naturalistic methods. The former included the practitioners and the enterprise modelling experts. To gather

feedback concerning how the method works in real settings, we applied action research, where the real user (practitioners) also participated to the formative design. The summative evaluation phase focused on the properties of the method by conducting an online survey. The 3rd method version incorporated the gained feedback, which mainly addressed a clear separation between scope setting, variability analysis and operationalization of the context model. Based on this finding, three method components were defined appropriately.

In the 3rd evaluation, single case study approach was adopted to gather the feedback from the method application in an industrial setting. During the method application, we observed that the client identified all possible gateways as variation points and all sub-processes as process variants. This caused confusion in the identification of the contextual factors, i.e. *everything related to the resolution of the gateways* were elicited as context elements, without considering its effect on capability delivery. Thus the 4th method version provided guidelines to identify i) what constitutes a context element and how to distinguish it from other information objects and ii) variability and variation points in business process models. Moreover, the context modelling notation is specified, i.e. pictograms for developing context models are provided to the method user. Now that the method user can model the context, the need for implementing it grew. However, the *operationalization* method component proved to be insufficient for this purposes, i.e. the clients did not know how to represent the business rules and how to model the adjustments in line with the application context. As a result, the 4th method version focused only on the early design phases and removed the runtime related aspects, which should be addressed in the further versions.

The 4th evaluation was formative-naturalistic and basically collected client feedback and requirements for the runtime aspects. The results were incorporated into the 5th version of the context modelling method. In particular, the new component described the way of adding part of the specifications such as preconditions and rules for using the context model during operations. Also, the guidelines regarding to context identification are enriched based on the experiences with the clients and use cases. We observed that the industrial partners had different enterprise models that had been developed before the application of the method. For instance, one partner offered business services in utilities industry and has already modelled business processes that are implemented to offer such services, whereas the other partner had established goal models. To support the investigation of the contextual factors based on existing enterprise models, the 5th version provided two different starting points, namely “goals-based” and “process-based” strategies.

The 5th and last evaluation to date focused on the effectiveness of the latest method version by conducting an action research cycle with one client. The cycle was applied in the course of a student project with the client. The group included a researcher, an enterprise architect and four students over a timeframe of three months. During the investigation it became clear that the context modelling method lacked support for the situations, where the business services are only described as textual specifications and no

formal models are adopted for their implementation. Last but not least, additional guidelines are provided to the method user on how to select the service(s) that should be implemented context-aware and concepts are updated and aligned with the procedures.

5 Experiences and Future Work

This paper extended our earlier work that reported on the practices and experiences in the development of a component-based context modelling method. The extension concerned the elaboration of the method development process, with a particular focus on artefact evaluation by means of the FEDS framework [Jo14] as well as the gained experiences from the method engineering and application.

During the method design, we benefited from the capability meta-model, which was developed before the project started. The advantage of a such meta-model was twofold. First, the concepts that the method components refer to were to a great extent represented there and they have been reused. Second, to define the relationship between the concepts in notation development, used applied the associations in the meta-model. According to the use case needs, the concepts and the meta-model were updated. In this respect, the evaluation cycles adopting action research was helpful, i.e. the practitioners involved in the method application raised their concerns whenever clarifications were needed. This created the basis for the discussions, where the researcher could intervene and help the client with the understandability issues. The symbiosis as such resulted in an improved context modelling method and will most likely influence the non-functional requirements listed in section 4.4 positively.

Application of the FEDS framework proved to be suitable for the evaluation. The evaluation activities executed after each method version contributed to the refinement of the procedures, concepts and notation of the following method versions. Unfortunately, mitigation of the researcher in such projects might be a problem, especially in the evaluation of the artefact. Although the bias of the method engineers, who also played a role in evaluation, cannot be completely eliminated, we minimized this threat by involving other researchers without expectations, as well as industry practitioners.

The CaaS project takes a use case-driven approach. The use cases defined in the beginning of the projects maturated over time. Accordingly, the requirements that the context modelling method fulfill evolved. Also, after the artefact evaluation, new requirements emerged that had to be taken into account in the upcoming versions. In a such highly iterative process, the component-oriented method conceptualization provided a holistic view and allowed for an easy maintainability of the method.

In line with the principles introduced in section 3, the method should not be a monolithic block. The artefact should allow for a situational use, thus we classified the outcomes of the design method step into different method components. Here, two options were feasible. First, each purpose defined earlier in the method design process could be

addressed by a respective method component. This option is preferable, when the method user has a complete overview on the industrial setting, in which the method is going to be practiced and is aware of the enterprise goals that should be fulfilled. The alternative way was the creation of method components depending on the procedures and the produced outputs. We opted for the latter one since we did not have any experiences with the industrial use cases defined in the project.

Future research needs to investigate the interaction with a complete CDD environment, which includes a Context Platform that provides information, a Capability Navigation Application that monitors context indicators and applies adjustments, and a Capability Delivery Application that supports the organizational work practice. Last but not least, to assure rigor of the method as well as its application in the practice, a final and summative-naturalistic evaluation is going to be conducted.

References

[BB05] Bazire, M.; Brézillon, P.: Understanding Context Before Using It. In: Modeling and Using Context. Springer 2005; pp. 29–40.

[Bē15] Bērziša, S. et al.: Capability Driven Development. An Approach to Designing Digital Enterprises. In Business & Information Systems Engineering, 2015, 57; pp. 15–25.

[De01] Dey, A. K.: Understanding and using context. In Personal and ubiquitous computing, 2001, 5; pp. 4–7.

[GLS98] Goldkuhl, G.; Lind, M.; Seigerroth, U.: Method integration: the need for a learning perspective. In Software, IEE Proceedings -, 1998, 145; pp. 113–118.

[Jo14] John Venable, Jan Pries-Heje, Richard Baskerville: FEDS: a Framework for Evaluation in Design Science Research. In European Journal of Information Systems, 2014.

[JP14] Johannesson, P.; Perjons, E.: An introduction to design science. Springer, Cham, 2014.

[KS15] Koç, H.; Sandkuhl, K.: A Business Process Based Method for Capability Modelling. In: Perspectives in business informatics research. 14th International Conference, BIR 2015, Springer, 2015.

[Mo09] Moody, D. L.: The Physics of Notations: Toward a Scientific Basis for Constructing Visual Notations in Software Engineering. In Software Engineering, IEEE Transactions on, 2009, 35; pp. 756–779.

[SK14] Sandkuhl, K.; Koç, H.: Component-Based Method Development: An Experience Report. In: The Practice of Enterprise Modeling. Springer Berlin Heidelberg, 2014; pp. 164–178.

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 33

Towards a Multi-Faceted Framework for Semantics in Enterprise Modeling Languages

Richard Braun[1]

Abstract: The semantic specification of Enterprise Modeling Languages (EMLs) is a challenging task that is primarily caused by the immanent subjectivity in the context of enterprise modeling. This covers the interpretation of respective meta model constructs due to their references to the reality. In contrast, EMLs may also contain formal semantics in regard of automating specific parts. Despite the generally accepted relevance of semantics for the application of EMLs, current research lacks in the provision of appropriate description means and largely omits semantic investigations. This paper therefore proposes a multi-faceted framework for the analysis and description of EML semantics in order to increase the awareness of relevant influences. The framework consists of an ontic and epistemological dimension in its core, as material semantics finally address such fundamental aspects. On this basis, several wrapping dimensions are outlined: Conceptualization dimension, pragmatic dimension, representation dimension and the final consensus dimension.

Keywords: Enterprise Modeling Languages, Semantics, Ontic Reality, Formal Semantics, Material Semantics, Semantics Specification, Meta Modeling

1 Context and Motivation

1.1 Enterprise Modeling Languages

Enterprises are multifarious, heterogeneous socio-technical information systems, whose components are interrelated within a complex nexus of interdependencies on various abstraction levels [Ve03, SL08, Fr14]. Enterprise Modeling (EM) aims to conceptualize, abstract and represent parts and aspects of enterprises by creating conceptual models in order to foster communication between involved stakeholders and enable an integration of static, procedural and functional dimensions [La09]. EM serves as capable and auspicious approach for managing present-day business complexity in the light of increasing interdependencies between and within information systems [Ve14]. EM may also provide specific means for operative support for different levels of automation [Ma13, BF14].

A plenty of Enterprise Modeling Languages (EMLs) evolved during the last decades. The range reaches from integrated approaches like ArchiMate [LPJ09] over Purpose-Specific Modeling Languages like BPMN [OM11] towards domain-specific approaches like the set of MEMO languages (e.g. RiskM [SHF11]). Especially rather generic languages like BPMN are often subject for language extension or simplification (cf. [BE14, Fe10]), since

[1] TU Dresden, Chair of Wirtschaftsinformatik, esp. Systems Development, 01062 Dresden, Germany, richard.braun@tu-dresden.de

the complexity of enterprise-related issues requires a permanent review of the communicative usefulness of existing EMLs [PVSH05], which leads to the addressed EML adaptations [BPS13] and language evolution [Pa06].

1.2 Relevance of Semantics and Struggles with Semantics

Language adaptations are inevitably related to semantic considerations in order to identify requirements of prospective users, which result from the expected utility of an EML [Fr13, dKMP14, DKM15, PVSH05]. Investigating the relevant semantics of an EML is further crucial for an adequate justification of EML adaptation need indicating respective syntactical necessities [BS14]. Consequently, the focus should merely lay on semantics and pragmatics of EMLs in order to facilitate adequate adaptations [BPS14].

Despite the high relevance of both aspects for EML application and dissemination (cf. [BSH99, p. 212], [BPS13, p. 440]), they are still under-investigated. Several authors explicitly criticize the imprecise semantic justification and specification of conceptual modeling languages (cf. [HR04, pp. 67-69], [HHS05, p. 19]), EMLs (cf. [Si03, p. 108], [SAG13, pp. 690, 706], [HBO12, pp. 485]) and also EML extensions [BE14, p. 52]. These shortcomings hamper language comprehensibility [Gu07] and cause severe issues in terms of inter-subjective communication. For instance, mismatched understandings of meta model elements remain undetected [Ka12] or superficially similar meta concepts are erroneously treated as being the same [vdL15]. Weak semantic specifications of EMLs also hinder the establishment of common understandings of meta concepts [vdL15, pp. 3, 66, 104].

The reasons for these issues are manifold. For instance, some EMLs have a rather formal background (e.g. BPMN), which often implicates a naive-realistic understanding of semantics. It means that a particular meta model element is supposed to be interpreted in exactly one way. This is insufficient in semi-formal modeling languages like EMLs, as the semantics of those languages are mostly material [GBE05]. Recipients of EMLs are mostly human beings, which in turn causes the immanent issue of subjectivity in regard of understanding a (meta) model differently (cf. [Se84, p. 6], [PG05, p. 112], [vdL15, p. 5]). Technically spoken, the semantic mapping of a syntactical construct to a particular semantic domain construct differs and leads to the above mentioned issues [vdLvZ14, KK02]. This is even intensified by multi-disciplinarity in present-day industries, the sheer amount of participating systems and resulting collaborative modeling tasks [Ro08].

Although objectification and particular semantic harmonization within a group of EML users are stated as worthwhile objectives (cf. [Sc98, p. 25] and [Fr13, pp. 13-14]), current research lacks in the provision of techniques for describing EML semantics in an appropriate manner. Also methodic guidance for detecting and eliminating misunderstandings is missing and there is no special consideration of integrating material semantics and formal semantics, which seems to be a relevant issue in the field of process modeling, for instance (cf. [BF14, p. 3400], [OM11, p. 435]). Also respective semantic description approaches like UEML [An10] are not well disseminated or applied in many EMLs. Research on semantics in the context of EMLs can hence be assessed as rather immature, isolated and less integrated.

1.3 Research Scope and Objective of the Paper

It is therefore advisable to focus EML semantics on the meta model layer in general. Due to the fact that EML semantics are closely related to the issue of subjectivity, each investigation finally results in a discussion of the fundamental questions, what something is (ontic aspects) and how this thing is perceived and described by somebody (epistemological aspect). While several works from the beginning of the last decade partly address such aspects for the model layer [Sc99, Be04, BE06, Fr06], there is a lack of research regarding to further development in recent years and explicit consideration in the context of EML semantics on the meta model layer. Also the very few papers on EML semantics largely omit such issues [Op11, BPS14, vdL15].

We therefore aim to design a multi-faceted framework for EML semantics in this paper, which has an ontic and epistemological dimension in its core. This is done in order to cover the diversity of relevant (mostly subjective) sources for ambiguity and establish awareness for different types of things and possible consequences. Additionally, surrounding dimensions are introduced in order to emphasize factors, which influence and determine particular EML semantics. Consequently, the paper aims to initially integrate several aspects and serves as starting point and orientation framework for further research on specifying EML semantics. The framework should also support the alignment of research on different dimensions. The framework is designed based on an analysis of existing research in the context of EML semantics and their grouping within particular dimensions.

The remainder of this paper is as follows. Section 2 briefly introduces the *SemFrame* framework, presents the ontic core of the framework and discusses consequences for semantics. Section 3 then briefly outlines the remaining dimensions. Section 4 summarizes the contributions of the paper and explicates further research topics.

2 Ontic and Epistemic Dimension

Figure 1 presents the structure of the *SemFrame* framework, which aims to provide orientation for the analysis of different facets in the context of semantics of EMLs. Each dimension is briefly introduced below.

2.1 Preliminary Considerations

The consideration of meta model semantics bases on the work of ULLMANN (1979), who proposes a triangle consisting of a *thing* (as part of an area of discourse), its *conceptualization* (by an individual) and a *symbol* (of a language) for its representation [Ul79]. Fig. 2a presents the adaptation of the linguistic triangle to the meta model layer in order to provide an orientation frame for the discussion below. A *meta model element is understood as symbol*, which aims to enable the explication of conceptualizations from a particular area of interest. It represents syntactical constructs. Further, *a thing is rather understood as*

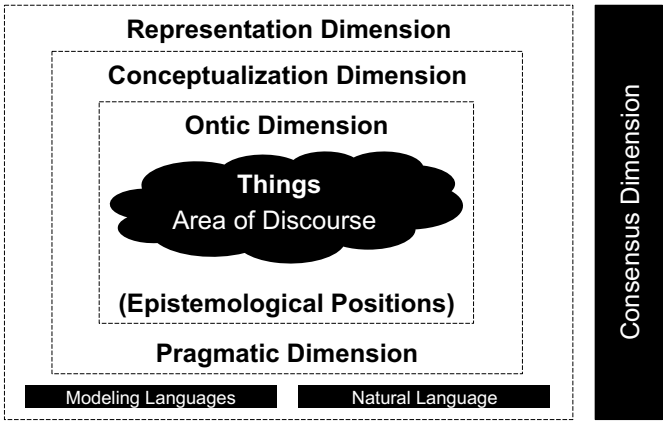


Figure 1: Dimensions of the *SemFrame* framework.

class of things, as the meta model layer usually refers to already abstracted things. Hence we consider an implicit abstraction step of meta model readers, which have to infer from single entities to a class of those entities[2]. Thus, it represents the affected semantic domain constructs and the *refers to* relation represents the semantic mapping (cf. [KK02]). Finally, *conceptualization* explicitly refers to the stated classes of things and cover the individual understanding of meta model constructs. VAN DER LINDEN (2015) therefore proclaims the term *personal semantics* in order to stress different understandings of fundamental enterprise-related things [vdLvZ14].

2.2 Ontic and Epistemic Dimension

Each consideration of EML semantics should start with an awareness of the ontic type of things[3], as the respective types may determine various conceptualizations of classes of things. Generally, the ontic positions of Realism, Idealism and the open-ontic position can be divided [Ca50, Be03].

Ontic Realism: *Realism* affirms the existence of an ontic reality that is generally perceptible [SBZ96]. Naturally, it seems to be plausible that physical and haptic things are perceived as real (e.g. the complex thing *production machine*) or that respective visual signs are perceived as real (e.g. optic or acoustic effects). Consequently, things that are somehow perceptible by sensory perception capabilities can be seen as real. In contrast, the ontic type of virtually constructed things from the field of EM like *processes*, *programs* or *competences* is debatable. On the one hand, it could be argued that such things are actually essential and hence *real* within the world of the group of enterprise modelers. On the other hand, it could be argued that the stated things only *become real* by final exposure

[2] The term *meta things* is avoided, as we follow a language-based understanding of the term *meta* that indicates a specific role in terms of creating statements about other elements.

[3] Thereby, *ontic* is understood in the sense of an observable and atomically describable entity; independent of any epistemic position (referring to [He96, AP03]).

of perceptible things. For instance, a process is physically exposed either by its physical outcome or respective state changes of participated things, which can be observed and quantified in some way. More precisely, a process itself can be rather seen as denotational wrapper around a specific set of connected perceptible explications.

With respect to the epistemic position, things in realism can be divided into objectively perceptible things (*Epistemic Realism*) and subjectively perceptible things (*Epistemic Idealism* [Be03]). As presented in Fig. 2b, the combination of the ontic and epistemic position determines the respective epistemological position, which in turn is relevant for applicable theories of truth (cf. [BE06]). In case of Positivism, semantics are understood as mappings from syntactical constructs to referred semantic domain constructs, which implies an invariant interpretation and possible automation [GFPVS02, PG05]. Possibly existing personal conceptualizations of individuals are hence less relevant (C_n). The unit of semantic analysis is therefore the relation *Sy-T*.

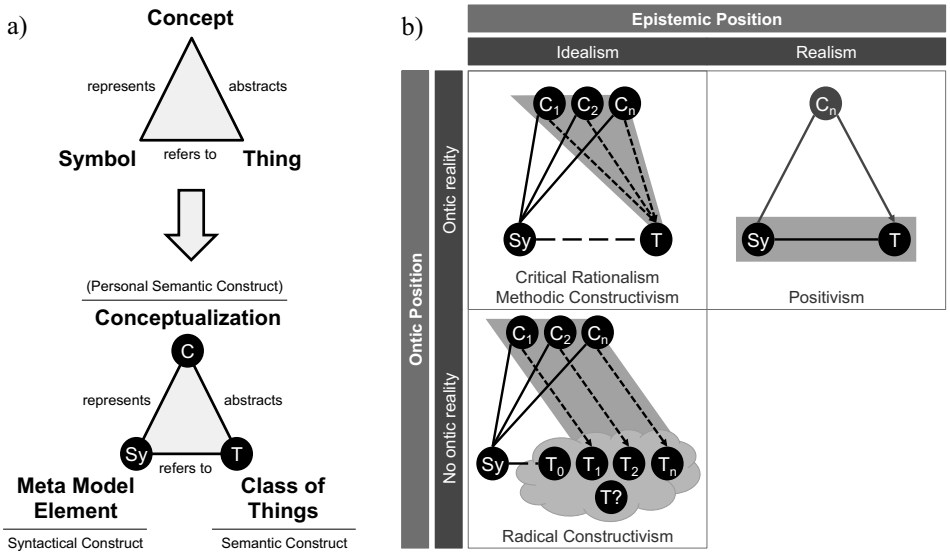


Figure 2: a) Adapting the generic linguistic triangle [Ul79] to the meta model layer of EMLs. b) Ontic and epistemic positions in the shape of the adapted linguistic triangle.

In contrast, subject-dependent Critical Rationalism [Re03] or Methodic Constructivism [Ka72] comply with subjective variance that is explicated by different conceptualizations of an ontic thing (C_1, C_2 and C_n). Those conceptualizations can be seen as personal semantics [vdL15]. It is therefore necessary to identify these differences and reduce them in order to establish shared semantics. Consequently, semantic analysis primarily considers the set of relations C_n-*T*. Conceptualizations differ according to granularity, level of detail and relations to other classes of things [vdLvZ14]. From a semantic point of view, it is desirable to identify and cluster similar conceptualizations for two reasons: Firstly, similar conceptualizations should be homogenized in order to shape shared semantics [vdLH12]. Secondly, notable differences between those groups of conceptualizations may indicate different views on one and the same thing (e.g. multi-perspectivity [Fr08]). The degree

of different conceptualizations is naturally influenced by the affected domain. A long existing domain (e.g. healthcare) may have a higher level of regulation and terminological standardization than a rather young domain (e.g. social media).

Ontic Idealism: Idealism negates the existence of objectively perceptible things in a world. Instead, things are completely constructed within the mind of individuals (e.g. [Be03]). This position mandatorily requires the epistemic position of Idealism and results in Radical Constructivsm (e.g. [Fr07, p. 13]). An idealist position seems to be plausible for totally immaterial things, highly innovative things and possible worlds. Semantics mean here that each individual has its own conceptualization of something s/he has in mind, which is then referred to a meta model element. Due to the lack of objective things (T_0, T_1, T_2 and T_n), it is questionable to accomplish shared semantics, as the analysis of each relation C_n-T_n actually remains contingent, since there is no rational opportunity to match them. Consensus-oriented approaches hence proclaim to focus the process of conceptualization by considering commonly applied methods (e.g. in Method Constructivism), but it is currently unclear how to adapt and conduct such approaches in the context of EML semantics. It is therefore hard to accept idealist things as reference points in EML semantics due to the questionable contribution to inter-subjective communication.

Open-Ontic Position and Remarks: Further, the open-ontic position is proposed in literature (e.g. [Be03]), which omits any ontic positioning. With respect to the above mentioned issue within Idealism, this position is also questionable, as it cannot provide a stable reference point for meta model constructs. Visually, the semantic reference point is vague and not precise. It became obvious that the ontic dimension is not trivial and even spans philosophical topics. As it is important to be aware the characteristics of things and their differing conceptualizations, we are facing a factual problem shift regarding to description (and consensus building) of those things; independent of any semantic discussion.

3 Further Dimensions of the SemFrame Framework

3.1 Conceptualization Dimension

As mentioned above, conceptualization is understood as the individual understanding of the stated class of things. This conceptualization is a central point of analysis, as it depends on the personal understanding of a particular meta model and finally refers to some things s/he has in mind. The only exception is represented by a class of things that is perceived as real and objectively perceptible (Positivism). In each other constellation, the conceptualization is strongly subject-dependent and can cause variant interpretations of meta model constructs by interpreting them differently, for instance [vdL15].

3.2 Pragmatic Dimension

The intended application context determines the expected capabilities of a modeling language [Th12, p. 5]. Also the situational modeling purpose plays an immanent role within

conceptualization [BPS14, p. 436]. Some authors state that the real meaning of a language finally results from its factual usage [BPS14, p. 438], serving a particular utility [PVSH05]. The strong influence of pragmatics on semantics is hence obvious and requires the respective consideration by defining requirements profiles, for instance (referring to [DKM15]). Table 1 summarizes typical purposes in the context of EMLs.

Table 1: Purposes in the context of EML pragmatics.

Purpose	**Description**
Documentation	EMLs are intended to work as base for documentation, inter-subjective communication and manual decision making. There is no kind of automation and this purpose usually covers material semantics and variant conceptualizations of addressed things of a domain. The semantics have therefore a *descriptive* character.
Documentation and Automation	As stated in Section 1.2, the combination of material and formal semantics may be required in process modeling. For instance, in case of manually interpretable process flows (e.g. in clinical treatment processes) and vertical processes (e.g. resources flows), which can be integrated with respective application systems. This scenario could be referred as *hybrid semantics*.
Automation	This purpose reflects the complete automation of an EML, i.e. formal semantics. This could be either required within model-driven engineering approaches in order to configure application systems or as direct intervention into parts of reality. For instance, if the control unit of a production machine is completely configured. The semantics have therefore a *prescriptive* character.
Model Analysis	This purpose reflects any kind of analysis or assessment of created models. There is consequently no direct relation to the actual area of discourse, but rather some kind of self-reference. However, such implementation can be found in EML extensions [BE14, p. 45] and may require respective formal semantics for the analysis of models.

3.3 Representation Dimension

Conceptualizations and things (in case of Positivism) need to be explicated in any form. Ontologies are often proclaimed as means for semantic annotations [Hö07, Ka15]. Basically, even those rather minimalistic languages have certain syntax and semantics, which have to be taken into account. Further, also the semantics of the meta modeling language have to be considered, as it indirectly refers to artificial things of constructs (e.g. *Generalizations*). The respective meta language further shapes and also limits a particular expression space. This is covered by the framework element **modeling language**.

In addition, **natural language** emphasizes the importance of single words (sememe) as basic source of ambiguity, since people usually think in the semantics of their own natural language [So10]. While structural issues are covered by the above mentioned dimensions, natural language based ambiguity is also a crucial issue, since all the stated

problems finally lead to lexical topics like synonym and homonym conflicts [PLM15]. For instance, further research on other lexical types like hypernyms, hyponyms, meronyms, holonyms, antonyms and troponyms is needed (cf. [Hö07, p. 1628], [Th12, p. 8], [MLP14, p. 89]). Also controlled natural language techniques or rather formal approaches like SBVR [OM15] are promising.

3.4 Consensus Dimension

Despite divergence and ambiguity, it is important to find a particular consensus on semantics in the sense of an agreement of different personal conceptualizations in order to provide an applicable language within a language community. Although consensus theory of truth is usually applied in Constructivism and Critical Rationalism, we suggest to examine its consequent application, since EM usually covers at least some things that are not invariant interpretable.

4 Conclusion and Outlook

4.1 Contribution and Framework Application

This research paper outlines a framework for the multi-faceted analysis and description of EML semantics by focusing the primal aspect of analysis – the things, which are addressed by an EML. Therefore, different ontic positions are discussed in regard of their consequences for semantics. Additional dimensions were outlined in order to foster a deeper integration and consolidation between existing research approaches, which relate to EML semantics. Due to the complexity of the addressed topic, it would be presumptuous to proclaim a complete solution for specifying semantics. Instead, the paper aims to revitalize a fruitful discussion of EML semantics and their potential specification in order to increase to practical relevance of EMLs to a certain degree.

The proposed framework should be understood as an initial approach to tackle the manifold issue of EML semantics in an integrated manner, especially regarding to various sources of ambiguity. The framework aims to provide an orientation architecture for several approaches like research on personal semantics [vdL15], linguistic ambiguity [PLM15] and user-centric language design [PVSH05, Fr13, BS14, BPS14, DKM15]. To the best of our knowledge, this is the first effort that intends to bring together all those relevant issues.

The framework should further support EML language designers at specifying the semantics of an EML. For instance, it is significant to state what things are covered by particular meta concepts and what things are explicitly not covered. Language designers should also explicate their ontic and epistemological position in regard of the addressed domain. The description of specific pragmatic use cases may illustrate the intended type of semantics. Further, the provision of synonyms may enhance the understanding of language concepts and may avoid linguistic misunderstandings. Finally, the framework may act as orientation framework for research on single semantic aspects and their alignment with affected dimensions.

4.2 Further Research

It is obvious that research on semantics and pragmatics should be generally intensified. Adequately specified semantics seems to be a potential gate opener for larger dissemination of EMLs in general. This paper also reveals the strong need for cumulative, inter-disciplinary and cross-cutting research in order to move EM forward. This comprises a deeper analysis of fundamental research disciplines like philosophy, linguistics and cognition, since fundamental semantic issues are at some point decomposable to such basic questions.

Consequently, plenty of research questions should be investigated. For instance: How can we determine the ontic type of things? How can personal conceptualizations explicated and compared in a standard manner? Is it feasible to adapt consensus-oriented techniques from Methodic Constructivism for elaborating shared semantics? Despite the academical relevance of these issues, it is also necessary to consider potential trade-offs between over-engineering (e.g. by massive semantic annotations) and practicability.

Acknowledgement: This paper presents partial results from the research project *SFB Transregio 96*, which is funded by the German Research Foundation (DFG).

References

[An10] Anaya, Victor; Berio, Giuseppe; Harzallah, Mounira; Heymans, Patrick; Matulevičius, Raimundas; Opdahl, Andreas L; Panetto, Hervé; Verdecho, Maria Jose: The Unified Enterprise Modelling Language – Overview and Further Work. Computers in Industry, 61(2):99–111, 2010.

[AP03] Atmanspacher, Harald; Primas, Hans: Epistemic and ontic quantum realities. In: Time, Quantum and Information, pp. 301–321. Springer, 2003.

[Be03] Becker, Jörg; Holten, Roland; Knackstedt, Ralf; Niehaves, Björn: Wissenschaftstheoretische Grundlagen und ihre Rolle für eine konsensorientierte Informationsmodellierung. pp. 307–334, 2003.

[Be04] Becker, Jörg; Holten, Roland; Knackstedt, Ralf; Niehaves, Björn: Epistemologische Positionierungen in der Wirtschaftsinformatik am Beispiel einer konsensorientierten Informationsmodellierung. Wissenschaftstheorie in Ökonomie und Wirtschaftsinformatik – Theoriebildung und-bewertung, Ontologien, Wissensmanagement. Wiesbaden, pp. 335–366, 2004.

[BE06] Braun, Robert; Esswein, Werner: Eine Methode zur Konzeption von Forschungsdesigns in der konzeptuellen Modellierungsforschung. In: Data Warehousing. pp. 143–172, 2006.

[BE14] Braun, Richard; Esswein, Werner: Classification of Domain-Specific BPMN Extensions. In: The Practice of Enterprise Modeling. volume 147 of LNBIP, pp. 42–57, 2014.

[BF14] Bork, Domenik; Fill, Hans-Georg: Formal Aspects of Enterprise Modeling Methods: A Comparison Framework. In: Proceedings of the 47th HICSS. pp. 3400–3409, 2014.

[BPS13] Bjekovic, Marija; Proper, Henderik Alex; Sottet, Jean-Sebastien: Enterprise Modelling Languages – Just Enough Standardisation? In: Business Modeling and Software Design. volume 173 of LNBIP, pp. 1–23, 2013.

[BPS14] Bjekovic, Marija; Proper, Henderik A; Sottet, Jean-Sébastien: Embracing pragmatics. In: Conceptual Modeling. volume 8824 of LNCS, pp. 431–444, 2014.

[BS14] Braun, Richard; Schlieter, Hannes: Requirements-based development of BPMN extensions: The case of clinical pathways. In: IEEE 1st RE-BPMN. pp. 39–44, 2014.

[BSH99] Brinkkemper, Sjaak; Saeki, Motoshi; Harmsen, Frank: Meta-modelling based assembly techniques for situational method engineering. Information Systems, 24(3):209–228, 1999.

[Ca50] Carnap, Rudolf: Empiricism, semantics, and ontology. Revue internationale de philosophie, pp. 20–40, 1950.

[DKM15] De Kinderen, Sybren; Ma, Qin: Requirements Engineering for the Design of Conceptual Modeling Languages - A Goal-and Value-oriented Approach. Applied Ontology, 2015.

[dKMP14] de Kinderen, Sybren; Ma, Qin; Proper, Henderik A: Model bundling: Towards a value-based componential approach for language engineering. In: Proceedings of the 8th VMBO. 2014.

[Fe10] Fernández, H Fernández; Palacios-González, Elías; García-Díaz, Vicente; G-Bustelo, B Cristina Pelayo; Martínez, Oscar Sanjuán; Lovelle, Juan Manuel Cueva: SBPMN – An easier business process modeling notation for business users. Computer Standards & Interfaces, 32(1):18–28, 2010.

[Fr06] Frank, Ulrich: Towards a pluralistic conception of research methods in information systems research. Technical report, ICB-research report, 2006.

[Fr07] Frank, Ulrich: Ein Vorschlag zur Konfiguration von Forschungsmethoden in der Wirtschaftsinformatik. Wissenschaftstheoretische Fundierung und wissenschaftliche Orientierung der Wirtschaftsinformatik, pp. 158–185, 2007.

[Fr08] Frank, Ulrich: The MEMO Meta Modelling Language (MML) and Language Architecture. ICB Research Report 24, Universität Duisburg-Essen, 2008.

[Fr13] Frank, Ulrich: Domain-specific modeling languages: requirements analysis and design guidelines. In: Domain Engineering, pp. 133–157. Springer, 2013.

[Fr14] Frank, Ulrich: Enterprise Modelling: The Next Steps. Enterprise Modelling and Information Systems Architectures, 9(1):22–37, 2014.

[GBE05] Gehlert, Andreas; Buckmann, Uta; Esswein, Werner: Ontology Based Method Engineering. AMCIS 2005 Proceedings, p. 436, 2005.

[GFPVS02] Guizzardi, Giancarlo; Ferreira Pires, L; Van Sinderen, Marten J: On the role of domain ontologies in the design of domain-specific visual modeling langages. 2002.

[Gu07] Guizzardi, Giancarlo: On ontology, ontologies, conceptualizations, modeling languages, and (meta) models. Frontiers in artificial intelligence and applications, 155:18, 2007.

[HBO12] Harzallah, Mounira; Berio, Giuseppe; Opdahl, Andreas L: New perspectives in ontological analysis: Guidelines and rules for incorporating modelling languages into UEML. Information Systems, 37(5):484–507, 2012.

[He96] Heidegger, Martin: Being and time: A translation of Sein und Zeit. SUNY Press, 1996.

[HHS05] Hausmann, Jan Hendrik; Heckel, Reiko; Sauer, Stefan: Dynamic Meta Modeling. PhD thesis, University of Paderborn, 2005.

[Hö07] Höfferer, Peter: Achieving Business Process Model Interoperability Using Metamodels and Ontologies. In: Proceedings of the 15th ECIS. pp. 1620–1631, 2007.

[HR04] Harel, David; Rumpe, Bernhard: Meaningful modeling: what's the semantics of semantics? Computer, 37(10):64–72, 2004.

[Ka72] Kamlah, Wilhelm: Philosophische Anthropologie Sprachkrit. Grundlegung U. Ethik. 1972.

[Ka12] Kaidalova, Julia; Seigerroth, Ulf; Kaczmarek, Tomasz; Shilov, Nikolay: Practical challenges of enterprise modeling in the light of business and it alignment. In: The Practice of Enterprise Modeling, pp. 31–45. Springer, 2012.

[Ka15] Kaczmarek, Monika: Categories of Ontologies' Applications in the Realm of Enterprise Modeling. In: Proceedings of IEEE 17th CBI. volume 1, pp. 98–107, 2015.

[KK02] Karagiannis, Dimitris; Kühn, Harald: Metamodelling platforms. In: EC-Web. volume 2455, p. 182, 2002.

[La09] Lankhorst, Marc: Enterprise Architecture at Work: Modelling, Communication and Analysis. 2009.

[LPJ09] Lankhorst, Marc M; Proper, Henderik Alex; Jonkers, Henk: The architecture of the archimate language. In: Enterprise, Business-Process and Information Systems Modeling, pp. 367–380. Springer, 2009.

[Ma13] Malavolta, Ivano; Lago, Patricia; Muccini, Henry; Pelliccione, Patrizio; Tang, Anthony: What industry needs from architectural languages: A survey. IEEE Transactions on Software Engineering, 39(6):869–891, 2013.

[MLP14] Mendling, Jan; Leopold, Henrik; Pittke, Fabian: 25 Challenges of Semantic Process Modeling. IJISEBC, 1(1):78–94, 2014.

[OM11] OMG: Business Process Model and Notation (BPMN) - Version 2.0. Object Management Group (OMG), 2011.

[OM15] OMG: . Semantics of Business Vocabulary and Business Rules, Version 1.3, 2015.

[Op11] Opdahl, Andreas L: Anatomy of the unified enterprise modelling ontology. In: Enterprise Interoperability, pp. 163–176. Springer, 2011.

[Pa06] Patig, Susanne: Evolution of entity–relationship modelling. Data & Knowledge Engineering, 56(2):122–138, 2006.

[PG05] Pfeiffer, Daniel; Gehlert, Andreas: A framework for comparing conceptual models. In: Proceedings EMISA. pp. 108–122, 2005.

[PLM15] Pittke, Fabian; Leopold, Helmut; Mendling, Jan: Automatic detection and resolution of lexical ambiguity in process models. IEEE Trans. on Soft. Eng., 41(6):526–544, 2015.

[PVSH05] Proper, Henderik Alex; Verrijn-Stuart, Alex A; Hoppenbrouwers, SJBA: On utility-based selection of architecture-modelling concepts. In: Proc. of the 2nd APCCM. pp. 25–34, 2005.

[Re03] Rehfus, Wulff D: Handwörterbuch Philosophie, volume 8208. Vandenhoeck & Ruprecht, 2003.

[Ro08] Rospocher, Marco; Ghidini, Chiara; Serafini, Luciano; Kump, Barbara; Pammer, Viktoria; Lindstaedt, Stefanie N; Faatz, Andreas; Ley, Tobias: Collaborative Enterprise Integrated Modelling. In: SWAP. volume 426. Citeseer, 2008.

[SAG13] Santos, Paulo Sérgio; Almeida, João Paulo A; Guizzardi, Giancarlo: An ontology-based analysis and semantics for organizational structure modeling in the ARIS method. Information Systems, 38(5):690–708, 2013.

[SBZ96] Smith, Steve; Booth, Ken; Zalewski, Marysia: International theory: positivism and beyond. Cambridge University Press, 1996.

[Sc98] Schütte, Reinhard: Grundsätze ordnungsmäßiger Referenzmodellierung: Konstruktion konfigurations-und anpassungsorientierter Modelle. Gabler, 1998.

[Sc99] Schütte, Reinhard: Basispositionen in der Wirtschaftsinformatik – Ein gemäßigt-konstruktivistisches Programm. In: Wirtschaftsinformatik und Wissenschaftstheorie, pp. 211–241. Springer, 1999.

[Se84] Searle, John R: Minds, brains and science. Harvard University Press, 1984.

[SHF11] Strecker, Stefan; Heise, David; Frank, Ulrich: RiskM: A multi-perspective modeling method for IT risk assessment. Information Systems Frontiers, 13(4):595–611, 2011.

[Si03] Siau, Keng: The psychology of information modeling. In (Siau, K., ed.): Advanced Topics in Database Research. volume 1, pp. 106–118, 2003.

[SL08] Sandkuhl, Kurt; Lillehagen, Frank: The early phases of enterprise knowledge modelling: practices and experiences from scaffolding and scoping. In: The Practice of Enterprise Modeling, pp. 1–14. Springer, 2008.

[So10] Sowa, John F: The role of logic and ontology in language and reasoning. In: Theory and Applications of Ontology: Philosophical Perspectives, pp. 231–263. Springer, 2010.

[Th12] Thalheim, Bernhard: Syntax, semantics and pragmatics of conceptual modelling. In: Natural Language Processing and Information Systems, pp. 1–10. Springer, 2012.

[Ul79] Ullmann, Stephen: Semantics: An Introduction to the Science of Meaning. 1979.

[vdL15] van der Linden, Dirk: Personal semantics of meta-concepts in conceptual modeling languages. PhD thesis, Radboud University Nijmegen, 2015.

[vdLH12] van der Linden, Dirk; Hoppenbrouwers, Stijn: Challenges of identifying communities with shared semantics in enterprise modeling. In: The Practice of Enterprise Modeling. volume 134 of LNBIP, pp. 160–171, 2012.

[vdLvZ14] van der Linden, Dirk; van Zee, Marc: On the semantic feature structure of modeling concepts: an empirical study. In: Proc. IEEE 16th CBI. IEEE, pp. 158–165, 2014.

[Ve03] Vernadat, François: Enterprise modelling and integration. Springer, 2003.

[Ve14] Vernadat, François: Enterprise Modeling in the context of Enterprise Engineering: State of the art and outlook. International Journal of Production Management and Engineering, 2(2):57–73, 2014.

Workshop zur Modellierung in der Hochschullehre

Michael Fellmann, Andreas Schoknecht, Meike Ullrich

In der Praxis findet die konzeptionelle Modellierung ihren Einsatz beispielsweise beim Datenbankentwurf oder bei der Geschäftsprozessmodellierung. Daher ist sie curricularer Bestandteil zahlreicher Studiengänge, insbesondere im Bereich der Wirtschaftsinformatik. Bislang wird die Modellierung in der Hochschullehre überwiegend in klassischen Frontalveranstaltungen, wie z.B. Vorlesungen unterrichtet. Jedoch wird aus der Wissenschaftsforschung und Hochschuldidaktik in den letzten Jahrzehnten verstärkt ein Perspektivenwechsel von einer dozenten- zu einer studierendenzentrierten Lehre hin gefordert, die eine aktive Rolle der Studierenden und praktische Anwendung theoretischer Inhalte vorsieht. Ebenso gewinnt nicht zuletzt durch den Bologna-Prozess die Frage nach der Qualität von Hochschulabschlüssen und damit verbunden die faire, objektive und lernzielgerichtete Überprüfung studentischer Leistungen zunehmend an Bedeutung. Auch im Rahmen zukünftiger digitalisierter Lehr- und Lernprozesse entstehen interessante innovative Ansätze für das Unterrichten und das Prüfen der Modellierung in der Hochschullehre.

Ziel des Workshops ist es, die oben genannten Themen aufzugreifen und mit Wissenschaftlern und Praktikern breit zu diskutieren. Daher sind neben wissenschaftlichen Untersuchungen auch Beiträge eingereicht und ausgewählt worden, die Erfahrungswerte aus der Praxis liefern oder Ideen und Anregungen für zukünftige Entwicklungen vorstellen. Parallel zum Workshop findet ein Wettbewerb zur Bewertung von Modellen statt. Zusammen mit dem Wettbewerb sollen Austausch und Diskussion über das Thema Modellierung in der Hochschullehre angeregt werden.

Zur Präsentation und Diskussion wurden fünf Beiträge angenommen, die verschiedene Aspekte der Modellierung in der Hochschullehre abdecken. Dies reicht von der curricularen Gestaltung sowie Lehr- und Lernzielen für die Modellierung über die Entwicklung von neuen Lehrkonzepten mit einem sogenannten „Social BPM Lab“ bis hin zur automatisierten Bewertung von Klausuren mit Modellierungsaufgaben. Eine weitere Einreichung befasst sich mit der Frage der Auswahl von Modellierungssprachen für Geschäftsprozesse, die in der Lehre behandelt werden sollen. Zudem konnte Prof. Dr. Martin Glinz von der Universität Zürich für einen Keynote-Vortrag auf dem Workshop gewonnen werden.

Wir danken Prof. Dr. Martin Glinz für die Bereitschaft, den Keynote-Vortrag zu übernehmen, sowie allen Einreichern für die sorgfältige Aufbereitung ihrer Arbeitsergebnisse. Ebenso danken wir den Mitgliedern des Programmkomitees für die Mitwirkung bei der Begutachtung und Auswahl der Beiträge. Den Organisatoren der Tagung danken wir für die Unterstützung bei der Ausrichtung der Veranstaltung.

Programmkomitee:

Katrin Bergener (Universität Münster)

Stefanie Betz (Karlsruher Institut für Technologie)

Jens Gulden (Universität Duisburg-Essen)

Constantin Houy (Universität des Saarlandes, DFKI)

Stefan Klink (DHBW Karlsruhe)

Birger Lantow (Universität Rostock)

Henrik Leopold (VU University Amsterdam)

Nicolas Pflanzl (Universität Münster)

Tom Thaler (Universität des Saarlandes, DFKI)

Modeling in der Hochschullehre: Lernziele, Lerninhalte

Hans-Peter Knittel[1]

Abstract: Ziel des Artikels ist es, den Gebrauch von Präsentationssoftware wie PowerPoint einzuschränken. Hierzu sieht der Verfasser das Modeling als geeignetes Mittel an. Dass es hierzu nicht genutzt wird, lastet der Verfasser der Hochschullehre als Versäumnis an. Dies wird mit 4 Thesen begründet. Die Quellen für diesen Artikel bilden die Erfahrung des Verfassers aus 20 Jahren IT-Consulting im Bereich Anwendungsentwicklung und der Einführung von Standard Software sowie Veröffentlichungen zum Thema Modeling und Hochschullehre. Die zur Zielerreichung notwendigen Lernziele und Lerninhalte werden abschließend als Inhalt einer Vorlesung und einer Workshop-Reihe im Detail benannt. Der Autor meint, dass der Einsatz von Modellen bei der Vorbereitung und Durchführung von Meetings zum Gewinn von Erkenntnis und Orientierung nützlicher ist, als der Einsatz von Slides.

Keywords: Modellierung, Hochschullehre, Bologna-Projekt, Kompetenzorientierung, Design-Structure-Matrix, Domain-Mapping-Matrix.

1 Thesen

These 1 unterstreicht die universelle Zuständigkeit der Modellierung. These 2 formuliert aktuelle Schwachstellen in der Hochschullehre im Bereich Modellierung. These 3 stellt die Kernforderung da und quantifiziert die Zielvorstellung. These 4 zeigt einen Ansatz auf, der eine Beseitigung der aktuellen Schwachstellen ermöglichen wird.

These 1. „Unsere Erkenntnisse und unsere Orientierung in dieser Welt sind letztlich das fortlaufende Bilden und Interpretieren von Modellen." [Gl08], S. 425.

These 2. Indem die Hochschullehre die Informatik in den Mittelpunkt der Modellierung stellt, wird sie dem universellen Anspruch aus These 1 nicht gerecht. Außerdem findet hierdurch Modellierung nur statt, wenn Interessen der IT Rechnung getragen werden muss und geschieht meist unter Führung von externen Beratern.

These 3. Ziel der Hochschullehre im Bereich Modellierung sollte es sein, die Voraussetzungen dafür zu schaffen, dass in mindestens 50% aller Fälle, in denen in Sitzungen die Diskussionen aufgrund von Slides geführt werden, die Slides durch Modelle ersetzt werden.

These 4. Der Trend hin zu einer „kompetenzorientierten Hochschullehre", wie ihn Bachmann beschreibt, angewandt auf den Bereich der Modellierung, bietet gute Ansätze, um These 3 zu erfüllen. [Ba13].

[1] IBIV GmbH, Geschäftsführer, Rüestelstich 4, CH-5073 Gipf-Oberfrick, pknittel@ibiv.ch

2 Definitionen

Modell: Ein Modell besteht aus mindestens zwei Elementen und einer Beziehung zwischen ihnen. Die Beziehung kann auch als Element aufgefasst werden [Gr04] S.101.

Aktive-, Passive-Modellierung: Bei der Aktiven-Modellierung werden Elemente und Beziehungen eines Modells explizit beschrieben. Bei der Passiven-Modellierung wird das Modell als solches nicht erkannt und nicht beschrieben.

Design-Structure-Matrix (DSM), Domain-Mapping-Matrix (DMM): „Während sich mit einer DSM Abhängigkeiten zwischen Elementen einer Domäne darstellen lassen, können mit einer DMM Beziehungen zwischen Elementen einer Domäne und Elementen einer anderen Domäne abgebildet werden .... .“ [Gü12] S. 101.

Kompetenz im Bereich Modellierung: Zur Kompetenz im Bereich Modellierung gehören als harte Faktoren, die Beherrschung eines Ablaufdiagramms, die DSM, die DDM und das Entity-Relationship-Modell sowie der sichere Umgang mit den Begriffen „Domain“, „Meta“ und „Instanziierung“. Als weiche Faktoren, Selbstvertrauen, „ich kann das“, und die Erkenntnisfähigkeit, „das lässt sich auch als Modellierung auffassen“.

3 Erläuterungen zu den Thesen

Mit seiner kritischen Einstellung dem Gebrauch von PowerPoint gegenüber steht der Autor nicht allein da. Konzerne wie Volkswagen, Amazon oder Apple haben sich hier ebenfalls kritisch zu Wort gemeldet, [We15]. Neu ist hingegen der Lösungsansatz über einen erweiterten Einsatz der Modellierung und eine hierauf ausgerichtete Hochschullehre, der aus These 1 abgeleitet wird. These 1 ist ein Zitat aus dem Artikel „Modellierung in der Lehre an Hochschulen: Thesen und Erfahrungen“ [Gl08]. Der gemachten Aussage kann voll zugestimmt werden, insbesondere, wenn man die Definition von Modell sehr weit fasst und die Passive-Modellierung mit Bezug auf die DMM miteinbezieht, so dass z.B. jede Abarbeitung einer Checkliste oder das Erstellen von Slides zur Modellierung wird. Die weiteren Ausführungen von Glinz, insbesondere seine Thesen 3,5,10 und 12 rechtfertigen es, in These 2 die Informatik als Mittelpunkt der Modellierung in der Hochschullehre zu bezeichnen. Mit Forschungsfrage 5 muss die Frage beantwortet werden, wem sich Fragen einer komplexen Modellierung überhaupt je stellen werden. These 3 formuliert das Ziel des Artikels. These 4 meint, dass durch eine Verminderung der Wissensvermittlung eine wichtige Hemmschwelle zur Anwendung der Modellierung, „wenn man ein Modell erstellt dann muss es mindestens diesen und jenen Anforderungen genügen“, in der Praxis, beseitigt wird.

4 Lernziele und Lerninhalte

Als Ausgangslage für eine weiterführende Diskussion sollen Lernziele und Lerninhalte

im Detail benannt werden. Der Grundkurs soll den Studierenden Kompetenz im Bereich Modellierung vermitteln und ihn ermuntern sich Erkenntnis und Orientierung in seinem Bereich durch Modellierung zu verschaffen, insbesondere auch wenn kein IT-Bezug besteht.

4.1 Allgemeiner Grundkurs Modeling

Durch minimale Wissensvermittlung aber in Kombination mit einem Praktikum im soll der Studierende Kompetenz entwickeln. Der Kurs sollte nach Bachmann, [Ba13], aufgebaut werden und somit auch Implikationen aus dem Bologna-Projekt berücksichtigen. Im Praktikum soll der Studierende ein Referenzmodell für seine künftige Stelle erstellen und sich an einem „Diskussionsmodell" im Sinne der Forschungsfrage 1 oder einem Mensch-Außenwelt-System, [St73], versuchen. In jedem Fall soll er persönlich angesprochen und betroffen sein. Die Modellierung mit Matrix-Methoden bildet einen Schwerpunkt.

Lektion 1. *Ziel: Sensibilisierung für alles, was als Modell betrachtet werden kann. Stärkung des Selbstvertrauens, „ich kann das", „alles ist easy".* Lerninhalt: Beispiele aus dem täglichen Leben, einfache Ablaufdiagramme.

Lektion 2. *Ziel: Vorstellung zielgerichteter einfacher Modelle.* Lerninhalt: Die DSM.

Lektion 3. *Ziel: Weiterführung von Lektion 2.* Lerninhalt: Die DMM.

Lektion 4. *Ziel: Datenmodellierung.* Lerninhalt: Das Entity-Relationship-Model.

Lektion 5. *Ziel: Einführung in die Mächtigkeit des Modellierens.* Lerninhalt: Meta-Modellierung, das E^3-Modell von Greiffenberg [Gr04].

Lektion 6. *Ziel: Behandlung der Modellierung in der wissenschaftlichen Forschung.* Lerninhalt: Was bedeutet „the state oft the art" für die Referenzmodellierung. [Th06].

Lektion 7. *Ziel: Interesse an der wissenschaftlichen Arbeit im Bereich Modellierung wecken.* Lerninhalt: Instanziierung der Grundsätze wissenschaftlichen Arbeitens für den Bereich Modellierung.

Lektion 8. *Ziel: Beurteilung und Auswertung von Modellen*. Lerninhalt: Simulation.

Lektion 9. *Ziel: Überblick über die Modellierung und von ihr erstellte Modelle.* Lerninhalt: Vorschau auf die Workshops.

Lektion 10. *Ziel: Zusammenfassung.* Lerninhalt: Wiederholung der Lektionen.

4.2 Spezifische Workshops

Es werden sieben Workshops vorgestellt, die mit dem Umfang ihrer Wissensvermittlung auch Spezialisten gerecht werden sollen.

Workshop 1. *Ziel: Kultivierung der Modellierung.* Lerninhalt: Definitionen des Begriffs Modell, Forderungen nach Schütte, [Sc98], Forderungen nach Hevner, [He04].

Workshop 2. *Ziel: Geschäftsprozessmodellierung.* Lerninhalt: Die Ereignisgesteuerte Prozesskette. [HKS93].

Workshop 3. *Ziel: Method Engineering.* Lerninhalt: Method Engineering nach Sarshar, K. [Sa08]; Seel, Ch. [Se10] und anderen; Sprachen zur Darstellung von Modellen.

Workshop 4. *Ziel: Graphen basierte Modelle.* Lerninhalt: Petri Netze.

Workshop 5. *Ziel: Modelle zur digitalen Transformation.* Lerninhalt: Business Engineering nach Oesterle. [Oe03]

Workshop 6. *Ziel: Unternehmensmodelle.* Lerninhalt: Bereichsübergreifende Modelle.

Workshop 7. *Ziel: Management Modelle.* Lerninhalt: Modell St. Gallen. [Rü03].

5 Weiterer Forschungsbedarf

Explorative Forschung: Die vorgeschlagene Vorlesung sollte durchgeführt und hinsichtlich Akzeptanz und Nutzen ausgewertet werden. Weiter ist zu klären:

Forschungsfrage 1: Wie sieht ein „Diskussions-Modell“ aus, das für die Problembehandlung in Meetings die gleiche Rolle einnimmt, wie das Entity-Relationship-Model bei der Diskussion über Datenerfordernisse?

Forschungsfrage 2: Wie sieht im Bereich der Modellierung ein Rapid-Modeling aus, das für die Modellierung die gleichen Aufgaben wahrnimmt, wie das Rapid-Prototypen im industriellen Modellbau und die Komplexität im Bereich der Modellierung reduziert?

Forschungsfrage 3: Wann kann ein Modell im Sinne des E^3-Modells durch Spreadsheet-Felder repräsentiert werden?

Forschungsfrage 4: Welche Funktionalitäten und Darstellungsmöglichkeiten sollte ein Spreadsheet haben, um eine DMM optimal abbilden zu können?

Forschungsfrage 5: Wer tritt neben Hochschulangehörigen und Consultants, bei der Modellierung noch als Leader auf und in welchem Verhältnis steht ihre Zahl in Bezug zu allen Studierenden im Bereich Betriebswirtschaft und Informatik?

Literatur

[Ba13] Bachmann, H. Hochschullehre neu definiert – shift from teaching to learning in (Bachmann H. Hrsg.) Forum Hochschuldidaktik und Erwachsenen Bildung Band 1: Kompetenzorientierte Hochschullehre, hep, Bern, 2014 S. 12-30.

[Gl08] Glinz, M. Modellierung in der Hochschullehre: Thesen und Erfahrungen, Informatik_Spektrum_31_5_2008. Springer, 2008.

[Gr04] Greiffenberg, St. Methodenentwicklung in Wirtschaft und Verwaltung. Dr. Kovac, Hamburg, 2004, S.112-131.

[Gü12] Gürtler, M. et.al. Von Anforderungslisten zum konzeptionellen Design – Funktionsbasierte Analyse von Anforderungen an Product-Service Systems, In (Thomas O.; Nüttgens M. Hrsg.) Dienstleistungsmodellierung 2012, Springer Fachmedien, Wiesbaden 2013.

[He04] Hevner, A.R. et.al. Design Science in Information Systems Research. MSI Quarterly 28(1), 2004.

[HKS93] Hoffmann, W.; Kirsch, J.; Scheer, A.-W. Modellierung mit ereignisgesteuerten Prozessketten (Methodenbuch, Stand Dezember 1992). Institut für Wirtschaftsinformatik der Universität des Saarlandes: IWi-Heft 101. 1993

[Oe03] Oesterle, H. Geschäftsmodell des Informationszeitalters. In (Oesterle H.; Winter R. Hrsg.) Business Engineering Auf dem Weg zum Unternehmen des Informationszeitalters. Springer, Berlin, Heidelberg, 2003.

[Rü03] Rüegg-Stürm, J. Das neue St. Galler Management-Modell. Grundkategorien einer integrierten Managementlehre. Der HSG-Ansatz. Haupt, Berne. 2003

[Sa08] Sarshar, K. Domänenspezifische Methodenkonstruktion Konzeption einer Metamethode zur Konstruktion von Methoden der Prozessmodellierung. Logos, Berlin, 2008.

[Sc98] Schütte, R. Grundsätze ordnungsmäßiger Referenzmodellierung. Gabler Verlag, Wiesbaden, 1998.

[Se10] Seel, Ch. Reverse Method Engineering Methode und Softwareunterstützung zur Konstruktion und Adaption semiformaler Informationsmodellierungstechniken. Logos, Berlin, 2010.

[St73] Stachowiak, H. Allgemeine Modelltheorie. Springer, Wien. 1973, S.69-114.

[Th06] Thomas, O. Management von Referenzmodellen Entwurf und Realisierung eines Informationssystems zur Entwicklung und Anwendung von Referenzmodellen. Logos, Berlin, 2006, S.96-169.

[We15] VW startet Großoffensive gegen PowerPoint-Exzesse. DIE WELT 25.03.2015. http://www.welt.de/wirtschaft/article138772040/VW-startet-Grossoffensive-gegen-Powerpoint-Exzesse.html (letzter Zugriff: 1.2.2016).

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 53

Integrated Enterprise Modeling Lectures for Master Classes

Richard Braun[1], Hannes Wendler[1], Martin Benedict[1], Martin Burwitz[1], Kai Gand[1], Peggy Richter[2], Richard Rößler[1], Hannes Schlieter[1], Jeannette Stark[1] and Werner Esswein[1]

Abstract: This paper presents the structure and contents of an integrated curriculum on teaching enterprise modeling for master students at a large German university. The module is composed of two main master classes (Business Engineering and Enterprise Modeling) and supplemented by an additional seminar and the final master thesis. The major classes respectively consist of twelve lectures and a large practical exercise part, in which the students have to solve given modeling tasks from two realistic case studies. The curriculum is organized and arranged according to an enterprise architecture framework in order to provide an integrated view on enterprise modeling and respective learning contents. It covers business-related and IT-related perspectives and their consequences for applicable modeling languages.

Keywords: Business Engineering, Enterprise Modeling, Modeling Lectures, Master Studies

1 Introduction and Context

Enterprises are multifarious, heterogeneous socio-technical information systems, whose components are interrelated within a complex system of interdependencies on various abstraction levels [Ve03]. The research discipline of Enterprise Modeling (EM) aims to conceptualize, abstract and represent parts and aspects of enterprises by creating conceptual models in order to foster communication between involved stakeholders and enable an integration of static, procedural and functional dimensions [La09, Fr13, Fr14a]. In the light of the growing number of interdependencies and dynamics between information systems, EM serves as capable and auspicious approach for managing present-day business complexity. EM is especially relevant for the crucial integration between different stakeholder groups (e.g. business and IT experts), EM fosters inter-organizational communication and it provides specific means for operative support on different levels of automation (e.g. [Ma13, BF14]). It is therefore imperative to provide appropriate educational programs and trainings in master classes at university level.

This paper therefore encourages the issue of educating EM by presenting the structure and contents of two integrated master classes from the curriculum of a large German university. The classes are respectively designed according to the consideration of different groups of students, i.e. business students, students of Information Systems (IS) and industrial engineers.

[1] TU Dresden, Chair of Wirtschaftsinformatik, esp. Systems Development, 01062 Dresden, Germany, forename.surname@tu-dresden.de
[2] TU Dresden, Chair of Wirtschaftsinformatik, esp. Systems Development, 01062 Dresden, Germany, peggy.richter2@tu-dresden.de

The remainder of this paper is organized as follows. Section 2 presents the structure of the master courses, outlines the general architecture and its underlying didactic motivation. Section 3 introduces the first master class *Business Engineering* aiming to motivate and elaborate the general idea of conceptual modeling and its various applications. Section 4 then presents the structure of the subsequent master class *Enterprise Modeling*, which focusses particular modeling methods. Section 5 finally discusses several aspects from current classes and outlines further improvement cycles.

2 Architecture of the Master Modules

2.1 Conceptual Scope

As stated in Section 1, the learning contents of the entire master classes are structured in accordance to the *Dresden Architecture Framework (DAF)* [EW08, AE07] in order to provide an integrated orientation framework for aligning different topics and hence facilitating the student's understanding of rather abstract issues. DAF was explicitly designed for model-based enterprise management, which proclaims the consequent and methodically guided usage of models for solving different types of business-related problems [EW08, p. 14]. DAF intends to emphasize the strengths of existing enterprise frameworks [AE07, p. 7] and aims to structure and consistently integrate different model types within a central model repository [EW08, p. 14]. Thereby, DAF provides a framework for considering and aligning modeling approaches from the business domain, the IS domain as well as from the IT domain.

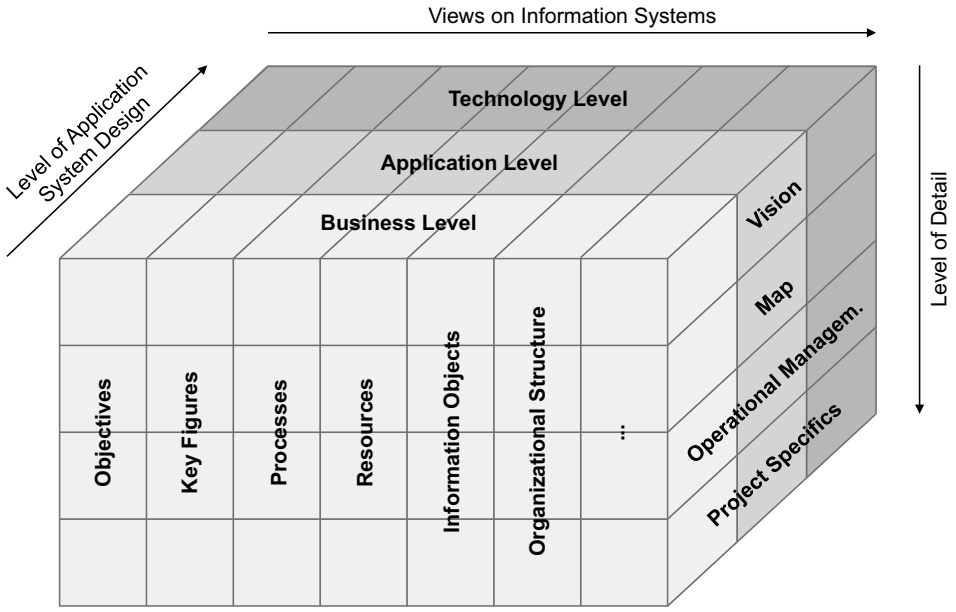


Figure 1: The *Dresden Architecture Framework (DAF)* serves as framework for the class contents.

Fig. 1 presents the DAF architecture, which is composed of three dimensions: *Views on Information Systems*, *Level of Detail* and the *Level of Application System Design* [AE07, p. 20]. The first dimension provides classical enterprise framework views like the process view or the resources view on the one hand. On the other hand, it provides further views for the definition of objectives and key figures, which are required for governance and management [AE07, EW08]. The second dimension aims to provide different levels of granularity and the third dimension should support the integrated derivation of appropriate application systems in order to support the software and hardware environment of an enterprise [AE07, p. 21].

The *Business Level* serves as starting point for several topics by addressing stakeholder-specific and rather business-oriented issues (e.g. by using the *Balanced Scorecard* approach) and by proposing respective modeling approaches (e.g. BPMN). We thereby intend to make the research field of EM explicitly available and accessible for different stakeholders (e.g. students of business administration or engineering economics). These issues are subject of the class *Business Engineering*, while the subsequent *Enterprise Modeling* class focusses specific modeling languages as well as layer-across topics like model-driven engineering (cf. Section 4).

Consequently, two main learning objectives are pursued. Firstly, it is intended to facilitate an integrated and holistic understanding of enterprises as complex socio-technical systems, which have multiple facets, abstraction layers and perspectives. Secondly, we propose the constant application of model-based approaches in order to structure and analyze enterprises and support respective transformation processes.

2.2 Organizational Structure

The organizational structure of the curriculum in master studies is depicted in Fig. 2. The *Business Engineering* class takes place in the winter semester and serves as business-driven motivation for the entire topic of EM and model-based management in order to elaborate the benefits of conceptual models for IS management. The class is scored by a written exam and the assessment of case study solutions (cf. Section 3.2).

Subsequently, the *Enterprise Modeling* class in the summer semester intensifies several topics, especially in regard of method engineering, meta modeling and selected Enterprise Modeling Languages (EMLs). This embodies a focus shift from the overall business view to the rather detailed and fine-grained level of conceptual modeling, method engineering and meta modeling. Consequently, those aspects cause the consideration of numerous model-driven techniques like multi-level modeling, reference modeling and model-driven architectures. Further, students are encouraged to learn and train several EMLs in detail (e.g. BPMN). The class is also scored by a written exam and the assessment of case study solutions (cf. Section 4.2).

Further, the seminar *Current Topics of Enterprise Engineering* is provided in parallel with the stated main courses. The seminar requires a detailed consideration of current topics within the EM domain by analyzing and discussing those topics based on a limited set

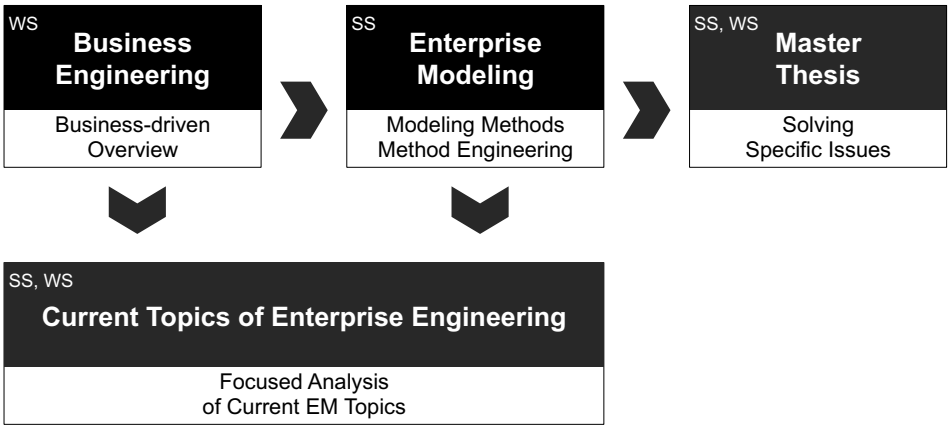


Figure 2: Curriculum of the classes (SS = summer semester, WS = winter semester).

of reputable journal papers. This should encourage master students to become acquainted with current EM research, critically reflect the work and assess alternative approaches. This serves as convenient preparation phase of the final master thesis and can also facilitate respective topic selection. Current topics in this class are, for instance, the Unified Enterprise Modeling Language (UEML) [An10, Op11], Natural Modeling [Za14], multi-level modeling approaches [Fr14b, AGF15] or research on ontological analysis [SAG13].

Finally, the *Master Thesis* is intended to work on specific EM problems from the area of the previously introduced topics.

The stated courses and contents contribute to the development of professional expertise of the students. Expertise is developed by the transmission of knowledge and the training of skills [AK11]. Corresponding to the master level, the lectures contribute to the attainment of a comprehensive, detailed knowledge concerning the mentioned learning objectives. The case studies contribute to the development of specialized technical and conceptual skills to solve business-related problems.

3 Business Engineering

3.1 Contents

The class *Business Engineering* aims to introduce into the field of modeling and EM by motiving several business-related scenarios and issues in order to emphasize the appropriateness of conceptual models for solving both business problems and IT-related issues. As stated in Section 2, the idea behind is an integrated model-based management approach that is consistently taught and flanked by essential topics like semiotics, general model theory and systems theory. Further, basics on method engineering, meta modeling and language engineering are addressed in order to theoretically support the understanding of introduced modeling languages in the case study.

After the stated introduction into several fundamental topics, the class covers several aspects of EM in accordance to the DAF: Firstly, the topic of goal modeling is addressed in order to stress the pragmatic means end relation behind model-driven management. Afterwards, the large field of process modeling is discussed and particular workflow patterns are introduced, for instance. Thirdly, the organizational structure of enterprises and respective techniques for its modeling are taught. Fourthly, different types of resources are discussed and finally the issue of modeling data and information objects is elaborated. At the beginning of each lecture, the current topic is located within the mentioned DAF in order to support an integrated understanding of EM and its interdependencies.

Each of the stated themes is further illustrated by several modeling techniques according to different modeling purposes. The level of detail is thereby limited to a certain pragmatic degree and the entire vocabulary of some modeling languages (e.g. BPMN) is introduced and applied in an extensive manner within the *Enterprise Modeling* class.

3.2 Case Study

The case study intends the application of the lecture's content in a simplified real world scenario. Therefore, the case study is built around a fictitious young company, which is faced by multiple challenges. The described company is a manufacturer of shoulder bags and is called *Saturday Inc*. The company started few years ago as a small start up and grew fast without having a reasonable strategy on how to respond to this growth. Main problems of the company are the undirected growth, not adaptable organizational structures and a small proportion of high margin direct sales due to a non-functional online shop and a missing IT strategy.

The case study is structured into five parts which correspond to the structure of the lecture: Business objectives, processes, organizational structure, resources and information objects. The overall task for the students is to put themselves into the position of an internal consultant of the company in order to asses its current situation and plan the required transformation of the company. This is realized by different tasks for each part of the case study. All of these tasks are solved in groups of five students and final results have to be documented in short papers (3-5 pages). For each task, one group is selected for presenting their results and encouraging a discussion of alternative solutions.

The *first part* of the case study provides an overview of the company's history and its current situation. The task for the students in this part is to identify problems and responsible complexity drivers, discuss appropriate strategies and explicate company goals in a Balanced Scorecard. The *second part* describes a selection of procurement and production processes, which have to be modeled with Petri Nets and EPCs. Additionally, a given BPMN process model has to be examined concerning its shortcomings and redesigned by reasonable improvements.

In the *third part* the students receive a brief history of the development of the organizational structure and a summary of problems it is causing. The students have to assess the situation in an organizational chart, elaborate respective strategies and improve the struc-

ture. Concerning the resources in the *fourth part* of the case study the students have to identify used resources in a given process, classify them and discuss required language extensions to integrate them within BPMN. The *fifth part* of the case study deals with the data and information objects. Therefore, the students have to analyze a given research article within the topic of data modeling. They have to present this excerpt and discuss interlinks with the lecture at all. Furthermore, the students have to build an Entity Relationship Diagram following the partial description of Saturday's data-related structures.

4 Enterprise Modeling

4.1 Contents

While the *Business Engineering* class primarily considers EM from a user perspective and discusses several fundamental themes, the *Enterprise Modeling* class has a rather technical focus and aims to intensify working on and working with enterprise models. The class therefore especially considers several issues in the context of meta modeling and language engineering. At the beginning, different principles and paradigms of meta modeling are presented in detail. This includes the introduction and comparison of existing meta modeling languages like MOF [OM14], MEMO MML [Fr11] and E3 [Gr04] as well as respective meta modeling tools like *MetaEdit+*[2], *ADOxx*[3], the *Eclipse Modeling Framework*[4] or *Cubetto*[5].

Within the *Enterprise Modeling* class single aspects are considered in detail. For instance, the role of cognition in the context of the concrete syntax and respective implementation capabilities in meta modeling languages [Mo09, SE12]. Also the topic of language extensibility and adaptability is addressed separately due to the increasing need for flexible modeling languages [BE14]. Besides syntactical topics, also the role of material and formal semantics as well their concern with pragmatic modeling purposes is taught and discussed (e.g. [BPS14, PG05]). This includes the consideration of the ontological analysis approach [RGI04] and the role of enterprise ontologies [An10].

The class further addresses the features and characteristics of Domain-Specific Modeling Languages (DSMLs), General Purpose Modeling Languages (GPMLs) and possible hybrid types. For instance, MEMO is discussed as framework for DSMLs [Fr11], UML for GPMLs and BPMN as hybrid form for the purpose of process modeling. This part aims to sharpen the understanding for different language types and their application consequences. The last part of the class is then used for covering several special issues like multi-level modeling [AGF15, Fr14b], reference modeling [BD07] or model-driven engineering [AK03]. Hence, the final derivation of IT-related models and artifacts is addressed.

[2] http://www.metacase.com
[3] https://www.adoxx.org
[4] https://eclipse.org/modeling/emf
[5] http://cubetto.semture.de/de

4.2 Case Study

Similar to the *Business Engineering* class, students have to accomplish multiple tasks in regard of a realistic case study that describes the structure and features of a large pharmaceutical company. Students are expected to elaborate multiple issues and modeling tasks in the context of this company by applying BPMN, UML and ARIS. The stated modeling languages should thereby be investigated in detail, which means that the entire vocabulary of a language has to be examined in regard of an appropriate modeling application. This explicitly covers the consideration of rather unknown modeling concepts or diagram types in order to encourage students to become familiar with the entire modeling language instead of just get to know the most common elements.

This should strengthen the modeling expertise on the one hand and should also provoke a critical reflection of existing approaches and alternative modeling approaches on the other hand. Therefore, students have to assess and discuss the modeling results of other students in order to sensitize the awareness of finding the most appropriate modeling solution. Despite pure modeling within the case study, students also have to extend modeling languages like BPMN in order to adapt them for particular purposes. This should foster the understanding and application of fundamental meta modeling capabilities.

5 Conclusion and Outlook

This paper presents the structure and contents of two major master classes for teaching EM at a large German university. The curriculum is organized by conducting an enterprise architecture framework for an integrated and consistent view on the entire topic of EM, its facets, perspectives, aspects and theoretical fundamentals. Each of the classes is supplemented by a mandatory case study practice aiming to apply several modeling languages indeed and in detail. Those exercises should also foster the critical reflection of used languages and their adaptation in view of respectively differing modeling purposes.

Feedback from industry is largely missing so far, since the entire course structure was revised and introduced in the last year. However, several students reported that especially their process modeling skills were appreciated in businesses during internships, for instance. The feedback from master students themselves is overwhelmingly positive, especially regarding to the complex case studies, as they provide an opportunity to apply and understand the *"rather abstract topics from the lectures"*. However, some students criticized the weighting of lecture contents and case study exercises in the final mark, as solving particular case study tasks was perceived as very time-intensive.

It remains generally challenging to strike a good balance between the sophisticated study of theoretical foundations (e.g. model theory and language engineering) and industry-oriented practical application (e.g. process modeling with BPMN). Both directions are subject of ongoing revision. For instance, it is planned to extend the class contents in regard of modeling semantics and pragmatics in order to tackle the still perceivable gap between industrial requirements and modeling capabilities [BPS14, DKM15]. It is also planned

to revise and extend the already existing case studies in order to provide more modeling opportunities and perhaps even apply novel modeling techniques like multi-level modeling [Fr14b, AGF15]. Finally, the repository of relevant modeling approaches is extended incrementally, which corresponds to the long-term objective of publishing a textbook on modeling languages from a business-driven perspective.

References

[AE07] Adam, Silke; Esswein, Werner: Untersuchung von Architektur-Frameworks zur Strukturierung von Unternehmensmodellen. Dresdener Beiträge zur Wirtschaftsinformatik 50. Technische Universität Dresden, 2007.

[AGF15] Atkinson, Colin; Gerbig, Ralph; Fritzsche, Mathias: A multi-level approach to modeling language extension in the Enterprise Systems Domain. Information Systems, 2015.

[AK03] Atkinson, Colin; Kuhne, Thomas: Model-driven development: a metamodeling foundation. IEEE Software, 20(5):36–41, 2003.

[AK11] AK, DQR: Deutscher Qualifikationsrahmen für lebenslanges Lernen. Arbeitskreis Deutscher Qualifikationsrahmen, 2011.

[An10] Anaya, Victor; Berio, Giuseppe; Harzallah, Mounira; Heymans, Patrick; Matulevičius, Raimundas; Opdahl, Andreas L; Panetto, Hervé; Verdecho, Maria Jose: The unified enterprise modelling language – overview and further work. Computers in Industry, 61(2):99–111, 2010.

[BD07] Becker, Jörg; Delfmann, Patrick: Reference Modeling. Springer, 2007.

[BE14] Braun, Richard; Esswein, Werner: Classification of Domain-Specific BPMN Extensions. In: The Practice of Enterprise Modeling. volume 147 of LNBIP, pp. 42–57, 2014.

[BF14] Bork, Domenik; Fill, Hans-Georg: Formal Aspects of Enterprise Modeling Methods: A Comparison Framework. In: Proceedings of the 47th HICSS. pp. 3400–3409, 2014.

[BPS14] Bjekovic, Marija; Proper, Henderik A; Sottet, Jean-Sébastien: Embracing pragmatics. In: Conceptual Modeling. volume 8824 of LNCS, pp. 431–444, 2014.

[DKM15] De Kinderen, Sybren; Ma, Qin: Requirements Engineering for the Design of Conceptual Modeling Languages - A Goal-and Value-oriented Approach. Applied Ontology, 2015.

[EW08] Esswein, Werner; Weller, Jens: Unternehmensarchitekturen – Grundlagen, Verwendung und Frameworks. HMD Praxis der Wirtschaftsinformatik, 45(4):6–18, 2008.

[Fr11] Frank, Ulrich: The MEMO meta modelling language (MML) and language architecture. Technical report, ICB Research Report, 2011.

[Fr13] Frank, Ulrich: Domain-specific modeling languages: requirements analysis and design guidelines. In: Domain Engineering, pp. 133–157. Springer, 2013.

[Fr14a] Frank, Ulrich: Enterprise Modelling: The Next Steps. Enterprise Modelling and Information Systems Architectures, 9(1):22–37, 2014.

[Fr14b] Frank, Ulrich: Multilevel modeling. Business & Information Systems Engineering, 6(6):319–337, 2014.

[Gr04] Greiffenberg, Steffen: Method Engineering in Business and Administration (Methodenentwicklung in Wirtschaft und Verwaltung). Kovač, 2004.

[La09] Lankhorst, Marc: Enterprise Architecture at Work: Modelling, Communication and Analysis. 2009.

[Ma13] Malavolta, Ivano; Lago, Patricia; Muccini, Henry; Pelliccione, Patrizio; Tang, Anthony: What industry needs from architectural languages: A survey. IEEE Transactions on Software Engineering, 39(6):869–891, 2013.

[Mo09] Moody, Daniel L: The "physics" of notations: toward a scientific basis for constructing visual notations in software engineering. IEEE Transactions on Software Engineering, 35(6):756–779, 2009.

[OM14] OMG: Meta Object Facility (MOF) Core Specification, Version 2.4.2. 2014.

[Op11] Opdahl, Andreas L: Anatomy of the unified enterprise modelling ontology. In: Enterprise Interoperability, pp. 163–176. Springer, 2011.

[PG05] Pfeiffer, Daniel; Gehlert, Andreas: A framework for comparing conceptual models. In: Proceedings EMISA. pp. 108–122, 2005.

[RGI04] Rosemann, Michael; Green, Peter; Indulska, Marta: A reference methodology for conducting ontological analyses. In: Conceptual Modeling, pp. 110–121. Springer, 2004.

[SAG13] Santos, Paulo Sérgio; Almeida, João Paulo A; Guizzardi, Giancarlo: An ontology-based analysis and semantics for organizational structure modeling in the ARIS method. Information Systems, 38(5):690–708, 2013.

[SE12] Stark, Jeannette; Esswein, Werner: Rules from cognition for conceptual modelling. In: Conceptual Modeling, pp. 78–87. Springer, 2012.

[Ve03] Vernadat, François B: Enterprise modelling and integration. Springer, 2003.

[Za14] Zarwin, Zoe; Bjekovic, M; Favre, Jean-Marie; Sottet, Jean-Sébastien; Proper, H: Natural modelling. Journal of Object Technology, 13(3):1–36, 2014.

Automated Assessment of Process Modeling Exams: Basic Ideas and Prototypical Implementation

Tom Thaler[1], Constantin Houy[1], Peter Fettke[1], Peter Loos[1]

Abstract: The assessment of process modeling exams is a time consuming and complex task. It is desirable to give each student a detailed feedback on their solution in terms of syntactic, semantic, and pragmatic quality. It is obvious that especially in the case of mass courses with hundreds of participants, individual grading of modeling exams by humans is challenging: Besides reliability, consistency, and validity, the efficiency of the grading process must be guaranteed. Against that background, this paper aims at developing first ideas for an automated assessment of process modeling exams. The goal is to improve modeling education while teaching students not only to model correctly but to develop *good* models. Our ideas were prototypically implemented and applied in an exemplary scenario with promising results. It was possible to identify limitations but also to derive reliable semi-automated approaches for the assessment of process modeling exams.

Keywords: process modeling, model matching, understandability, metrics, e-assessment.

1 Introduction

Conceptual modeling in general and business process modeling in particular are common tools for designing and managing information systems (IS) in organizations. Furthermore, conceptual models are indeed extensively used in organizational practice [Fe09]. Against this background, many degree programs at German universities dealing with IS in a business context, e. g. *Business Informatics*, put considerable emphasis on *conceptual* and *business process modeling*, which becomes obvious looking at the content of common text books in the field, e.g. [Ha15] or [He10]. Moreover, process modeling is quite often part of introductory courses to Business Informatics which can be attended by students from many different business-related disciplines leading to large business process modeling courses with several hundred participants.

The manual assessment of process modeling exams is a time consuming and complex task. At the same time, it contains some sub tasks, like checking for syntactic issues, which are monotonous with many recurring corrections. Automated assessment in general can considerably speed up evaluation procedures resulting in a lower expenditure of time needed for assessment, which has also been acknowledged by several e-Assessment initiatives in different contexts, e.g. for distance learning [Ro08] or for staff recruitment [La09]. Moreover, automated assessment supports a consistent and objective evaluation. It is questionable whether human correctors are able to compete

[1] Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Campus $D3_2$, 66123 Saarbrücken, Germany, firstname.lastname@dfki.de

with algorithmic methods in terms of inter- and intra-rater reliability. However, automated assessment can also bear considerable risks. The high degree of modeling freedom of common process modeling languages such as *event-driven process chains* (EPCs) can lead to inconsistent model assessments as there is no *one and only* correct solution for an assignment. Hence, there seem to be quite interesting opportunities and challenges regarding an automated assessment of process modeling exams. However, so far, no approaches or related experiences in this field are known. Besides the activities in the context of automatic model checking which serves the verification of formal system designs [BK08], relevant *related work* has been provided by [Sa12] in the context of automatically assessing "3D modeling" exams or by [NL11] in the context of assessing multiple choice exams. However, to our best knowledge, there are no publications concerning an automated assessment of business process modeling exams, which is certainly also one important motivation of the MoHoL 2016 workshop.

Against that background, this paper aims at investigating the potential and challenges of an automated assessment of process modeling exams using a design-oriented research approach [He04]. We present some basic ideas as well as a software prototype for an automated assessment of EPCs. In this context, we first explain *which aspects* of EPC models can be automatically checked and *how* they can be checked differentiating (1.) *syntactic*, (2.) *semantic* and (3.) *pragmatic* aspects [Li94]. Our prototype addresses all of these types of aspects to a certain extent and can, moreover, provide feedback concerning each analyzed process model on this basis. Students can, thus, not only learn to design "correct" but also "good" process models which will be easier to understand for human model readers. Especially regarding that point, it might be useful to apply such a tool not only for the assessment of exams but also during the learning process.

This paper is *structured* as follows: after this introduction, we will present some basic ideas for an automated assessment of process modeling exams in section 2 focusing on selected syntactic, semantic and pragmatic aspects which shall be assessed by our software prototype. In section 3, the prototypical implementation will be introduced and explained in more detail before we present an exemplary application of the prototype in section 4. Section 5 provides a short discussion of our findings and concludes this article.

2 Ideas for an Automated Assessment of Process Modeling Exams

2.1 Syntactic Aspects

Syntactic correctness. Since the EPC is a non-standardized modeling notation, it is not possible to consistently assign the degree of syntactic correctness for arbitrary modeling exams. However, regarding relevant literature, e.g. [Ke92, Me08, Ho14a], there are common criteria for correct EPCs, which can be applied:

(1) Functions have exactly one incoming and exactly one outgoing arc.
(2) Events have a maximum of one incoming and a maximum of one outgoing arc.

(3) An EPC contains at least one start event and at least one end event.
(4) Connectors have at least one incoming arc and at least one outgoing arc.
(5) A connector is either a split connector (one incoming arc, at least two outgoing arcs) or a join connector (at least two incoming arcs, one outgoing arc).
(6) Each function and event label occurs exactly once.
(7) Events and functions do alternate (connectors are skipped).

All these rules can easily be checked automatically without having a sample solution at hand. However, it might be necessary to select the individually relevant rules since there are different perceptions of modeling a correct EPC, e.g. depending on the lecturer.

2.2 Semantic Aspects

Completeness of content. In the context of process modeling exercises and exams, we assume the availability of a natural language text description of a business process which has to be modeled by the students. Often, one important challenge is to identify all relevant information and contain them in the process model. Since the given textual descriptions are equal for all participants as well as for the lecturer, a "controlled modelling scenario" is given [Th15]. Thus, it can be assumed that the generated process models use a homogeneous terminology for labeling the nodes. Against that background, a promising approach for checking the completeness of the content is the application of recently developed process model matching techniques as presented in [An15]. It is searched for node correspondences between the student solution and the sample solution. Identified correspondences can then be used to quantify the extent to which a student solution contains the expected nodes in terms of the sample solution.

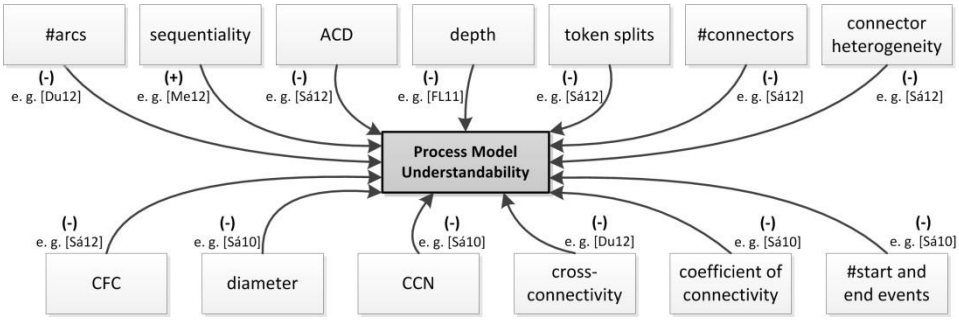
Semantic correctness. The semantic correctness addresses the process behavior defined by the process model. In fact, caused by the high degree of modeling freedom, there are different possibilities to model the same process. At the same time, different solutions may have different state spaces. Thus, indeed, the intended execution traces are covered by the different models but there may also be possible instances which are not intended.

There are different possibilities to measure behavioral correspondence, e.g. by analyzing the state space, the possible execution traces, the behavioral profiles [We09] or the causal footprints [Me07]. Analyzing the state space can be done based on reachability graphs (e.g. [Me08]), which have to be derived from the process model. The reachability graph can then be used to derive the possible execution traces. However, they can also be derived directly, based on the process model itself. The behavioral profile defines three different order relations (strict order relation, exclusiveness relation, interleaving order relation) for each node pair in a process model. In contrast to that, a causal footprint of a process model holds information on the pre-set and the post-set of nodes for all functions in a process model. All mentioned approaches can be used to compare the possible behavior of a process model to the one expected in terms of a sample solution in order to quantify its semantic correctness.

2.3 Pragmatic Aspects

Indicators for attempts to deceive. One important characteristic of an attempt to deceive in exams or exercises is a high similarity between generated solutions. An easy way to detect potential attempts to deceive is to check the similarity between the student solutions using existing process model similarity measures. Hence, since it is assumed that in case of an attempt to deceive a solution is largely copied, a node mapping based on (nearly) identical labels seems to be meaningful. Based on that assumption, a graph edit distance or the percentage of common nodes and edges might be used to determine the similarity between two student solutions.

Process model understandability. As another relevant pragmatic aspect, we aim at an automated assessment of model features related to pragmatic model quality, especially the understandability of a process model. *Process model understandability* (PMU) is related to the *ease of use* and *effort for reading and correctly interpreting a model*, which is a cognitive process of assigning meaning to the parts of a model [Pa08]. In the last years, there has been a whole host of research trying to identify underlying principles, characteristics or factors influencing the understandability to improve process modeling success. Relevant factors can be related to the model itself, the model reader (personal characteristics) or the modeling language used [Ho14b]. In this research, we concentrate on factors related to model complexity which can be automatically assessed. The relationships between computable and well-known complexity metrics and PMU in figure 1 have proven to be reliable in several empirical studies (**(+)** for a positive influence, **(-)** for a negative influence, e.g. "a higher number of arcs has a negative influence on PMU" and "a higher sequentiality has a positive influence on PMU"):



Legend: ***#arcs / S_A***="number of arcs"; ***sequentiality / Ξ***="degree to which the model is constructed of task sequences"; ***ACD / $\overline{d_C}$***="average connector degree describing the average number of input and output arcs of the connectors"; ***depth / A***="amount and deepness of nested control structures"; ***token split / TS***="number of different states after a split connector"; ***#connectors / S_C***="number of connectors"; ***connector heterogeneity / CH***="diversity of connector types"; ***CFC / control flow complexity***="Cardoso's control flow complexity metric"; ***diameter / diam***="length of the longest path in a process model"; ***CCN*** ="number of nodes connected to a connector"; ***cross-connectivity / CC***="extent to which all the nodes in a model are connected to each other"; ***coefficient of connectivity / CNC***="ratio between the total number of arcs and the total number of nodes"; ***#start and end events / $S_{E_{S+E}}$***="sum of the number of start and end events"

Figure 1: Some complexity metrics and process model understandability

3 Prototypical Implementation

We implemented the above described basic ideas as an integrated model assessment functionality in the RefMod-Miner-as-a-Service (http://rmm.dfki.de) – a research prototype for process model analysis and reference model mining which is continuously developed at the Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University. The source is open and publicly available at http://bit.do/RMMaaS. The realization is described in Table 1.

Table 1: Implementation of the syntactic, semantic and pragmatic aspects

Syntactic	**Syntactic correctness.** The seven mentioned correctness criteria can be checked automatically. Against the background of the different perceptions of modeling a correct EPC, it can be selected whether a particular criterion is relevant for the assessment or not. Furthermore, additional criteria can be selected to generate warnings, which are presented in natural language text within in the assessment results. However, the warnings have no influence on the model rating.
Semantic	**Completeness of content.** The RefMod-Mine/NHCM algorithm, the overall best performing matching approach of the *Process Model Matching Contest 2015*, is used to compute mappings between the functions of the student solutions and a given sample solution. Based on that, the completeness of content is defined as the recall of activities of the student solution with regard to the sample solution [Th14]. **Semantic correctness.** The semantic correctness is operationalized based on the alignment of the possible execution traces [Me08] of the student solutions to the possible execution traces of a sample solution. The true and false positive traces as well as the false negative traces are identified in order to calculate the corresponding precision, recall and f-measure values [Th14]. Traces with matching subsequences are weighted by the fraction of the length of the longest common subsequence. The f-measure value states the semantic correctness.
Pragmatic	**Attempts to deceive.** In order to automatically identify attempts to deceive, we applied the percentage of common nodes and edges [Mi07] as a similarity measure. In that context, two nodes are considered as equal if they have the same label. The similarity measure is applied to all student solution pairs. A potential attempt to deceive is assumed when a predefined similarity threshold of 0.9 is passed. **Process model understandability.** All presented metrics were implemented in order to be able to give students a detailed feedback on the understandability of their generated solution. The metrics are compared to those of a sample solution and consequences for the process model understandability are derived.

Overall assessment and parameters. Relevant aspects (syntactic correctness, completeness of content, semantic correctness) can be individually weighted for a particular assessment case. Further additional parameters are the max. points and the max. amount of syntax errors which, if reached, sets the points for syntactic correctness to 0. Since the completeness of content and the semantic correctness are values on an interval [0;1], the rating is trivial. Finally, the overall score for a model is the weighted mean of the syntactic and the semantic correctness as well as the completeness of content.

As a result, the tool generates a CSV file containing all partial results as e.g. the number of syntax errors and warnings, the function recall and the semantic precision, recall and f-measure. Moreover, the concrete issues are delivered in the form of natural language texts, e.g. “Function A does not have exactly one incoming edge”. Missing or false positive nodes are explicated by their labels. Furthermore, for each student solution, potential attempts to deceive are indicated. In the context of model understandability, a matrix with all above mentioned metrics for all solutions is generated with an additional “+” for a positive and “-“ for a negative assessment compared to the reference solution.

4 Exemplary Application

In order to get a first impression of the performance of the described ideas, we applied the tool to the MoHoL 2016 dataset (http://butler.aifb.kit.edu/MoHoL/). It contains a textual description of a business process, a corresponding EPC reference solution (*ref. sol.*) and 10 EPC student solutions (S01 - S10). While using our prototype, we adjusted weightings and selected relevant modeling rules. The availability of start and end events, the correct event and function syntax and the precise assignment of connectors as split or join were selected as mandatory syntax rules, other rules were selected to just generate warnings. Syntactic correctness and completeness of content were weighted with 2, semantic correctness with 1. The maximum number of syntax errors was set to 5 and the overall maximum of points to 100. The tool was able to correctly detect all syntax errors respectively warnings. Only 3 of the 10 student solutions offend the selected rules, all of them used incorrect function syntax. With regard to the completeness of content, 7 of the 10 student solutions contained all expected functions. A defect of the implementation can be identified in the case of one of the other three solutions, where functions were not matched because of a different labeling style. The student combined two functions, e.g. "Create rejection + inform customer" in one label, which was not correctly assigned. That misinterpretation leads to lower semantic correctness. However, the other solutions were scored correctly. One of the most important benefits is the automatic feedback on the models' understandability. An abstract of the output is provided in Tab. 2, the complete CSV can be accessed at http://rmm.dfki.de/docs/MoHoL_2016_Assessment.csv.

Table 2: Abstract of the assessment result

syntactic aspects													
			S01	**S02**	**S03**	**S04**	**S05**	**S06**	**S07**	**S08**	**S09**	**S10**	
#syntax errors			0	0	2	0	2	0	0	0	0	2	
#syntax warnings			6	2	0	0	0	0	0	0	0	2	
semantic aspects													
cont. completeness			1	1	1	1	0,8	0,4	1	0,8	1	1	
sem. correctness			1	1	1	1	0,59	0,39	0,33	0,69	1	1	
pragmatic aspects													
attempt at deception			no	no	no	no	no	no	no	no	no	no	
model understandability													
metrics	S_A	Ξ	$\overline{d_C}$	Λ	TS	S_C	CH	CFC	$diam$	CCN	CC	CNC	$S_{E_{S+E}}$
ref. sol.	21	0,238	3,2	2	5	5	1	5	12	16	0,05	1,105	2
S01	25 (-)	0,72 (+)	3,5 (-)	0 (+)	5	2 (+)	1	5	10 (+)	7 (+)	0,083 (-)	0,962 (+)	5 (-)
…													
S08	20 (+)	0,2 (-)	3,2 (+)	2	5	5	2 (-)	4 (+)	12	16	0,088 (-)	1,111 (-)	2
…													
overall scoring			S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	
			100	**100**	**84**	**100**	**67,8**	**63,8**	**86,6**	**85,8**	**100**	**84**	

Legend: ***#arcs / S_A***="number of arcs"; ***sequentiality / Ξ***="degree to which the model is constructed of task sequences"; ***ACD / $\overline{d_C}$***="average connector degree describing the average number of input and output arcs of the connectors"; ***depth / Λ***="amount and deepness of nested control structures"; ***token split / TS***="number of different states after a split connector"; ***#connectors/ S_C***="number of connectors"; ***connector heterogeneity / CH***="diversity of connector types"; ***CFC /control flow complexity***="Cardoso's control flow complexity metric"; ***diameter / diam***="length of the longest path in a process model"; ***CCN*** ="number of nodes connected to a connector"; ***cross-connectivity / CC***="extent to which all the nodes in a model are connected to each other"; ***coefficient of connectivity / CNC***="ratio between the total number of arcs and the total number of nodes"; ***#start and end events / $S_{E_{S+E}}$***="sum of the number of start and end events"

5 Discussion and Conclusion

Applying our prototype showed that an automated assessment can quickly provide useful information on different correctness and quality aspects and, thus, improve the efficiency of model evaluation processes. However, there are also some *limitations* of an automated assessment: first, the widely acknowledged problems of matching corresponding nodes in process models remains. Although a well-performing matching approach was used in the assessment tool and although in modeling exams the terminology is provided by textual process descriptions ("controlled modeling scenario"), it was not possible to identify all alignments in the exemplary scenario. That defect lead to problems in automatically judging the semantic correctness and completeness. At the same time, it should be noted that for 9 of the 10 student solutions the matching produced very proper results. Second, the derivation of all possible traces in the current implementation is quite time consuming. In the future, we will investigate the potential of improving the approach's efficiency also involving causal footprints or behavioral profiles.

In fact, the developed assessment approach was not able to perfectly score all process modeling exams in the application scenario. However, the high potential in some sub tasks could be demonstrated. Thus, we provide a semi-automated assessment approach, which could be used in two variants: (1) all assessment aspects requiring a node mapping are excluded and should be performed manually; (2) node mappings are still automatically generated but have to be verified by a proofreader. However, an automated assessment of process modeling exams always requires the availability of student solutions in a digital and processable format, which is still a big hurdle since process modeling exercises and exams are mostly done by hand and on paper. Thus, adequate techniques for digitizing paper-based process models are required.

6 Literature

[An15] Antunes, G. et al.: The Process Model Matching Contest 2015. In: J. Kolb; H. Leopold; J. Mendling (Eds.): Proc. of the 6th International Workshops on EMISA. pp. 127-155.

[BK08] Baier, C.; Katoen, J.-P.: Principles of Model Checking. Cambridge, Massachusetts 2008.

[Du12] Dumas, M. et al.: Understanding Business Process Models: The Costs and Benefits of Structuredness. In: J. Ralyté et al. (Eds.): Advanced Information Systems Engineering (CAiSE 2012), LNCS 7328. Berlin 2012, pp. 31-46.

[Fe09] Fettke, P.: How Conceptual Modeling Is Used. In: Communications of the Association for Information Systems (CAIS) 25 (2009) 43, pp. 571-592.

[FL11] Figl, K.; Laue, R.: Cognitive Complexity in Business Process Modeling. In: H. Mouratidis; C. Rolland (Eds.): Advanced Information Systems Engineering (CAiSE 2011), LNCS 6741. Berlin 2011, pp. 452-466.

[Ha15] Hansen, H. R.; Mendling, J.; Neumann, G.: Wirtschaftsinformatik. Berlin 2015.

[He10] Heinrich, L. J.; Heinzl, A.; Riedl, R.: Wirtschaftsinformatik – Einführung und Grundlegung. 4. ed., Berlin 2010.

[He04] Hevner, A. R.; March, S. T.; Park, J.; Ram, S.: Design Science in Information Systems Research. In: MIS Quarterly 28 (2004) 1, pp. 75-105.

[Ho14a] Houy, C.; Fettke, P.; Loos, P.: Zur Evolution der Ereignisgesteuerten Prozesskette. Multikonferenz Wirtschaftsinformatik 2014 (MKWI). D. Kundisch; L. Suhl; L. Beckmann: 1020-1033. Paderborn 2014.

[Ho14b] Houy, C.; Fettke, P.; Loos, P.: On the Theoretical Foundations of Research into the Understandability of Business Process Models. 22nd European Conference on Information Systems. M. Avital; J. M. Leimeister: 1-26. Tel Aviv, Israel 2014.

[Ke92] Keller, G.; Nüttgens, M.; Scheer, A.-W.: Semantische Prozeßmodellierung auf der Grundlage "Ereignisgesteuerter Prozeßketten (EPK)". Institut für Wirtschaftsinformatik, Universität Saarbrücken, IWi-Heft 89. Saarbrücken 1992.

[La09] Laumer, S.; Stetten, A.; Eckhardt, A.: E-Assessment. In: Business & Information Systems Engineering 1 (2009) 3, pp. 263-265.

[Li94] Lindland, O. I.; Sindre, G.; Sølvberg, A.: Understanding Quality in Conceptual Modeling. In: IEEE Software 11 (1994) 2, pp. 42-49.

[Me08] Mendling, J.: Metrics for Process Models - Empirical Foundations of Verifiction, Error Prediction, and Guidlines for Correctness. Springer, Berlin 2008.

[Me07] Mendling, J.; van Dongen, B. F.; van der Aalst, W. M. P.: On the Degree of Behavioral Similarity between Business Process Models. Proceedings of the EPK 2007-Workshop. M. Nuettgens; F. J. Rump; A. Gadatsch: 39-58. St. Augustin, Germany 2007.

[Me12] Mendling, J.; Sánchez-González, L.; García, F.; La Rosa, M.: Thresholds for error probability measures of business process models. In: Journal of Systems and Software 85 (2012) 5, pp. 1188-1197.

[Mi07] Minor, M.; Tartakovski, A.; Bergmann, R.: Representation and Structure-Based Similarity Assessment for Agile Workflows. In: R. O. Weber; M. M. Richter (Eds.): Case-Based Reasoning Research and Development, LNCS 4626. Berlin, 2007, pp. 224-238.

[NL11] Nettekoven, M.; Ledermüller, K.: Assess the assessment: An automated tool for analyzing multiple choice exams. 4th International Conference of Education, Research and Innovation (ICERI 2011): 2564-2571. Madrid, Spain 2011.

[Pa08] Patig, S.: A practical guide to testing the understandability of notations. Proc. of the 5th Asia-Pacific Conf. on Conceptual Modelling (APCCM '08). Wollongong, Australia 2008

[Ro08] Rovai, A. P.; Ponton, M. K.; Baker, J. D.: Distance Learning in Higher Education: A Programmatic Approach to Planning, Design, Instruction, Evaluation, and Accreditation. New York 2008.

[Sá10] Sánchez-González, L. et al.: Prediction of Business Process Model Quality Based on Structural Metrics. In: J. Parsons et al. (Eds.): Conceptual Modeling (ER 2010), LNCS 6412. Berlin 2010, pp. 458-463.

[Sá12] Sánchez-González, L.; García, F.; Ruiz, F.; Mendling, J.: Quality indicators for business process models from a gateway complexity perspective. In: Information and Software Technology 54 (2012) 11, pp. 1159-1174.

[Sa12] Sanna, A.; Lamberti, F.; Paravati, G.; Demartini, C.: Automatic Assessment of 3D Modeling Exams. In: IEEE Transactions on Learning Technologies 5 (2012) 1, pp. 2-10.

[Th15] Thaler, T.; Dadashnia, S.; Sonntag, A.; Fettke, P.; Loos, P.: The IWi Process Model Corpus, Publications of the Institute for Information Systems (IWi), IWi-Heft 199. Institut für Wirtschaftsinformatik. Saarbrücken 2015.

[Th14] Thaler, T.; Hake, P.; Fettke, P.; Loos, P.: Evaluating the Evaluation of Process Matching Techniques. Multikonferenz Wirtschaftsinformatik 2014 (MKWI). D. Kundisch; L. Suhl; L. Beckmann: 1600-1612. Paderborn 2014.

[We09] Weidlich, M.; Mendling, J.; Weske, M.: Computation of Behavioural Profiles of Processes Models. Business Process Technology, Hasso Plattner Institute for IT-Systems Engineering. Potsdam 2009.

Experience Report: Social BPM Lab enhanced with participation of professionals

Dominik Augenstein[1], Murat Citak[2], Meike Ullrich[2], Arthur Vetter[1]

Abstract: This article describes the experiences of conducting an enhanced Social BPM Lab. The basic idea of a Social BPM Lab is a case study centered around a fictitious company, where student groups from different locations all over the world are taking part. Thus, computer-supported collaboration and modern communication tools are essential for its success. In addition to earlier conducted Labs, in this Lab not only university students participated, but also professionals, to give students an even more realistic learning atmosphere. So the background of the participants was quite heterogeneous. This paper gives an outline of the enhanced Lab setting, the challenges we faced during the Lab and lessons learned.

Keywords: Social BPM Lab, Business Process Modeling, Horus method, BPM Education

1 Introduction

Business Process Management (BPM) is one of the hot topics of business managers and CIOs [Wa08, WH14]. One important aspect of BPM is the modeling of business processes. With the need of more BPM courses, especially BPM modeling courses, and a more cross-functional, inter-organizational and collaborative setting [Se12] the Social BPM Lab teaching concept was developed and conducted by PROMATIS software GmbH in cooperation with the Institute of Applied Informatics and Formal Description Methods at the Karlsruhe Institute of Technology (KIT) [Ca13].

After conducting a couple of those Social BPM Labs, they were developed further with a wider target group, not just to focus on university students, but also on professionals. The objective of PROMATIS software GmbH was not only to offer the Lab concept to professionals, but also to give university students an even deeper atmosphere of professional life by collaborating with real professionals. For university students practical experience is a very important part of their education, but simultaneously they are quite unsatisfied with the current course offer, because of missing applied learning courses [BMW08].

With this background, an enhanced version of the already established Social BPM Lab

[1] PROMATIS software GmbH, Pforzheimer Straße 160, 76275 Ettlingen,
<first name>.<last name>@promatis.de
[2] Karlsruher Institut für Technologie, AIFB, Kaiserstraße 89, 76133 Karlsruhe,
<first name>.<last name>@kit.edu

was developed and conducted, which in addition to the previous labs, involves also professionals, instead of just students. In this paper that enhanced version of the Social BPM Lab is presented.

2 The Horus method and Horus modelling tool

The Horus method described by Schönthaler et al. is a method for business process engineering and can be seen as a recipe which guides the user through different defined steps of a modelling process [Sc12]. It is not a project procedure model like Scrum, but can be used additionally for the modelling tasks in a project. Also other aspects of a project procedure should be kept in mind like project management, quality assurance and documentation. For the application of the method a comprehending modelling tool is available, which can be downloaded for free from the Horus software GmbH Webpage[3]. That tool was also used during the Lab.

The method makes heavy use of the abstraction and structuring principle and is divided in four phases: *preparation* phase, *strategy and architecture* phase, *business process analysis* phase and *application* phase. Figure 1 gives an overview of the different modelling phases and the tasks conducted in those phases. As the Horus method as well as the Social BPM Lab emphasise the *strategy and architecture phase* and the *business process analysis* phase, these two phases will be described in more detail.

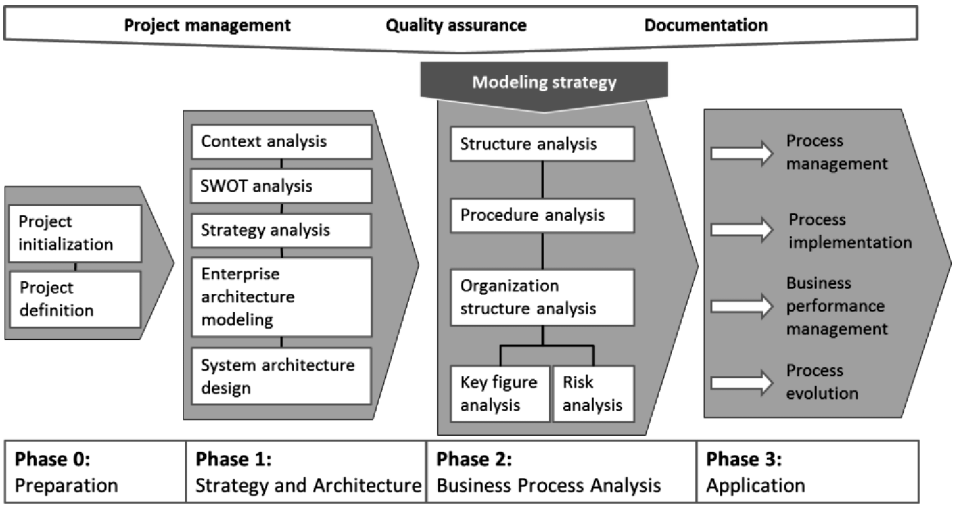


Figure 1: Overview of the Horus method (adapted from [Sc12, p. 62])

Before the actual business process analysis is done, the corporate strategy and

[3] http://www.horus.biz/de/

architecture has to be analysed. The reason is more a practical than a theoretical one, because practical experience shows, that involving decision makers into a modelling project helps to increase the acceptance of the project. In phase 1 a context analysis is conducted to describe the environment, the aims and the supply & services model of the project. The next step is a SWOT analysis to address the strengths, weaknesses, opportunities and threats in the given context of the project. After the SWOT analysis the strategy analysis follows to identify strategies, risks and key figures to measure the corporate goals and strategy implementations. The strategy analysis is followed by modelling the enterprise architecture. The enterprise architecture model represents the decision makers, who will detail the different enterprise processes. The core of the enterprise architecture is the business process architecture, linking business objects, business units and business rules. If the modelling project aims at the development of an information system, phase 1 ends with the system architecture design, which is a high level representation of the system architecture. It will be detailed in phase 2.

Phase 2 begins with a structure analysis. During the structure analysis business objects and business rules, which span the business processes, are defined. Afterwards a procedure analysis is undertaken, resulting in one or more business process models, which are linked to the structural models. During the organization structure analysis the organizational structure and the needed roles are defined. Competencies and responsibilities are established through links to the object and procedure models. Based on the organization and process structure a key figure analysis and risk analysis are conducted. For more information regarding the Horus method see [Sc12].

3 Social BPM Lab enhanced

The enhanced Social BPM Lab is based on the Social BPM Lab concept presented by Caporale et al. [Ca13]. Since 2013, this Lab concept has been applied to university courses conducted at the Department of Economics and Management of KIT on a regular basis. During this time, the concept has been developed further in many aspects, for example in providing elaborated course material and a communication infrastructure suitable for the academic learning context. The enhanced Social BPM Lab addressed with this article differentiates from the previously conducted Labs only with respect to the participants. It has been opened for students from universities as well as professionals. Therefore it offers the chance for students not only to get in touch with business process modeling and the Horus tool, but also with potential future employers. By inviting professionals, it is now possible to give participants additional practical insights through working with experts, who share their experience, not only in business process modeling, but also in conducting meetings and professional communication.

In the following, the setting and scenario of the conducted Lab is described. Furthermore an evaluation of the Lab and lessons learned are provided.

3.1 Setting

The enhanced Social BPM Lab took part in three different locations, namely Turkey, Russia and Germany. Usually 10 to 30 students and a couple of professionals are set in one location. For the enhanced Social BPM Lab a group of 30 students and three professionals stayed in Turkey, whereas 10 students and one professional stayed in Russia. The Lab was organized and moderated from Germany. There were no students in Germany for that time. The student groups were divided in groups of two to three people. The main subject of the students was international business administration and informatics. The professionals had an IT background and knowledge about business process modelling. However, they have rare knowledge about Petri nets. For them this lab is like a further education. Therefore, the conditions for students and for professionals is nearly the same. This makes it easier to form teams with professionals and students, based on this chance of further education.

Each group had an own laptop with the current version of the Horus business process modeler. Furthermore they had internet access and a version of the communication program “Skype” installed on their laptops. All participants at one location were in one room, containing at least one video projector. A professional of PROMATIS software GmbH supervised the participants on-site.

The time frame for such a Lab lays between half a day and two days. For each task, the groups got a solving time frame of 30 minutes up to two hours, depending on the complexity of the task.

3.2 Scenario

The participants in the conducted Social BPM Lab played the role of employees of a fictive company called “SOWU Enterprises”. The enterprise is specialized in IT and security and produces its own products, e.g. a secure smartphone. An own company website was built to give participants the impression of a “real” company. The fictive history of the SOWU Enterprises started in 1998 as a spin-off of the institute AIFB and has now more than 2.000 employees all over the world. The locations are in Brazil, China, Hungary, USA and in Germany. In each location the same five departments exist: department A is the Product Development and Marketing, B has the tasks of Production and Procurement, C plays the Customer Service. Department D has the tasks of a Sales department and E fulfils the tasks of managing the online store. Figure 2 gives an overview of the locations and departments.

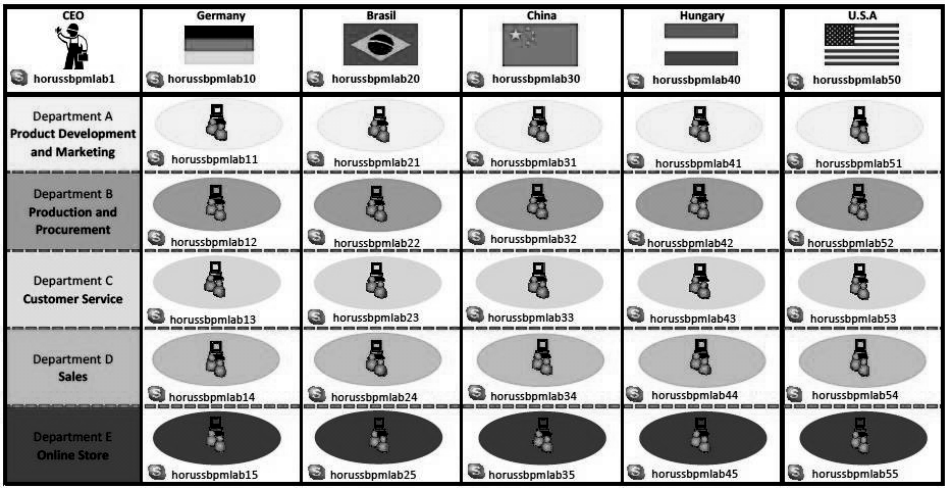


Figure 2: Overview of locations and departments

As Figure 2 shows, 25 department-location combinations exist. Conducted Tasks during the Lab are divided in "team internal" and "department internal" tasks. Team internal means one department of one location, e.g. department A in Germany. Department internal means one department in all countries, e.g. department B in cooperation with all 5 countries. Head of SOWU Enterprises is a professional of PROMATIS software GmbH, who leads the whole Lab. Each participant location has a local leader, who helps participants and answers questions. Local leaders are on-site. For an easier understanding, we call the fictive locations "SOWU locations". This is because for example a location in Germany can play the SOWU location China. In the picture, additionally the skype names were shown, so a matching in Skype is easier for the participants. Tasks can be specific for one SOWU location and department, e.g. department C in China, or cooperative between different SOWU locations. The local leaders have a look at the different groups. If the time is over and the groups aren't finished, they help them or provide them solutions, so they can solve the rest of the tasks.

The tasks for each department (local and international) were from the same character, but with different manifestations. The tasks contain mainly exercises from phase three of the Horus method, presented in chapter 2. Examples for tasks are:

- **Exercise 1.1 (Team internal):** Model the processes at level 1 with the help of videos and the interview statements.
- **Exercise 1.2 (Department internal):** Communicate with all other locations of your department via Skype and create an universal process for the department. Integrate the given four transitions correctly (The transitions are shown on a given model, but they aren't linked with the process. So the students have to

link them).

- **Exercise 1.3 (Team internal):** Split up the four given transitions in your department to one team of each location. Edit the refinement process at level 2, for the transition your team is responsible. The descriptions of the activities can be found in the intranet.

3.3 Evaluation

Participants showed great interest in conducting the Social BPM Lab. We had 25 participants, who filled in the questionnaire. As Figure 3 shows, the overall result is very positive. Four questions were answered neutral or positive.

	I do not agree	I neither agree nor disagree	I agree
1. I was able to improve my knowledge about Petri nets during the lab.	5%	10%	85%
2. The lab showed me the relevance of collaborative work.	0%	15%	85%
3. The lab increased my interest in BPM and process modelling.	10%	25%	65%
4. There was sufficient information about the business case "SOWU enterprises".	0%	35%	65%
5. I was able to understand the tasks.	10%	35%	55%
6. There was sufficient time to work on the tasks.	10%	25%	65%
7. It was clear at all times which model was supposed to be worked on.	5%	65%	30%
8. The number of participants was appropriate.	15%	35%	50%
9. I always had someone to ask when needed.	0%	10%	90%
10. The lab was a lot of fun.	0%	25%	75%

Figure 3: Evaluation Questionnaire and results

The only exception from positive answers is question seven. When looking at this question seven, it seems that the majority has not fully known, which model they should use. This may be grounded in the number of possible models, used in the Horus method. All in all, the Lab is viewed in a quite positive way.

3.4 Lessons Learned

Mostly the interest and attention paid of participants is quite high and tasks are solvable

even for participants without modelling background. A big challenge for the Lab is the tough time frame of one and a half day up to two days.

The most time consuming challenge is a technical one. Different computers and operating systems require different versions of the software. Participants were invited to install and try the software before taking part in the lab. However some participants do not follow those instructions. The challenge is not to lose too much time in installing the needed software. Sometimes the technical room equipment is challenging, too. For example the wireless LAN was too weak to hold connection to the servers of Horus. For future Labs it is planned to provide virtual machines, which contain already configured software, so no time is lost because of missing software packages.

Another challenge is the number of functions of the Horus business modeler. Participants sometimes try to use as many functions as possible of the tool with the result of loosing time for solving tasks. The loss of time is not only a challenge for the local department, but for all the same departments in the different countries. The reason lays in the linkage of tasks, which are often build up on each other. Local leaders should take care of the teams and remind them to focus on the specific tasks to avoid delays.

Last but not least, one reason for delays are extensive discussions. For solving tasks, people were invited to debate. Nevertheless sometimes discussions were spread about a long period of time. To avoid a delay, the discussion should be brought to an end without destroying the thoughts or ideas of the participants. Here again good soft skills of the local leaders are required, to end discussion without destroying good thoughts.

In comparison to earlier conducted Labs the participation of professionals seems to reduce time delays because of long discussions and playing with the functionality of the Horus business modeler. But as time delays were not measured, this effect cannot be quantified and remains a subjective perception of the local leaders.

4 Conclusion and future work

All in all, the feedback for the enhanced Social Lab was very good. The participation of professionals helped the students to stay focused and gave them some insights into their professional working life and how they communicate and work.

In future we plan to conduct the Lab in different time zones with different cultures. We assume that the intercultural teams will solve the tasks in different ways with different outcomes. Such a setting would also increase the practical impact, because in todays world employees often have to work in intercultural teams and different time zones.

References

[BMW08] Bargel, T.; Müßig-Trapp, P.; Willige, J.: Studienqualitätsmonitor 2007. In: Studienqualität und Studiengebühren. HIS: Forum Hochschule. Bd. 1, 2008, S. 2008

[Ca13] Caporale, T.; Citak, M.; Lehner, J.; Schoknecht, A.; Ullrich, M.: Social BPM Lab– Characterization of a Collaborative Approach for Business Process Management Education. In: Business Informatics (CBI), 2013 IEEE 15th Conference on : IEEE, 2013, S. 367–373

[Se12] Seethamraju, R.: Business process management: a missing link in business education. In: Business Process Management Journal Bd. 18 (2012), Nr. 3, S. 532–547

[Sc12] Schönthaler, F.; Vossen, G.; Oberweis, A.; Karle, T.: The Horus Method. In: Business Processes for Business Communities : Springer, 2012, S. 61–136

[Wa08] Watson B. P.: BPI: The CIO`s Secret Weapon. In: CIO Insight (2008)

[WH14] Wolf, C. Harmon, P.: The state of business process management. In: BP Trends June (2014)

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 79

Modellierungssprachenunabhängige Anwendung des Geschäftsprozessmanagements

Andreas Drescher[1]

Abstract: Für das Geschäftsprozessmanagement und der damit zusammenhängenden Geschäftsprozessmodellierung existieren zahlreiche Modellierungssprachen, so dass insbesondere Dozenten von Hochschulen bei der Auswahl von geeigneten Lehrinhalten vor große Herausforderungen gestellt werden. Dabei sollten die Lehrinhalte für die Modellierung von Geschäftsprozessen in der Hochschullehre so gestaltet sein, dass Studierende bei einem gegebenen Anwendungskontext, unter Berücksichtigung der Anforderungen der Praxis, eine geeignete Sprache auswählen können sowie unabhängig von der Auswahl die Anwendung des Geschäftsprozessmanagements ermöglicht wird. Darüber hinaus sollte das erlernte Wissen dazu befähigen neue Modellierungssprachen ohne eine signifikante Einarbeitungszeit anwenden zu können. In diesem Zusammenhang empfiehlt der Beitrag die Verwendung von zwei Modellierungssprachen. Zum einen werden aufgrund der formalen Beschreibung, impliziten Flusslogik und Geschäftsprozessanalyseverfahren Petri-Netze vorgeschlagen sowie zum anderen BPMN, angesichts des de-facto Standards in der Praxis. Weiterführend wird ein Transformationsverfahren für die Lehre empfohlen, um die Zusammenhänge der Modellierungssprachen für die Studierenden aufzeigen zu können sowie die modellierungssprachenunabhängige Anwendung des Geschäftsprozessmanagements zu ermöglichen.

Keywords: BPMN, Petri-Netze, Lehre, Modellierungssprachen, Transformationsverfahren

1 Einleitung

Für die Dokumentation von spezifischen Sachverhalten einer Organisation wird unter anderem die Geschäftsprozessmodellierung verwendet, welche ein bedeutender und relevanter Bereich des Geschäftsprozessmanagements ist [We12]. Dementsprechend unterstützt die Geschäftsprozessmodellierung unter anderem die Gestaltung, Analyse und Implementierung von prozessgestützten Informationssystemen [Du08] oder die leichtere Einarbeitung neuer Mitarbeiter [Ob96]. Aber auch die Analyse und Verbesserung der Produktqualität, der Durchlaufzeiten, Kundenbedürfnisse und die Erhöhung der Effizienz, z.B. mittels der quantitativen Bewertung durch Zeit-, Kosten- und Qualitätskennzahlen wird durch die Modellierung der Geschäftsprozesse ermöglicht [Ob96]. Aufgrund dieser Aspekte ist die Modellierung von Geschäftsprozessen sowie das Geschäftsprozessmanagement ein zunehmender Bestandteil im Curriculum zahlreicher Studiengänge [An15, Ba10]. Geschäftsprozesse werden mithilfe von Modellierungssprachen dokumentiert, wobei in der Literatur und Praxis zahlreiche Sprachen existieren, so dass im Rahmen des Beitrags die folgenden Hypothesen diskutiert werden sollen:

[1] Karlsruher Institut für Technologie (KIT), Institut für Angewandte Informatik und Formale Beschreibungsverfahren (AIFB), 76128 Karlsruhe, Andreas.Drescher@kit.edu

1. Hypothese: BPMN und Petri-Netze sind adäquate Repräsentanten für die Hochschulehre, um neue, beliebige, graphische Modellierungssprachen ohne eine signifikante Einarbeitungszeit erlernen und anwenden zu können (Abschnitt 2).

2. Hypothese: Ein Transformationsverfahren von Modellierungssprachen in der Lehre ist für eine modellierungssprachenunabhängige und ganzheitliche Anwendung des Geschäftsprozessmanagements erforderlich (Abschnitt 3).

2 Auswahl der Modellierungssprachen

In Abb. 1 wird zunächst eine Auswahl von Modellierungssprachen aufgezeigt, welche textuelle und graphische Sprachen enthält. Jedoch werden durch die formulierte Hypothese die textuellen Modellierungssprachen im Rahmen dieser Arbeit ausgeschlossen, da für die Beschreibung von Geschäftsprozessen überwiegend graphische Notationen verwendet werden [Ko09b]. Die textuellen Sprachen werden in der Regel als Ausführungssprache für Workflow-Management-Systeme herangezogen, so dass diese trotzdem nicht vernachlässigt werden sollten und daher eher in Veranstaltungen für Workflow-Management-Systeme zu integrieren sind [Hu08]. Weiterführend wird im Rahmen dieses Beitrags nur die Kontrollflussperspektive betrachtet sowie eine anwendungsdomänenunabhängige Ausbildung angestrebt. Aus diesen Einschränkungen wird deutlich, dass graphische, anwendungsdomänenunabhängige Modellierungssprachen betrachtet werden, um eine generische Ausbildung zu ermöglichen und somit die auszuwählenden Modellierungssprachen der zweiten bzw. dritten Schicht, nach dem 4-Schichtenmodell von [Ob96], zuzuordnen sind (vgl. Abb. 1). Zu den bekanntesten Modellierungssprachen aus diesen Schichten zählen BPMN, EPK, UML-AD, Petri-Netze sowie YAWL [Ko09a]. Dementsprechend soll im Weiteren zum einen auf der Basis von Studien aus der Literatur sowie aus den persönlichen Erfahrungen des Autors diskutiert werden, ob die Modellierungssprachen BPMN und Petri-Netze adäquate Repräsentanten für die Hochschulehre sind, damit Studierende neue, beliebige, graphische Modellierungssprachen ohne eine signifikante Einarbeitungszeit erlernen und anwenden können.

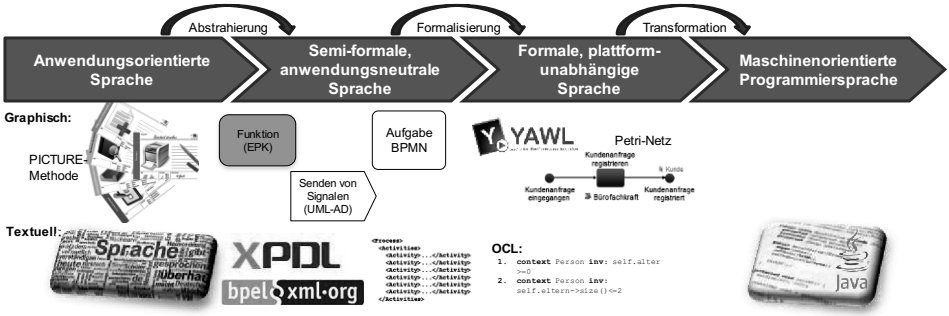


Abb. 1: Klassifikation von Modellierungssprachen nach [Ob96]

Für die engere Auswahl kann die empirische Studie von [Re07] herangezogen werden, welche das Verständnis von Modellierungssprachen im Kontext der Lehre und Praxis betrachtet. Darin wird gefolgert, dass Anwender, die die Modellierungssprache EPK beherrschen auch BPMN-Diagramme verstehen können, ohne dass diese BPMN kennen müssen und vice versa. Analog kann dies für die Verständlichkeit von BPMN und UML-AD gefolgert werden, da die Modellierungssprache UML-AD unter anderem als Grundlage für die Entwicklung von BPMN verwendet wurde. Ebenso wird die These durch die empirische Studie von [Bi10] unterstützt. Dementsprechend erscheint es weder sinnvoll mehrere Modellierungssprachen in einem Kurs zu unterrichten sowie mehrere Modellierungssprachen in verschiedenen Kursen [Re07]. Die Studien lassen jedoch die Frage offen, ob dies für alle Modellierungssprachen möglich ist oder ob dieses Verständnis möglicherweise für Petri-Netze nicht vorausgesetzt werden kann. In diesem Zusammenhang kann auf die Studie von [Sa05] zurückgegriffen werden, welche die Verständlichkeit des Kontrollflusses von Petri-Netzen und EPK vergleicht. Demgemäß kann nicht gefolgert werden, dass Anwender, welche BPMN, EPK oder UML-AD Geschäftsprozessdiagramme verstehen auch Petri-Netz Geschäftsprozessdiagramme verstehen können, was unter anderem auf die implizite Flusslogik zurückzuführen ist. Es sollten daher mindestens zwei Modellierungssprachen in der Hochschullehre betrachtet werden, welche jeweils einmal eine implizite und explizite Kontrollflusslogik aufweist.

Die Erkenntnisse können durch die Erfahrungen des Autors in der Lehre (Veranstaltung: *Modellierung von Geschäftsprozessen*) am KIT bestätigt werden, dass Studierende, welche BPMN, EPK oder UML-AD beherrschen auch jeweils die anderen Sprachen verstehen können. In diesem Zusammenhang wird vorgeschlagen BPMN zu lehren, da BPMN derzeit der de-facto Standard im Kontext der Geschäftsprozessmodellierung ist [Ko15]. Zusätzlich sollten in der Hochschullehre aufgrund der impliziten Flusslogik sowie der formalen Beschreibung und den dazugehörigen Geschäftsprozessanalyseverfahren Petri-Netze betrachtet werden. Die Modellierungssprache YAWL muss im Rahmen der Lehre nicht gesondert betrachtet werden, da zum einen YAWL über explizite Notationselemente für die Kontrollflusslogik verfügt sowie zum anderen auf der formalen Beschreibung von Petri-Netzen basiert. Zusätzlich fehlt die breite Akzeptanz und Anwendung von YAWL [Re07], was darauf zurückzuführen ist, dass YAWL auf die Unterstützung der Workflow-Muster ausgerichtet ist und weniger auf die Endanwender [Ha05]. In diesem Zusammenhang sollte durch die empfohlene Kombination von BPMN und Petri-Netze die Modellierungssprache YAWL leicht erlernbar sein.

3 Transformationsverfahren

Das Verständnis einer beliebigen, graphischen Geschäftsprozesssprache ermöglicht noch nicht zwangsläufig die ganzheitliche Anwendung des Geschäftsprozessmanagements, da beispielsweise eine formale Sprache benötigt wird, um unter anderem Geschäftsprozessanalyseverfahren einsetzen zu können oder auch um Missverständnisse bei der Implementierung zu vermeiden. Dementsprechend sollten weiterführend Transformations-

verfahren in die Lehre integriert werden, so dass eine beliebige, graphische Modellierungssprache in eine bereits formalisierte Sprache transformiert werden kann.

Der Transformationsansatz sollte auf Petri-Netzen oder BPMN basieren, da diese Modellierungssprachen bereits in Abschnitt 2 für die Lehre vorgeschlagen wurden. Aufgrund der formalen Semantik von BPMN [Ko14] sowie den zur Verfügung stehenden Analyseverfahren, wie beispielsweise in [Ka14] aufgezeigt, kann die Auswahl in diesem Zusammenhang als indifferent bezeichnet werden. Unter Betrachtung der Anwenderperspektive kann BPMN als Transformationssprache empfohlen werden, da eine explizite Flusslogik zugrunde liegt, sie in der Praxis als de-facto Standard gilt, sowie eine Vielzahl von unterschiedlichen Modellierungselementen zur Verfügung stehen, um eine direktere und somit leichtere Transformation, im Vergleich zu Petri-Netzen, zu ermöglichen. Es existieren jedoch nur wenige Transformationskonzepte auf BPMN, da erst in [Ko14] eine durchgängige Semantik für BPMN definiert wurde. Ein Verfahren wird beispielsweise in [Dr16] vorgeschlagen, mit dessen Hilfe die Semantik einer beliebigen, graphischen Geschäftsprozessmodellierungssprache formalisiert werden kann, ohne einen Notationswechsel vorzunehmen. Die Formalisierung der Semantik wird durch die Zuordnung der BPMN-Modellierungselemente zu den verwendeten Elementen durchgeführt, so dass unter anderem eine modellierungssprachenunabhängige Anwendung des Geschäftsprozessmanagements ermöglicht wird. Die semantischen Zusammenhänge der Sprachen können zusätzlich dabei visualisiert werden und somit eignet sich das Verfahren für die Lehre im Kontext der Modellierung von Geschäftsprozessen.

4 Zusammenfassung und Ausblick

Im Rahmen des Beitrags wurde eine Auswahl von Modellierungssprachen sowie ein Transformationsverfahren vorgeschlagen. Hierbei wurden im zweiten Abschnitt, unterstützt durch empirische Studien aus der Literatur, die Modellierungssprachen BPMN und Petri-Netze für die Hochschullehre vorgeschlagen. Im dritten Abschnitt wurde ein Transformationskonzept für die Hochschullehre empfohlen, um eine beliebige, graphische Modellierungssprache mithilfe von BPMN formalisieren zu können. Dementsprechend wird hierdurch eine ganzheitliche Anwendung des Geschäftsprozessmanagements ermöglicht. Die Auswahl der Modellierungssprache und eines Transformationskonzeptes bildet zwar eine gute Grundlage, jedoch basieren die Empfehlungen nur auf den Erfahrungen des Autors sowie aus Folgerungen von Studien aus der Literatur. Die Einzelstudien müssen daher weiterführend evaluiert werden und für die Untermauerung der Thesen des Autors sind weitere Forschungen erforderlich. Beispielsweise wurden die Verständlichkeitsfolgerungen in der obigen Studie von EPK und BPMN für BPMN 1.2 durchgeführt und nicht für BPMN 2.0.2, welche über eine umfangreichere Symbolpalette verfügt. Zusätzlich sollte mit Hilfe einer Evaluation die These überprüft werden, ob Studierende, welche die Modellierungssprache BPMN und Petri-Netze beherrschen auch die Modellierungssprache YAWL verstehen können.

5 Literaturverzeichnis

[An15] Antonucci, Y. L.: Business Process Management Curriculum. In (Brocke, J. v.; Rosemann, M. Hrsg.): Handbook on Business Process Management 2, 2015; S. 547–572.

[Ba10] Bandara, W.; Chand, D.; Chircu, A.; Hintringer, S.; Karagiannis, D.; Recker, J.; Rensburg, A. v.; Usoff, C.; Welke, R.: Business Process Management Education in Academia. Status, Challenges and Recommendations. In CAIS, 2010, 27.

[Bi10] Birkmeier, D.; Kloeckner, S.; Overhage, S.: An Empirical Comparison of the Usability of BPMN and UML Activity Diagrams for Business Users. In (Alexander, P. M.; Turpin, M.; Deventer, J. P. v. Hrsg.): ECIS, 2010.

[Dr16] Drescher, A.: Modellierungssprachenunabhängige IT-basierte Geschäftsprozessanalyse. In (Stelzer, D.; Nissen, V.; Straßburger, S. Hrsg.): MKWI, Berlin, 2016.

[Du08] Dumas, M.; Reichert, M.; Shan, M.C. Hrsg.: BPM. Springer, 2008.

[Ha05] Havey, M.: Essential business process modeling. OReilly, Beijing, 2005.

[Hu08] Huth, S.; Wieland T.: Geschäftsprozessmodellierung mittels Software-Services auf Basis der EPK. In (Nissen, V.; Petsch, M.; Schorcht, H. Hrsg.): Service-orientierte Architekturen, Wiesbaden, 2008; S. 61–76.

[Ka14] Kalenkova, A.; Leoni, M. d.; Aalst, W. v. d.: Discovering, Analyzing and Enhancing BPMN Models Using ProM. In (Limonad, L.; Weber, B. Hrsg.): BPM Demos. CEUR-WS.org, 2014; S. 36–40.

[Ko09a] Ko, R. K. L.; Lee, S. S. G.; Lee, E. W.: Business Process Management Standards: A Survey. In Business Process Management Journal, 2009, 15; S. 744–791.

[Ko09b] Kopp, O.; Martin, D.; Wutke, D.; Leymann, F.: The Difference Between Graph-Based and Block-Structured Business Process Modelling Languages. In EMISA Journal, 2009, 4; S. 3–13.

[Ko14] Kossak, F.; Illibauer, C.; Geist, V.; Kubovy, J.; Natschläger, C.; Ziebermayr, T.; Kopetzky, T.; Freudenthaler, B.; Schewe, K.-D.: A Rigorous Semantics for BPMN 2.0 Process Diagrams, 2014.

[Ko15] Kocbek, M.; Jost, G.; Hericko, M.; Polancic, G.: BPMN. The Current State of Affairs. In Computer Science and Information Systems, 2015, 12; S. 509–539.

[Ob96] Oberweis, A.: Modellierung und Ausführung von Workflows mit Petri-Netzen, 1996.

[Re07] Recker, J.; Dreiling, A.: Does it matter which process modelling language we teach or use? In (Toleman, M.; Cater-Steel, A.; Roberts, D. Hrsg.): ACIS, 2007; S. 356–366.

[Sa05] Sarshar, K.; Loos, P.: Comparing the Control-Flow of EPC and Petri Net from the End-User. In (Aalst, W. v. d. et al. Hrsg.): BPM, 2005; S. 434–439.

[We12] Weske, M.: Business Process Management. Concepts, Languages, Architectures. 2. Auflage, Heidelberg, 2012.

2nd Workshop Requirements Engineering & Business Process Management (REBPM)

Robert Heinrich[1], Kathrin Kirchner[2], Felix Reher[3] and Rüdiger Weißbach[4]

While Requirements Engineering (RE) is concerned with eliciting and managing requirements related to a particular (software) system, Business Process Management (BPM) deals with modeling and managing organizational processes and business objectives. Because information technology is an enabler of business change and business processes are often some part of the software requirements both domains are heavily interrelated, which is also demonstrated by overlapping use of concepts and artifacts. Business processes modeling, for example, serves as an interface between both domains since the models combine knowledge about the business and the involved (software) systems.

The methods and processes concerned with the business people, while trying to achieve similar goals, differ from those concerned with the software as well as requirements engineers. The goal of the REBPM workshop series is to analyze and discuss the relations between both domains in order to get an understanding of their joint usefulness and mutual benefits in organizational management, process design and software development from both a research and practical point of view so that methods and shared models can be developed in the future.

The workshop series is organized by the working group "Requirements Engineering and Business Process Management" of the German Informatics Society (GI). This working group brings researchers and practitioners together to discuss the interlocking from both RE and BPM fields (www.rebpm.org).

In this year's workshop, three papers are presented that discuss the overlapping field of BPM and RE from different perspectives.

During the implementation of a business function, a conceptual view is taken during the phase of requirements engineering. Requirements analysts start with thinking about the requirement by designing an overall business process. For describing the elements of a business process, natural language is used that can be ambiguous and later lead to misunderstandings. Ralf Laue focuses in his paper "Qualität von Geschäftsprozessmodellen aus dem Blickwinkel der Anforderungsanalyse" on the quality of business process models from a requirements engineering perspective due uncertain language.

Another problem can be changing requirements as in agile development projects. David

[1] Karlsruhe Institute of Technology (KIT), heinrich@kit.edu
[2] Berlin School of Economics and Law, kathrin.kirchner@hwr-berlin.de
[3] University of the West of Scotland, felix.reher@uws.ac.uk
[4] Hamburg University of Applied Sciences (HAW Hamburg), ruediger.weissbach@haw-hamburg.de

Kuhlen and Andreas Speck discuss in their paper “The potentials of a code generator to face the stress ratio of requirements engineering processes in agile development projects” the usage of a code generator that supports the requirements engineering processes.

Johannes Schubert and Lisardo Prieto-González recommend in their paper “Requirements Engineering and Business Process Management as preconditions for the application of the Cloud Blueprinting Model” the integration of a requirements standard classification to enhance the interoperability in case of Business Processes as a Service, increasing the semantic concept of the solution, and reducing potential risks derived from an unstructured analytics development phase.

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 87

The potentials of a code generator which faces the stress ratio of requirements engineering processes in agile development projects

David Kuhlen[1], Andreas Speck[2]

Abstract:

The agile software development method is common in many software development companies worldwide. The following paper approaches an universal problem of agile development projects in the whole software development branch of industry. Unfortunately, in many cases, the requirements are incomplete and the projects are under-specified. Imprecise requirements and specifications cause not only problems in the development, but they also result in inaccurate cost estimations. This leads to problems even in the development and in the requirements engineering. Moreover, the lack of clear specifications may lead to further customer requests at the development time. They might be realized at very high costs. This increases the time pressure for the developers. In order to realize the software in time, the developers lower the quality level of the code. A lack of quality causes technical debts which reduces the economic efficiency of the system considerably. A potential solution, proposed in the paper, is the use of code-generation systems. The use of a code generator could offer potentials to improve the processes of requirements engineering. The support of these generators enables the software developers to focus on the requirements engineering. As the generated code contributes directly to the sprint goal, this approach could be well accepted by the developers. The potentials of such a concept are investigated.

1 Introduction

In agile development projects the developers may decide to skip (or shorten) the process of a comprehensive requirements engineering [Sc13]. Without requirements engineering the software producer might save the effort and finish the project faster [Hr14]. The focus on activities which fulfil the sprint goal is typical for agile projects. However, requirements engineering is a long-term goal. It is not attractive, particularly in short iterations. Nevertheless, good requirements engineering methods help to reduce the error rate of a software system from 0,23 to 0,08 per function point [Hr14]. Increased time pressure enhances the risk of technical debts. The quality of the requirements engineering process results from its contribution to reduce technical debts. There emerges the trend to ignore the long-term profitability [Al12].

[1] Datenlotsen Informationssysteme GmbH, Technische Beratung, Beim Strohhause 27, 20095 Hamburg, David.Kuhlen@nordakademie.org
[2] Christian Albrechts Universität zu Kiel, Abteilung, Hermann-Rodewald-Straße 3, 24098 Kiel, aspe@informatik.uni-kiel.de

1.1 Research Question

Agile software development has to solve many challenges. The impact of code generation on these challenges should be examined. The paper should investigate the impact of the use of a code generator on the challenges of requirements engineering processes in agile software development. It tries to show how the universal problem of the whole software development branch of industry could be solved by the application of a code generator.

In the following sections it has to be examined which potentials a code generator offers, in order to solve the stress ratio of requirements engineering in agile development projects. At first, the stress ratio in agile projects has to be analysed. Secondly, the impact of a code generator on the stress ratio has to be assessed. At last, standards for a code generator should be formulated. These standards have to be fulfilled by a code generator in order to aid agile projects.

1.2 Related Work

This work bases on various researches in different fields. It includes research on technical debt, on code generation, on requirements engineering and on agile process models. In this section, just a few works will be described, which have a special impact on this paper.

[Al12] and [MS12] described that technical debt harms the long-term profitability of software development projects. Ultimately, the savings have a negative impact on the maintainability of a software. Like every debt, it has to be repaid with interest. Thus technical debt is similar to financial debt which shows its impact. In order to prevent technical debts, their financial consequences have to be transparent. Previous publications recommend documentation of technical debts in an own backlog, with its financial impact [Al12]. Unfortunately, this impact cannot be determined easily [KS14]. Therefore, this method might be hard to apply in practice.

Techniques of code generation have been investigated intensively. An example for a technique, which expresses specified procedures graphically, is the *Business Application Modeler* (BAM). BAM allows checking business process models. The graphical tool bases on the *Eclipse Graphical Editing Framework* (GEF) [Sp11]. A code generator can consist of the combination of a *Domain Specific Language* (DSL) and a possibility for graphical modelling. The *Domain Specific Language* enables the code generation. The graphics editor allows the generation of corresponding diagrams. This generator could be realized by the combination of *Eclipse Graphiti* and *Xtext*. To support the requirements engineering by a code generator it is important to link the generator with the domain. Pulvermüller and Speck describe the *XOpt* generation concept. In this concept, a hierarchical structure consists of generic operators, which are domain-independent. For the adaptation to a specific domain, domain-dependent operators are refined [PS04].

The field of process analysis of software development approaches is topic of [KS15]. Kuhlen and Speck consider the phase of business process modelling as substantial. They

explained software development process to vary by the selected development approach. Because requirements were considered as main cost drivers during the development, the model, which describes the process of development, could be used to calculate the average execution costs.

2 Challenges of agile process models

The agile methodology influences the entire project. A reduction in the phase of conception is often justified by the fact that requirements are changing continuously. This shortens several aspects of the process of requirements engineering. [Hr14] explains one to three per cent requirements changes per month!

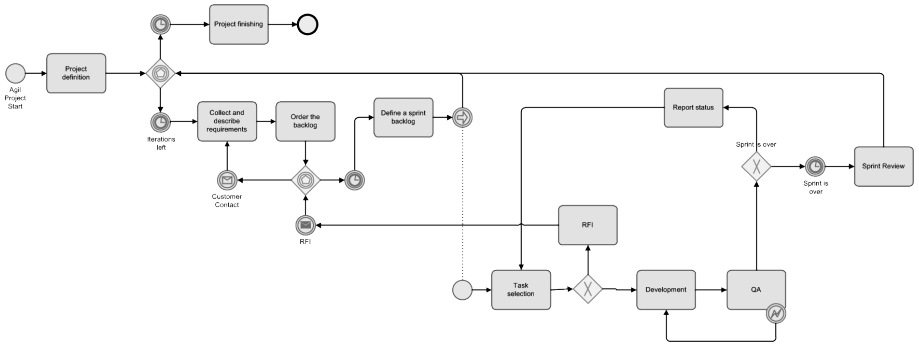


Abb. 1: Model of an agile development process inclusive requirements engineering activities

In Figure 1 the model of an agile development process is illustrated. A special emphasis is put on the requirement engineering activities in this model. As displayed in the diagram, the process consists of several activities which are arranged in a cycle. As explained by [KS15], this cyclic repetition during the requirements increases the costs of the whole process.

"Embrace the Change" leads to requirements that are rarely analysed. An agile process gives developers and customers a certain amount of freedom in terms of content design of software requirements. However if the effort of a requirement is not estimated correctly, the effort for a successful implementation will be difficult to assess at the end. In order to keep the project deadline, software developers partially reduce the quality of implementation. These savings act primarily on those aspects, which have not been described in any design requirement scarce. In the process, this leads to **technical debts**.

2.1 Requirements engineering in agile development projects

In agile development projects, the time budget of requirements engineering is often reduced. This is legitimized by the fact that requirements change rapidly in any case. Therefore, it is common to perform the requirements analysis only as it is required for the control

of the project. For those reason requirements descriptions do not have to contain many details of the specification. However, this leads to the risk that important details are missing before development could start (see cycle in Figure 1). The agile process model does not ensure that a written concept will be formulated between developers and customers. In order to reduce the time used for the analysis of the details, representatives of the customers will be integrated in the development process. It is assumed that the customer representatives can resolve ambiguities, resulting from the limited requirement conception during the software development process.

2.2 Technical debts and quality of code in agile development projects

Technical debts are savings in the production of software which deteriorate the quality of the service provided [Al12]. Typically, it is caused by the use of "short-cuts", thus save development time. When developers avoid the use of "best practices" or conventions, they can quickly find out what their requirements are. Many developers also avoid documentation in order to win speed [Ka12].

The use of agile software development often results in savings of time and money. This decreases the process costs. It is typical in agile development projects (where the circumference is less rigidly formulated) to regard the function set to be implemented as flexible in contrast to the firm constant of development time.

If developers are developing more and more functionality in a defined period of time, then this pressure on costs misleads the building up of technical debts [MS12]. In agile software development projects, technical debts can occur any time. Technical liabilities are accepted as inevitable and periodic. Therefore, iterations for their solution become scheduled [Al12]. The scheduling of such "bug fix" iterations is not optimal.

These iterations lead to the parts of the request, which become implemented in a later iteration. Better, requirements should be implemented undivided and technical debts would consequently not arise [Al12].

2.3 Effort estimation in agile projects

When using traditional development methods, (e.g. the waterfall model) it was not possible to define requirements completely in advance [Ar14]. As the requirements always change, a new development paradigm developed - the agile process model. Agility is often equated with "unpredictability" in software development. Instead, it focuses on flexibility and responsiveness to market changes [Ec13]. The description of this flexible process in formal terms of a process model is hard, but necessary to analyse its performance.

Many agile methods focus on the development of code without waiting for formal requirements analysis [CR08]. A comprehensive elaboration of concepts is not seen as an advantage. This leads to inaccurate goals (which cannot be measured) at the beginning of a sprint.

A cost analysis is a regular part of the requirements engineering. This analysis defines a budget, which must not be exceeded by the implementation. It has to be large enough to prevent the formation of technical debts. The budget must therefore not be too large, otherwise it can lead to the risk that additional features are developed which did not belong to the first scope. This risk can increase because of the communication with the customers.

The execution of a comprehensive requirements engineering for projects with high complexity and duration is criticized as being impossible [Ec13]. However, most of the development projects have to pass a business approval process, which assesses this viability. To obtain estimation rapidly a technical expert analyses the project quickly [Ar12]. Estimations, which are created without a reasonable investigation, will be proven wrong which harms the economics of the project. To increase its quality, those who are responsible for the implementation often perform the estimation. They are liable for the accuracy of the estimation [Al12].

3 Potentials of a code generator to solve the stress ratio

The success of a software development depends on four variables: time, functionality, resources and technical debts [Al12]. A process of a code generator has a positive effect on three of these variables: the time, the functionality and the technical debts. All these variables were affected by requirements engineering.

3.1 Generation leads to better estimations

A code generator shifts effort in development to the requirements engineering. It enables a process where larger parts of the software become configured instead of developed by the formulation of source code. This could increase the overall performance of the development process.

The application of a code generator leads to a formal procedure. The formal procedure ensures that all necessary steps are taken and all details are collected which are important in order to perform a valid estimation.

An improvement in the cost estimation is a key element in the success of a development project. Although every estimation inherent uncertainty about the future, the companies which can create better estimations are able to compete better on the market than others [Ca11].

3.2 Impact on Requirements Engineering

The use of a code generator changes the process of software development. As mentioned above, a code generator has to replace development time for the requirements engineering.

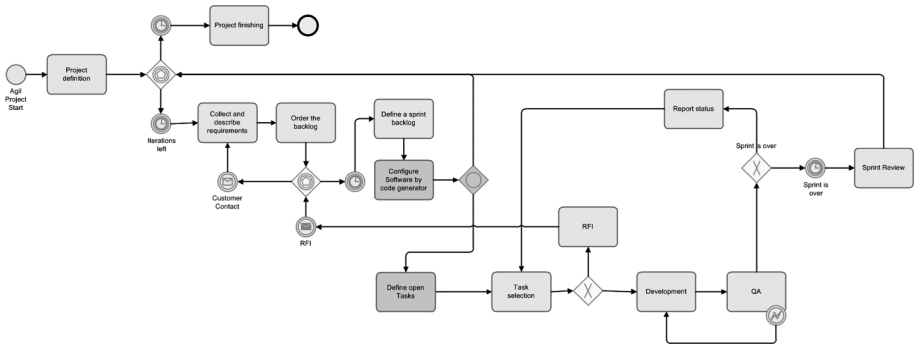


Abb. 2: Model of an agile development process in which a code generator is used

Therefore, the time of requirements engineering has to donate more than just investing the time in the development of a new functionality.

Figure 2 illustrates the process of software development which uses a code generator. This process is similar to the development process in Figure 1. The differences between the models are highlighted in green colour in the diagram. As displayed, the integration of a code generator in the development process allows building a required functionality without the need of developing a new functionality in a common way. However if it is not possible to fulfil a requirement by the use of the code generator, the classic development part of the process starts. Therefore, the integration of a code generator leads to a gateway and a probability that validates the execution of classic development.

By using a code generator, business requirements could be expressed in a high-level language (like *UML*). The expression of these business objects leads to a source code, which fulfils requirements partially, or complete (depending on the complexity and the possibilities of the generator). With this procedure, the development team has to focus on the requirements first.

A valid requirements engineering can be the basis of effort estimation. The quality of the estimations can be improved when more time is devoted to the analysis of the requirements engineering [Ar12]. However, customers will not demand less functionality of software vendors [Al12].

Finally, a code generator enables new ways of traceability. The traceability of requirements to source codes is especially relevant for subsequent changes of the requirements [Hr14].

3.3 Impact on technical debt

Generated source would regard to the given conventions and the generator would not take "short cuts". This would ensure that relevant models could be understood at any time. The maintainability of software will also be easier if bug fixes have not been incorporated [MS12]. If errors become fixed in the models, the correction can be realised through a

new code generation. So the quality of source would not become injured after multiple corrections. This could increase the process performance in long terms.

4 Standards for a code generator

Concentration on the essentials has a central meaning in agile software development. To reduce technical debts, requirements engineering has to take an important role. Therefore, unattractive, time-consuming and perhaps apparently unnecessary activities need to contribute to the fulfilment of the sprint goal directly. The use of a code generator can make this possible.

4.1 Modelling procedures in the requirements engineering

It is possible to express requirements in various ways. Only a bounded subset of these requirements engineering methods are used in agile development projects. Thus, requirements analysis should provide a basic understanding about the customers needs [CR08]. The methods of the classic requirements engineering include the creation of state diagrams and activity diagrams. These methods describe the process of functionality in formal terms. In contrast, in agile projects less formal and detailed methods are used to describe requirements.

In agile requirements engineering, there are essentially six different methods used to investigate more details of requirements [CR08]: (1) Direct communication with the customer, (2) Cyclic repetitions of small analysis, (3) Prioritization of requirements, (4) Scheduling changes in requirements, (5) Prototyping, (6) Test-Driven Development.

The cyclic repetition of the requirement analysis helps to gain detailed information on the requirement [CR08]. This analysis takes place mostly at the beginning of iteration. It does not result in a fully formulated specification. A code generator has to fit into this process model. Therefore, it has to be possible to add contents iteratively, in the entire project. The design of the code generator needs to separate the generated source sharply from the source which was written manually.

4.2 Performance needs for a code generator

A code generator could use the requirement specification to produce a source, which meets the request. This should not lead to increasing efforts for the specification and the implementation. The description of algorithms has to be simple enough so that the process of the generator would not become a barrier. It also needs formal descriptions of the algorithm to provide a source code. Being formal is not easy at any time.

If the requirements analysis just provides general information, it would only be possible to generate objects on the same level of abstraction. In order to increase the benefit of code

generation, it is necessary to express the content of a required algorithm. Therefore, the result of functionality and its computation path has to be designed in the requirements engineering. Large descriptions are produced which demonstrate how complex it is to perform computations in concepts. This level of detail enriches the project. Software manufacturers want to make sure that the requirements of their customers are fulfilled. Therefore, they describe what has to be done.

An example of a solution could be realized by XML transformation languages (XSLT). Fötsch and Pulvermüller describe transformation languages by building new high-level operators on top of existing ones, based on the generic XML operator hierarchy concept. The higher the level of the operators is, the more similar they get to everyday languages. This improves the readability and maintenance of code [FP09].

4.3 Specification of the Generator

If developers implement a business function, they begin to define different business objects. An object could represent a data record which itself consists of different objects. Therefore, the developers build hierarchical structured objects. Each object could get its own business functions. After the developers have built the business objects, they can identify the business process that deals with these objects.

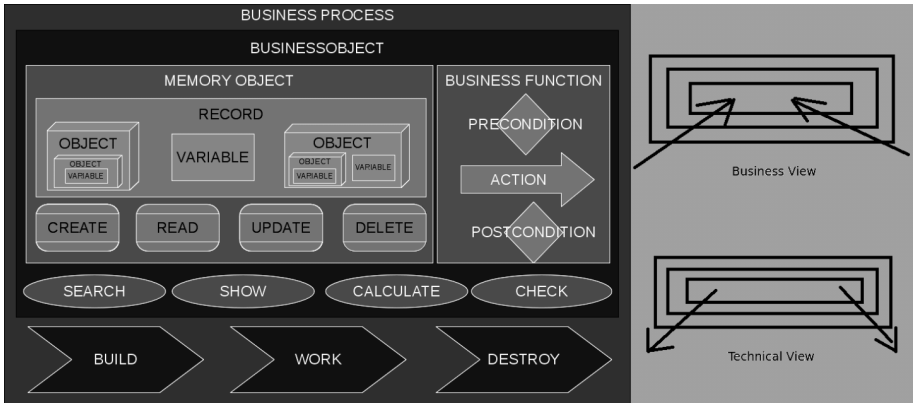


Abb. 3: Specification of the operator's hierarchy

The business view will be taken during the phase of requirements engineering. Requirements analysts start with thinking about the requirement by designing the overall process. The overall process is often described in a formal way. During the process, business objects are used (build, work, destroy). The use of these objects will be described by using more details. Therefore, different functions will be described. On the opposite, technical analysts (for example developers) start with defining memory objects. They look at the requirement from a technical perspective (technical view). After designing objects, they implement business functionality. Therefore, technical analysts start working on a deep technical level and go in the direction of a business level. On the other side, business designers proceed in the direction of the implementation (Cf. Figure 3).

The hierarchical structure of business objects can be presented in a class diagram. In development projects the requirements engineering often stops after describing the functions. The code generator has to support the analysis on different levels of abstraction.

The analysis should start on the highest level of abstraction, which is typical for the requirements engineering. From this point on, the analysis should go deeper so that more details of the requested functionality can be analysed. The different levels of operations are displayed in Figure 3. The requirements analysis goes from the outside to the inside of the layers. The development starts inside and goes out of the layers. By this specification, the code generator also defines a metric. The quality of results depends on the effort software producers want to invest in the requirements engineering.

5 Conclusion

A further step is the refinement of the generator systems and their validation in commercial software development operations. This could show the savings which are realized by the code generator. It has to be checked to which extend this efficient approach leads to a reduction of software development.

Literaturverzeichnis

[Al12] Allman, E.: Manageing Technical Debt. COMMUNICATIONS OF THE ACM, 5(5):50–55, March 2012.

[Ar12] Armour, P., G.: The Business of Software The Goldilocks Estimate. COMMUNICATIONS OF THE ACM, 55(10):24–25, 2012.

[Ar14] Armour, P. G.: The Business of Software Estimation Is Not Evil. COMMUNICATIONS OF THE ACM, 57(1):42–43, 2014.

[Ca11] Cantor, Murray: Calculating and improving ROI in software and system programs. Communications of the ACM, 54(9):121–130, 2011.

[CR08] Cao, Lan; Ramesh, Balasubramaniam: Agile Requirements Engineering Practices: An empirical Study. Software, IEEE, 08(1):60–67, February 2008.

[Ec13] Eckstein, Dipl-Ing Jutta: Agilität – ein Baustein der dritten industriellen Revolution. HMD Praxis der Wirtschaftsinformatik, 50(2):77–83, 2013.

[FP09] Foetsch, Daniel; Pulvermueller, Elke: A Concept and Implementation of Higher-level XML Transformation Languages. Journal on Knowledge-Based Systems (KNOSYS), 22(3):186 – 194, April 2009.

[Hr14] Hruschka, Dr. Peter: Business Analysis und Requirements Engineering. Carl Hanser Verlag München, 2014.

[Ka12] Kamp, P.-H.: The Hyperdimensional Tar Pit. COMMUNICATIONS OF THE ACM, 55(3):52–53, 2012.

[KS14] Kuhlen, David; Speck, Andreas: Wertanalyseverfahren für Kundenanforderungen. In (Plödereder, Erhard; Grunske, Lars; Schneider, Eric; Ull, Dominik, eds): INFORMATIK 2014 Big Data - Komplexität meistern. volume P-232 of Lecture Notes in Informatics (LNI) - Proceedings, Gesellschaft für Informatik e.V. (GI), Stuttgart, pp. 2317 – 2322, September 2014. Thanks to Prof. Dr. Andreas Speck and Prof. Dr. Hinrich Schröder.

[KS15] Kuhlen, David; Speck, Andreas: Business process analysis by model checking. In (Ceravolo, Paolo; Rinderle-Ma, Stefanie, eds): 5th International Symposium on Data-Driven Process Discovery and Analysis SIMPDA 2015. Vienna, Austria, pp. 154–170, December 2015.

[MS12] McKeen, James D; Smith, Heather A: Effective Application Maintenance. Communication of the Association for Information Systems, 30(5):73–82, 2012.

[PS04] Pulvermüller, Elke; Speck, Andreas: XOpT-XML-based composition concept. In: Proceedings of the 3rd International Conference on New Software Methodologies, Tools, and Techniques (SoMeT'04). volume 111, Citeseer, Proc. of 3rd International Conference on Software Methodologies, Leipzig, Germany, pp. 249–262, September 2004. IOS Press, pages , 2004.

[Sc13] Schwaber, K.; Sutherland, J.: , Der Scrum Guide Der gültige Leitfaden für Scrum: Die Spielregeln, July 2013. Zuletzt Abgerufen am 06.09.2014.

[Sp11] Speck, Andreas; Feja, Sven; Witt, Sören; Pulvermuller, Elke; Schulz, Marcel: Formalizing business process specifications. Computer Science and Information Systems, 8(2):427–446, 2011.

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 97

Qualität von Geschäftsprozessmodellen aus dem Blickwinkel der Anforderungsanalyse

Ralf Laue[1]

Abstract: Kommunikation von Anforderungen ist nur einer von zahlreichen Einsatzzwecken von Geschäftsprozessmodellen. Nicht selten stehen zur Anforderungserhebung daher Modelle zur Verfügung, die ursprünglich eine andere Aufgabe hatten (etwa die Prozessdokumentation oder die Unterstützung einer internen Schulung). Das hat zur Folge, dass solche Modelle unter Umständen wesentliche Informationen nicht enthalten, da selten vorkommende Abläufe, Fehlerzustände und Ausnahmen bewusst nicht modelliert wurden. Aufgabe bei der Anforderungsanalyse ist es, solche Modellierungslücken zu erkennnen und das Stellen geeigneter Nachfragen zu unterstützen.

In diesem Beitrag wird die Idee eines Werkzeugs vorgestellt, das einige typische Indikatoren für fehlende Informationen im Modell automatisch findet und die erforderlichen Nachfragen formuliert. Dies kann Anforderungsanalytiker bei der Arbeit mit Geschäftsprozessmodellen unterstützen.

1 Einführung

Die Zwecke, zu denen Geschäftsprozessmodelle (GPM) erstellt werden, sind sehr vielfältig: Häufig dienen sie der Prozessdokumentation, der Vorbereitung von Prozessverbesserungen, der Prozessanalyse (z.B. durch Simulation) oder der Bestimmung der Prozessqualität [NK05].

Ebenso können Geschäftsprozessmodelle aber auch bei der Kommunikation von Anforderungen unterstützen oder sogar selber (als Konfiguration einer Workflow-Engine) Bestandteil einer Softwarelösung werden.

In der Literatur finden sich zahlreiche Untersuchungen zur Definition des Qualitätsbegriffs für Geschäftsprozessmodelle [MDN09, Ri10, Ne12, OBS12]. Wird dabei keine Unterscheidung nach dem Zweck eines GPM getroffen, ist eine Qualitätseinschätzung jedoch unbefriedigend, da die Qualität eines Modells immer nur mit Hinblick auf dessen Verwendungszweck beurteilt werden kann. In diesem Beitrag wollen wir uns mit der Nutzung von GPM zur Beschreibung von Anforderungen befassen.

Nicht selten erhält der für die Anforderungserhebung zuständige Analytiker zur Beschreibung eines Prozesses GPM, die zuvor für einen ganz anderen Zweck erstellt wurden. Selbst wenn die Qualität der Modelle für diesen ursprünglichen Zweck hoch war, heißt das noch nicht, dass dies auch für die Modellqualität zum Zwecke der Anforderungserhebung gilt.

So empfiehlt beispielsweise Miers [Mi06] zur Vereinfachung der Kommunikation, in früheren Phasen von Modellierungsprojekten nur die am häufigsten durchlaufenen Pfade ins

[1] Westsächsische Hochschule Zwickau, Fachgruppe Informatik, Dr.-Friedrichs-Ring 2a, 08056 Zwickau, ralf.laue@fh-zwickau.de

Modell aufzunehmen. Es entstehen GPM, die nur den sog. „Sonnenschein-Pfad“ zeigen und mögliche Fehlerzustände und Ausnahmen nicht abdecken. Um einen Überblick über einen Prozess zu bekommen, sind solche GPM durchaus geeignet. Sie verwirren den Leser nicht durch die Betrachtung seltener Fälle. Bei der Erhebung von Anforderungen ist es aber das Ziel, eine *vollständige* Beschreibung des Leistungsumfangs des zu schaffenden Systems zu bekommen.

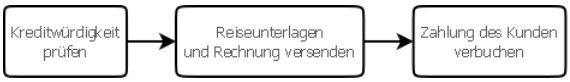


Abb. 1: Fragment aus einem Prozess „Reise verkaufen“

Während also zur Dokumentation eines Geschäftsprozesses für das Management das in Abb. 1 gezeigte Modellfragment möglicherweise völlig ausreichend ist, muss ein Anforderungsanalytiker gerade nach den Ausnahmefällen fragen: Wie soll sich das zu schaffende Softwaresystem verhalten, wenn der Kunde nicht kreditwürdig ist oder nicht zahlt? Die Antwort auf die letztgenannte Nachfrage könnte etwa zu einer bisher nicht gefundenen Menge von Anforderungen zum Forderungsmanagement führen.

Im Beitrag werden typische Situationen in einem GPM gezeigt, die Anforderungsanalytiker zu Nachfragen veranlassen sollten. Ein Werkzeug-Prototyp nutzt Methoden der automatischen Sprachverarbeitung, um diese Nachfragen automatisiert am Modell anzuzeigen.

2 Automatische Erkennung sprachlicher Probleme in Anforderungen

Die in diesem Beitrag vorgestellte Forschung ist inspiriert von Arbeiten, die potentielle Unklarheiten in natürlichsprachigen Anforderungsdokumenten untersuchen [BKK03, BK04]. Einige der dort erkannten Muster können auch bei Beschriftungen von GPM-Elementen zu Problemen führen.

Eine weitere Anregung waren Arbeiten, die Methoden der automatischen Sprachverarbeitung nutzen, um die Qualität natürlichsprachiger Anforderungen zu untersuchen [Fa02]. Entsprechende Ansätze werden bereits in verschiedenen akademischen sowie kommerziellen Werkzeugen verwendet [Ki08]. Sie lassen sich jedoch aus zwei Gründen nicht unmittelbar auf die Analyse von GPM übertragen. Erstens sind Modellelemente in GPM in der Regel nicht mit vollständigen Sätzen, sondern nur mit kurzen Wortgruppen beschriftet. Gängige Werkzeuge etwa zum Part-of-Speech-Tagging setzen aber das Vorliegen vollständiger Sätze voraus [SLG15].

Zum Zweiten müssen die Modellelemente, die den Kontrollfluss in GPM abbilden (also etwa Verzweigungen, Schleifen und Parallelität – in der Sprache BPMN durch Gateways dargestellt), ebenso als Bestandteil der zu analysierenden Sprache betrachtet werden wie die natürlichsprachigen Beschriftungen. Folglich müssen Indikatoren für Unvollständigkeit oder Missverständlichkeit in GPM sowohl den Kontrollfluss als auch die Beschrifungen der Elemente berücksichtigen.

Bisherige Untersuchungen zur Anwendung der automatischen Sprachverarbeitung in GPM zielten nicht auf das Finden potentieller Verständnisprobleme, sondern eher auf das Vorbeugen solcher Probleme durch die Durchsetzung von Namenskonventionen [LSM12, Le13] sowie Vereinheitlichung der in den Beschriftungen verwendeten Terminologie [Ha14, PW10].

Nur wenige Arbeiten beschäftigen sich mit der Analyse von Beschriftungen in GPM, um mögliche Modellierungsprobleme zu erkennen. In [GL11] zeigten wir, wie vermutliche Fehler in GPM aus der Analyse von Elementbeschriftungen erkannt werden können. Ein Beispiel für einen solchen Fehler ist, wenn im Modell die Ereignisse „Antrag angenommen“ und „Antrag abgelehnt“ gleichzeitig eintreten können. Anders als in dieser Arbeit soll es im vorliegenden Beitrag weniger um wirkliche Fehler im GPM als vielmehr um Unvollständigkeit und Unklarheit gehen. Diese müssen im Rahmen der Anforderungsermittlung erkannt und behoben werden.

Um solche Probleme in GPM zu identifizieren, wurde das in [GL11] beschriebene regelbasierte Werkzeug weiterentwickelt. Dieses zerlegt zunächst, ähnlich wie in in [LKW07] vorgeschlagen, die Beschriftung einer Aufgabe in ein oder mehrere Aktivitätsverben und Zusatzinformationen, die aus Geschäftsobjekten und näheren Angaben zu Aktivitätsverben und Geschäftsobjekten bestehen. Wie aus dem Beispiel in Abb. 2 zu erkennen ist, werden dabei Stoppwörter (z.B. Artikel) ignoriert und verschiedene Flexionsformen des Verbs in die Grundform umgewandelt. Dies geschieht mittels einer Vollformen-Liste. Sie enthält die Flexionsformen von gegenwärtig etwa 1800 Verben, die typischerweise in GPM genutzt werden. Außerdem wird eine Liste von derzeit etwa 500 Funktionsverbgefügen berücksichtigt, so dass etwa der Wendung „Genehmigung erteilen“ das Verb „genehmigen“ zugeordnet wird.

Ergebnis der Analyse ist es, dass Fragen, die während der Anforderungsermittlung auftauchen, direkt im Modellierungswerkzeug angezeigt werden (siehe Abb. 3). Ebenso ist auch ein Durchsuchen von Modellen in Stapelverarbeitung möglich.

Der kommende Abschnitt stellt die Indikatoren für potentielle Unklarheiten und offene Fragen in GPM vor, die automatisch erkannt werden können.

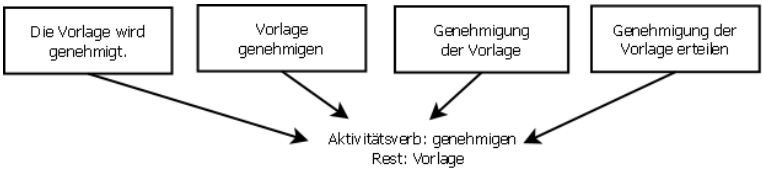


Abb. 2: Aufteilung einer Beschriftung in Aktivitätsverb und Zusatzinformationen

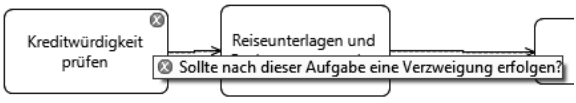


Abb. 3: Mögliches Problem wird im Modellierungswerkzeug angezeigt

3 Indikatoren für mögliche Qualitätsprobleme in Geschäftsprozessmodellen aus Sicht der Anforderungserhebung

3.1 Fehlende Aufgaben

Wenn in einem Modell wie in Abb. 1 nur der „Sonnenschein-Pfad“ modelliert ist, so ist nach einer Aufgabe, nach der üblicherweise eine Verzweigung folgen sollte, nur der „normale“ positive Ausgang modelliert. Möglich ist auch, dass in Erwartung eines positiven Ausgangs ein Test, ob dieser auch tatsächlich eintritt, ganz fehlt.

Das Vorliegen des erstgenannten Falls erkennt man daran, dass eine Aufgabe ein Aktivitätsverb wie z.B. „prüfen“ enthält, dieser Aufgabe jedoch kein XOR-Split-Gateway folgt (oder weitere Prüfungen gefolgt von einem XOR-Split). Dies ist in Abb. 1 für die Aufgabe „Kreditwürdigkeit prüfen“ der Fall. Im Kasten in Abb. 4 sind Aktivitätsverben zusammengestellt, nach denen in der Regel eine Verzweigung folgen sollte. Fehlt eine solche, ist zu hinterfragen, ob im Modell nur der positive Ausgang einer Entscheidung modelliert ist und wie in anderen möglichen Fällen zu verfahren ist.

Dass der Test auf mögliche Ausnahmen im Modell ganz fehlt, kann erkannt werden, wenn im Modell Zustände (bzw. Ereignisse) durch Wörter wie „erfolgreich“ modelliert sind, jedoch eine davorliegende Verzweigung zu einem negativen Gegenstück (hier: „erfolglos“, „ohne Erfolg“, „fehlgeschlagen“, etc.) fehlt. In Abb. 5 ist eine Auswahl der Wörter und Wortgruppen zusammengestellt, bei denen vermutet werden kann, dass auch ein möglicherweise negativer Ausgang im Modell berücksichtigt werden sollte. Besonders gut gelingt diese Analyse in Modellen in der Modellierungssprache der ereignisgesteuerten Prozessketten (EPK), da diese - anders als die Sprache BPMN - die Modellierung von Ereignissen zwingend vorschreibt.

entscheiden (Eine Entscheidung kann mehrere Ausgänge haben.), ebenso Verbindungen wie *Entscheidung treffen*
bewerten (Das Ergebnis der Bewertung sollte den weiteren Prozessablauf bestimmen.), ebenso: *abwägen*, *begutachten*, *beurteilen*, *einschätzen*, *reviewen*, *rezensieren*, *vidieren*, dazu weitere Verbindungen wie *Gutachten abgeben*
prüfen (Eine Prüfung hat immer mehr als einen möglichen Ausgang.), ebenso: *abchecken*, *abprüfen*, *checken*, *durchchecken*, *durchprüfen*, *durchtesten*, *evaluieren*, *kontrollieren*, *nachprüfen*, *testen*, *überprüfen*, *validieren*, *vergewissern*, *verifizieren*, dazu weitere Verbindungen wie *einer Prüfung unterziehen*
suchen (Möglicherweise wird das Gewünschte nicht gefunden.), ebenso: *heraussuchen*, *lokalisieren*
vergleichen (Das Ergebnis des Vergleichs sollte den weiteren Prozessablauf bestimmen.), ebenso: *abgleichen*
versuchen (Der Versuch kann glücken oder nicht.), ebenso *ausprobieren*, *erproben*, *proben*, *probieren*

Abb. 4: Aktivitäten, denen in der Regel eine Verzweigung folgen sollte.

Es gibt außerdem noch einen weiteren Fall, in dem automatisiert erkannt werden kann, dass Aufgaben im Modell fehlen: Wenn Aufgaben einander folgen, zwischen denen vernünftigerweise mindestens eine weitere Aufgabe liegen sollte. Typische Beispiele sind:

- *Daten abrufen* → *Daten löschen*
- *Dokument empfangen* → *Dokument weiterleiten* Dazwischen sollte eine Entscheidung liegen, ob und an wen das Dokument weiterzuleiten ist, oft verbunden mit einer Prüfungs- und Genehmigungsaktivität

erfolgreich, *bestanden*, *gültig*, *in Ordnung*, *korrekt*, *ok*, *mit Erfolg*
vollständig, *ausreichend*, *ohne Ausnahme*
fehlerfrei, *ohne Fehler*, *korrekt*
akzeptieren, *anerkennen*, *approbieren*, *befürworten*, *bewilligen*, *bejahen*, *billigen*, *einwilligen*, *erlauben*, *gestatten*, *genehmigen*, *gewähren*, *positiv entscheiden*, *stattgeben*, *zubilligen*, *zuerkennen*, *zugestehen*, *zulassen*, *zusprechen*, *zustimmen*, ebenso Funktionsverbgefüge wie *Einwilligung aussprechen*
einverstanden
rechtzeitig, *fristgemäß*, *fristgerecht*, *form- und fristgerecht*, *innerhalb der gesetzten Frist*
vorhanden, *verfügbar*, *auf Lager*
annehmbar, *durchführbar*, *machbar*, *gefunden*, *passend*

Abb. 5: Wörter und Wortverbindungen, die in der Regel das Vorliegen des „guten Falls“ beschreiben

- *Antrag empfangen* → *Antrag unterschreiben* Auch hier fehlt die Information, unter welchen Voraussetzungen die Unterschrift zu leisten ist.

3.2 Fehlende Informationen zu einer Entscheidung

In [BKK03, BK04] wird darauf hingewiesen, wie problematisch die Verwendung logischer Konjunktionen wie „und“, „oder“, „beziehungsweise“, etc. in Anforderungsdokumenten sein kann. Dies gilt auch für GPM: Auch wenn die gängigen Geschäftsprozessmodellierungssprachen eigene Symbole zur Modellierung von Verzweigungen und paralleler Ausführung mitbringen, finden sich doch auch in den Beschriftungen von Aufgaben in GPM solche Konjunktionen.

Ein *oder* oder *bzw.* zwischen zwei Aktivitätsverben deutet darauf hin, dass im Modell die Entscheidung, welche der beiden Aktionen durchzuführen ist, nicht modelliert ist und somit bei der Anforderungserhebung erfragt werden sollte. Ein Beispiel für eine solche Beschriftung wäre „Ware bestellen oder produzieren“[2].

Ähnliches gilt für die in Abb. 6 aufgeführten Wörter und Wortverbindungen, die darauf hindeuten, dass eine Aufgabe nur optional auszuführen ist. Auch hier ist zu hinterfragen, auf welche Weise die Entscheidung über die Ausführung zu fällen ist.

falls/wenn erforderlich/nötig/notwendig
optional, *eventuell*, *gegebenenfalls*, *in der Regel*

Abb. 6: Wörter und Wortverbindungen, auf Optionalität hindeuten

Auch wenn Entscheidung und mögliche Ausgänge modelliert sind, kann es vorkommen, dass mögliche Ausgänge im Modell vergessen wurden. Ein typischer Fall wäre ein GPM mit einer Aufgabe „Erfragen des Alters“, gefolgt von zwei möglichen Bedingungen „Anmelder unter 27 Jahre alt“ und „Anmelder über 27 Jahre alt“. Hier ist die Frage zu stellen, wie für den Randwert =27 zu verfahren ist. In [Pa05] ist beschrieben, wie eine Menge von solchen als Wertevergleich formulierten Bedingungen auf Vollständigkeit geprüft werden kann. Da Bedingungen in GPM auch in natürlicher Sprache beschriftet sein können, müssen neben den Vergleichsoperatoren auch Wortgruppen wie *ist größer als*, *beträgt*

[2] gefunden in einem Modell des BPM Academic Initiative-Repositories (bpmai.org)

mehr als, *überschreitet*, *übertrifft* oder *übersteigt* (und andere Flexionsformen dieser Verben) berücksichtigt werden.

3.3 Fehlende Informationen zu einer Aufgabe

Findet sich zwischen zwei Aktivitätsverben ein *und* oder *sowie*, (*A und B*, also z.B. *Handbuch korrekturlesen und übersetzen*), so ist zu hinterfragen, ob implizit eine zeitliche Reihenfolge ausgedrückt werden soll, d.h. A immer vor B stattfinden muss. Ebenso ist die Möglichkeit zu prüfen, ob A und B parallel durchgeführt werden sollen.

Schließlich finden sich in GPM leider häufig Aktivitätsverben, die so vage sind, dass beim Lesen des Modells unklar bleibt, welche Aufgabe denn nun konkret durchzuführen ist. So sagt eine Aufgabenbeschriftung „Arbeitsvorbereitung unterstützen“ nichts Konkretes über die erwarteten Tätigkeiten aus. Eine Zusammenstellung solcher vagen Verben, die sämtlich Aufgabenbeschreibungen in GPM entnommen wurden, findet sich in Abb. 7.

abfertigen, *absichern*, *administrieren*, *anvisieren*, *assistieren*, *aufarbeiten*, *ausgestalten*, *beachten*, *bearbeiten*, *befassen*, *befolgen*, *beitragen*, *berücksichtigen*, *beteiligen*, *bewirtschaften*, *bewirken*, *durchsetzen*, *einbinden*, *einbeziehen*, *ermöglichen*, *gewährleisten*, *helfen*, *herbeiführen*, *koordinieren*, *kooperieren*, *managen*, *mitarbeiten*, *mitwirken*, *neuorganisieren*, *nachgehen*, *organisieren*, *reagieren*, *reorganisieren*, *sicherstellen*, *unterstützen*, *verarbeiten*, *verhindern*, *vermeiden*, *verwalten*, *verwerten*, *weiterverarbeiten*, *zuarbeiten*, *zusammenarbeiten*

Abb. 7: Verben, die zu wenig über die durchzuführende Aufgabe aussagen

Ebenso gibt es Modelle, in denen nicht die Verben, sondern die Geschäftsobjekte unklar beschriftet sind. Beispiele hierfür sind Wörter wie *Daten*, *Dokument*, *Maßnahmen*, *Unterlagen* oder *Informationen*, aber auch Kombinationen wie *zuständige Stellen* oder *erforderliche Aktivitäten*, sofern nicht an anderer Stelle eindeutig dokumentiert ist, was unter den Begriffen in diesem Kontext zu verstehen ist. Auch bei solchen Begriffen muss bei der Anforderungserhebung nachgefragt werden, was jeweils genau gemeint ist.

3.4 Fehlende Informationen zu einem Datenobjekt

Selbst dann, wenn in einem GPM „nur“ der Kontroll- und nicht der Datenfluss modelliert ist, liefern Aktivitätsverben wie beispielsweise „abrufen“, „eintreffen“, „senden“ oder „weiterleiten“ Informationen über Empfang und Weitergabe von Daten und Dokumenten. Trčka et al. katalogisierten in [TvS09] Indikatoren für Datenflussprobleme in GPM, die automatisiert gefunden werden können und Anlass für gezielte Nachfragen bei der Anforderungsermittlung bieten. Ein wichtiger Fall ist, wenn in einer Aufgabe ein Dokument erzeugt wird, das von keiner anderen Aufgabe im Modell benötigt wird. Eine Prüfung für den umgekehrten Fall - ein Dokument wird benutzt, ohne dass klar ist, wann es erzeugt oder empfangen wurde, wird in [HF12] beschrieben.

Auch hier werden wir es in der Regel nicht mit einem wirklich falschen Modell zu tun haben, sondern mit einem, in das einzelne Informationen bewusst oder unbewusst nicht

aufgenommen wurden. Bei der Ermittlung von Anforderungen müssen die fehlenden Informationen über Herkunft bzw. Zweck von Dokumenten bzw. Informationen erfragt werden.

4 Zusammenfassung und Ausblick

Bei der Anforderungserhebung werden andere Qualitätsanforderungen an GPM gestellt werden als bei anderen Einsatzzwecken. Insbesondere sollen die modellierten Informationen über mögliche Ausführungspfade möglichst vollständig sein und nicht nur die häufigsten Fälle abdecken. In diesem Beitrag wurden Ideen für eine automatische Untersuchung von GPM vorgestellt. Diese Untersuchung soll fehlende Informationen in GPM aufspüren und damit Anforderungsanalytikern helfen, zusätzliche Informationen einzufordern. Es ist zu betonen, dass ein solches Werkzeug zwar eine Hilfe bei der Suche nach offenen Fragen zu einem GPM ist, jedoch keinesfalls eine gründliche manuelle Inspektion der Modelle ersetzen kann.

Bei der Entwicklung eines Werkzeug-Prototypen zeigte sich, dass die Vielfalt an Beschriftungsstilen (vgl. Abb. 2) die Aufgabe wesentlich erschwert. In einschlägigen Veröffentlichungen zur Analyse von GPM-Beschriftungen werden nicht selten vereinfachende Annahmen gemacht, etwa dass die Beschriftungen aus genau einem Verb im Infinitiv und genau einem Objekt bestehen. Eine solche Annahme ist zwar bequem und erlaubt eine schnelle Werkzeug-Erstellung. Das Werkzeug ist dann aber nur unter den getroffenen Annahmen einsetzbar (und sonst wenig nützlich).

Unter der Annahme, dass ein Anforderungsanalytiker schon existierende GPM vorgelegt bekommt, kann keine bestimmte Namenskonvention für die Modellbeschriftung vorausgesetzt werden. Wie vielfältig dabei die Regeln zur Bestimmung eines Aktivitätsverbs sein müssen, zeigen die folgenden Beispielbeschriftungen von Aufgaben in einem Geschäftsprozessmodell:

- Student bereitet sich auf Prüfung vor → Als Aktivitätsverb sollte „vorbereiten“ identifiziert werden.
- Prüfung durchführen → Als Aktivitätsverb sollte „prüfen“ identifiziert werden.
- Werkstück einer Prüfung unterziehen → Als Aktivitätsverb sollte „prüfen“ identifiziert werden.

An den Beispielen ist zu erkennen, dass für eine sinnvolle Analyse eine eingehende Beschäftigung mit der sprachlichen Vielfalt von tatsächlich in der Praxis vorkommenden Modellbeschriftungen unerlässlich (wenn auch freilich aufwendig) ist. Eine unkritische Anwendung von Standard-Werkzeugen der Computerlinguistik ohne weitere Anpassung führt nicht zum gewünschten Ziel. In den beiden letztgenannten Beispielen würden dann etwa die Aktivitätsverben „durchführen“ und „unterziehen“ ermittelt werden, was nicht wie in Abb. 3 die Folgerung erlaubt, dass nach einer entsprechend beschrifteten Aufgabe im Modell eine Verzweigung zu erwarten ist.

Der in diesem Beitrag diskutierte Werkzeug-Prototyp zur Identifikation offener Fragen zu einem GPM aus Sicht des Anforderungsanalytikers erkennt alle in Abschnitt 3 genannten Indikatoren für potentielle Unklarheiten im Modell. Darüber hinaus werden noch einige weitere gefunden, etwa fehlende Informationen über Zuständigkeiten und unterstützende EDV-Systeme. Es ist beabsichtigt, das Werkzeug weiter auszubauen und als Add-On für das freie Modellierungswerkzeug *bflow* toolbox* (www.bflow.org) bereitzustellen.

Literaturverzeichnis

[BK04] Berry, Daniel M.; Kamsties, Erik: Ambiguity in Requirements Specification. In: Perspectives on Software Requirements, Jgg. 753 in The Springer International Series in Engineering and Computer Science, S. 7–44. Springer, 2004.

[BKK03] Berry, Daniel M.; Kamsties, Erik; Krieger, Michael M.: , From Contract Drafting to Software Specification: Linguistic Sources of Ambiguity, A Handbook, 2003.

[Fa02] Fantechi, Alessandro; Gnesi, Stefania; Lami, Giuseppe; Maccari, Alessandro: Application of Linguistic Techniques for Use Case Analysis. In: Proceedings of the 10th Anniversary IEEE Joint International Conference on Requirements Engineering. S. 157–164, 2002.

[GL11] Gruhn, Volker; Laue, Ralf: Detecting Common Errors in Event-Driven Process Chains by Label Analysis. Enterprise Modelling and Information Systems Architectures, 6(1):3–15, 2011.

[Ha14] Havel, Jean-Marie; Steinhorst, Matthias; Dietrich, Hanns-Alexander; Delfmann, Patrick: Supporting Terminological Standardization in Conceptual Models - a Plugin for a Meta-Modelling Tool. In: 22st European Conference on Information Systems. 2014.

[HF12] Humm, Bernhard G.; Fengel, Janina: Assessing Semantic Consistency of Business Process Models. International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering, 6(6):94 – 99, 2012.

[Ki08] Kiyavitskaya, Nadzeya; Zeni, Nicola; Mich, Luisa; Berry, Daniel M.: Requirements for tools for ambiguity fication and measurement in natural language requirements specifications. Requir. Eng., 13(3):207–239, 2008.

[Le13] Leopold, Henrik; Eid-Sabbagh, Rami-Habib; Mendling, Jan; Azevedo, Leonardo Guerreiro; Baião, Fernanda Araujo: Detection of naming convention violations in process models for different languages. Decision Support Systems, 56(0):310 – 325, 2013.

[LKW07] Lincoln, Maya; Karni, Reuven; Wasser, Avi: A Framework for Ontological Standardization of Business Process Content. In: International Conference on Enterprise Information Systems 2007. S. 257–263, 2007.

[LSM12] Leopold, Henrik; Smirnov, Sergey; Mendling, Jan: On the refactoring of activity labels in business process models. Inf. Syst., 37(5):443–459, 2012.

[MDN09] Mohagheghi, Parastoo; Dehlen, Vegard; Neple, Tor: Definitions and approaches to model quality in model-based software development - A review of literature. Information & Software Technology, 51(12), 2009.

[Mi06] Miers, Derek: Best Practice BPM. ACM Queue, 4(2):40–48, 2006.

[Ne12] Nelson, H.James; Poels, Geert; Genero, Marcela; Piattini, Mario: A conceptual modeling quality framework. Software Quality Journal, 20(1):201–228, 2012.

[NK05] Nysetvold, Anna Gunhild; Krogstie, John: Assessing Business Process Modeling Languages Using a Generic Quality Framework. In: Proceedings of the CAiSE'05 Workshops. S. 545–556, 2005.

[OBS12] Overhage, Sven; Birkmeier, Dominik Q.; Schlauderer, Sebastian: Quality Marks, Metrics, and Measurement Procedures for Business Process Models. Business & Information Systems Engineering, 4(5):229–246, 2012.

[Pa05] Pap, Zsigmond; Majzik, Istvn; Pataricza, Andrs; Szegi, Andrs: Methods of checking general safety criteria in UML statechart specifications. Reliability Engineering & System Safety, 87(1):89 – 107, 2005.

[PW10] Peters, Nicolas; Weidlich, Matthias: Using Glossaries to Enhance the Label Quality in Business Process Models. In: Dienstleistungsmodellierung 2010. 2010.

[Ri10] Rittgen, Peter: Quality and perceived usefulness of process models. In: Proceedings of the 2010 ACM Symposium on Applied Computing. ACM, New York, NY, USA, S. 65–72, 2010.

[SLG15] Storch, Arian; Laue, Ralf; Gruhn, Volker: Flexible Evaluation of Textual Labels in Conceptual Models. In: Enterprise modelling and information systems architectures - EMISA 2015. 2015.

[TvS09] Trčka, Nikola; van der Aalst, Wil M. P.; Sidorova, Natalia: Data-Flow Anti-patterns: Discovering Data-Flow Errors in Workflows. In: Conference on Advanced Information Systems Engineering 2009. Jgg. 5565 in Lecture Notes in Computer Science. Springer, S. 425–439, 2009.

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 106

Requirements Engineering and Business Process Management as preconditions for the application of the Cloud Blueprinting Model

Lisardo Prieto-González[1], Johannes Schubert[2]

Abstract: In this paper, we test the cloud blueprinting approach against a modelled use case. Hereby, we show the importance of both Requirements Engineering (RE) and Business Process Management (BPM) to that application. We highlight the main features of Business-Process-as-a-Service (BPaaS) and the Cloud Blueprint approach, and explain how the integration of requirements following a standard classification allows to enhance the interoperability with other existing models. This is done by means of a business process example modelled with BPMN and later translated to the Blueprint Specification Language (BSL) with the help of RE.

Keywords: Requirements Engineering, Business Process Management, IT, Cloud Computing, Software Engineering, Cloud Blueprinting Model.

1 Introduction

As automation of internal processes is one of the main concerns for businesses operating at different scales, the advent of cloud computing could make it possible for cloud users to outsource the automation processes once undertaken in-house. Business-Process-as-a-Service (BPaaS) is an extension [Hö09] [Zh12] [Mo11] to the traditional three-level cloud stack [Va08], and is already promoted for the utilization of cloud computing in different scenarios [SSY14]. With BPaaS, business processes can be delivered via cloud either vertically or horizontally [LBM12].

The aim of this paper is to test the cloud blueprinting approach against a modelled use case and hereby show the importance of both Requirements Engineering (RE) and Business Process Management (BPM) to that application. The paper is structured as follows: in section 2, we highlight the main features of BPaaS and the cloud blueprint approach. In section 3, we propose a standard classification for RE. In section 4, we briefly explain a given use case in a health care scenario which is modelled with BPMN and its potential for the BPaaS layer. One process is exemplary then translated to the blueprint specification language (BSL) with the help of RE. In section 5, we give a conclusion and encourage future work on this promising approach.

[1] Universidad Carlos III de Madrid, Avenida de la Universidad 30, 28911 Leganés (Madrid) Spain, lisardo.prieto@uc3m.es
[2] SRH Hochschule Berlin, Institute of Information System, Ernst-Reuter-Platz 10, 10587 Berlin, johannes.schubert@srh-hochschule-berlin.de

2 BPaaS and Cloud Blueprinting

2.1 Business-process-as-a-Service

Although slightly mentioned before [Ac11], the BPaaS concept was more frequently discussed from 2011 when Papazoglou and van den Heuvel explained their "*syndicated multichannel cloud delivery model*" [PH11] adding the BPaaS layer to the traditional cloud stack consisting of SaaS, PaaS, and IaaS [MG09]. Purpose of the BPaaS model is a full integration of the other layers to a cloud ecosystem based on the specific needs which are given by the business processes of the cloud user. Central focal point of the BPaaS approach is the virtualization of end-to-end processes which are translated into the proposed cloud blueprinting languages in order to standardize deployment plans and adapt cloud configuration according to the needs of the respective business processes [PH11]. Main advantage of the BPaaS paradigm is the change from "*a monolithic SaaS/PaaS/IaaS stack architecture where a one-size-fits-all mentality prevails*" [Ng12] to a mash up of cloud services in order to provide tailored service-based applications (SBA).

2.2 The Cloud Blueprint Model

The blueprint languages are proposed in order to apply the BPaaS model to the cloud. In other words, based on given business processes, standardized requirement templates for SaaS, PaaS, and IaaS can be filled accordingly [PH11]. Even though the model is very mature it is still at system design level and use cases are rarely to find [CWW15]. While BPaaS is becoming more popular, research on the blueprint model only reveals literature related to the "4CaaSt" FP7 project [Ga12], where the approach has been developed. The blueprint model is the projects' reaction to at least seven lacks the researchers could find in a state-of-the-art study on cloud standardization support [Ta12]. In [Ng11], the authors present the blueprint as an abstract description of a cloud service offer hiding the technical details and complexities. The blueprint template is more elaborated in [Ng12], explaining the structural schema of the blueprint XML file, providing more details about the proposed language. The fundamental blueprint structure is described as follows:

Basic Properties: basic description properties (e.g. unique ID, release date),
Offering: properties of according cloud service offerings (e.g. names, functionalities, signature interfaces, interaction protocols),
Implementation Artifacts: list of artifacts implementing the offerings (e.g. binary files, configuration files, deployable web packages).
Resource Requirements: required cloud resources including their QoS requirements,
Virtual Architecture: visualization of the target architecture to provide interdependencies and interconnections between the offerings, implementation artifacts and resource requirements,

Policy: non-functional properties as declared in service level agreements (e.g. security, privacy, compliance requirements).

The most detailed description of the blueprint model is given in [Ng13]. Here, the term Blueprint Specification Language (BSL) was introduced, displacing and extending the previously used Blueprint Definition Language (BDL). The blueprint structure became more diverse with the help of modules that reduce complexity and focus on specified requirements.

Finally, Nguyen [Ng13] gives an overview on future issues which are e.g. a potential extension of categories, resource description modules, and further validation of the concept. Concluding the findings about BPaaS and the blueprint approach, we can make the following general statements:

- The BPaaS paradigm supports the definition and deployment of business process related cloud services.
- The blueprint model is a solid and stable approach to apply the BPaaS layer to any kind of cloud marketplaces.
- The Blueprint Specification Language is supporting RE with a standardized structure and extensible parameter set.

3 Standard classification for RE

Requirements capture and analysis phase is used in the different methodologies to acquire the customer's needs and translate them into a set of requirements that define what the system must do and how well it must perform among other characteristics. During this phase, the systems engineer must ensure that the requirements present various attributes [Li01] [Ma94]. While business process modelling focuses on the interdependency of tasks and users within the business process, it creates a managerial perspective on the set of tasks. The BSL template, however, is supposed to integrate different system offers to match with the requested task. Therefore, specifying requirements by using standardized classifications is an inevitable precondition to let the cloud blueprinting concept take full effect.

Summing up, requirements must be, among other set of characteristics: complete, comprehensive, concise, unambiguous and understandable [SBA13].

Usually, requirements are documented following a standard classification. Although there are general classification schemes [Li01], this study will be focused in the categories defined under FURPS+ [Gr92] for Information Systems by Hewlett-Packard. FURPS+ Is the acronym for Functional, Usability, Reliability, Performance, Supportability and the extension (+) includes three additional categories: Constraints, Interface Requirements and Business Rules. In the following, the categories and sub-categories are shown:

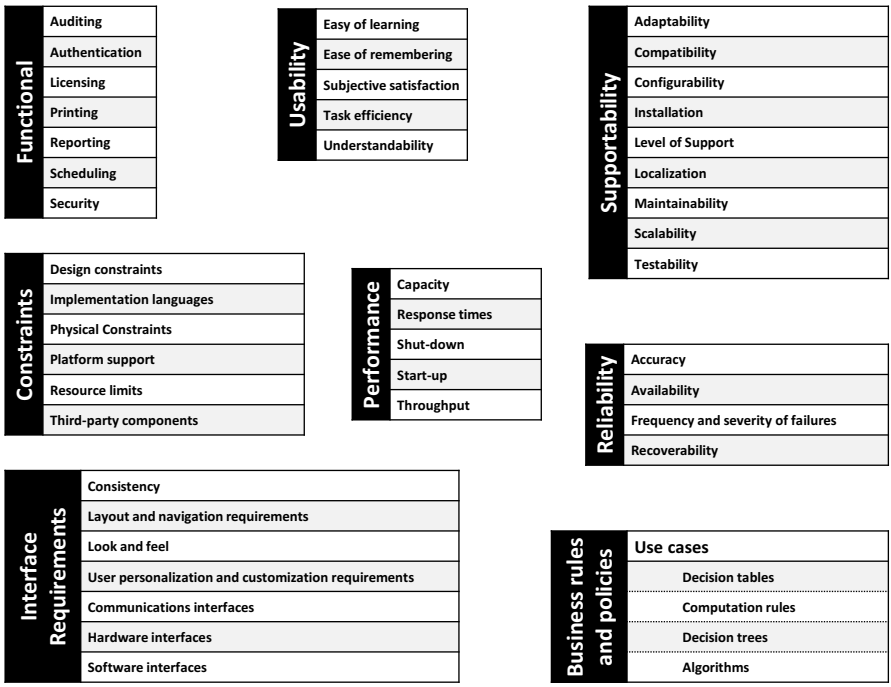


Figure 1. Requirements categories defined by FURPS+

In order to verify that the different types of system-wide requirements covered by FURPS+ have been considered, it seems to be useful to follow an organized strategy during the capture phase and use a checklist [Ec12].

4 Translation of a business process to BSL

Since the blueprint model is intended to organize and structure requirements and definitions for service-based applications (SBA), we are seeking to evaluate its benefits with applying the model to a given use case in a health care scenario. The use case is present in BPMN which will be translated to the blueprint model. The translation is done in two steps. First, the relevant processes modelled in BPMN will be extracted. Second, the core definitions of these processes are applied to the blueprint template. Actually, the business processes imply all technical requirements directly, so the target blueprint will remain incomplete at this stage. However, in this paper we are seeking for the general application, so that this issue is not considered now.

Within our use case, we introduce a smart blister dispenser for residential care facilities. The blister dispenser controls whenever a medication blister was taken by the occupant of the care facility and checks against a database whether medication needs to be taken or not. The complete process with all users involved is modelled as shown in Figure 2.

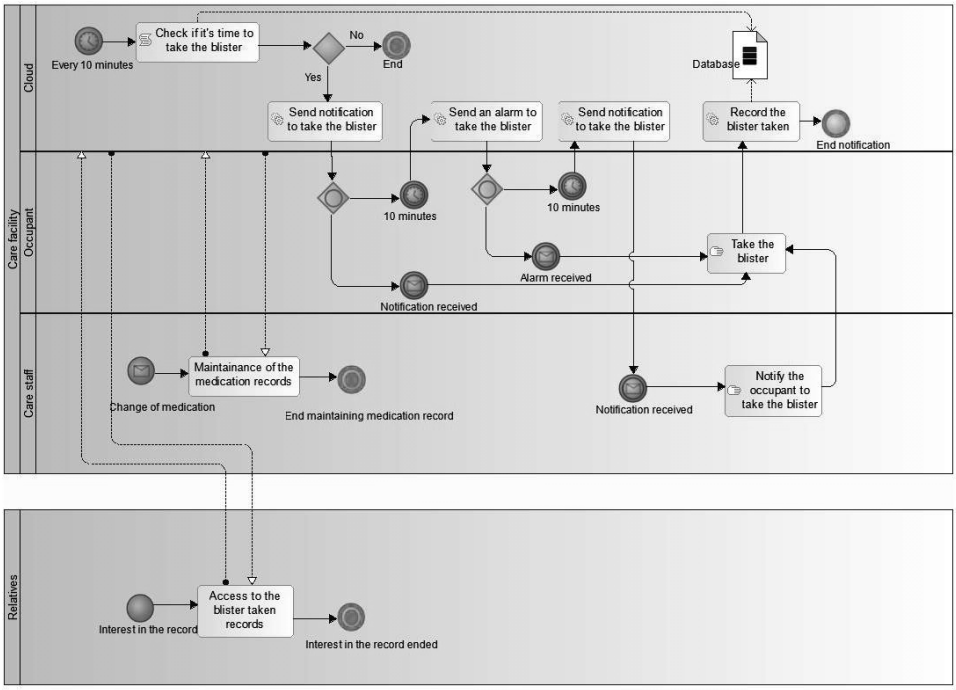


Figure 2. Full BPMN model for the smart blister dispenser use case

In order to create the BPaaS layer for this use case, the modelled processes in the cloud lane are extracted. In other words, the future business processes fulfilled by the cloud, are filtered and briefly explained. These processes and their properties are defined in Table 1.

Process	User	Usage	Parameters	User Requirements
Check for blister to be taken	Web back-end	Every 10 minutes match current time against time the blister needed to be taken by specific person stored in a database table	Request: current time Response: Person, dedicated output device, number of blisters, time of blister to be taken, status of blister taking	Server is able to handle script tasks on a regularly basis
Send notification for the blister to be taken	Server	If time of blister to be taken is less than 10 minutes compared to current time and blister was not taken yet, send an XML or JSON file to the dedicated end user device	Request: message status, number of blisters to be taken Response: status feedback	Server is able to push XML or JSON files
Send message for the blister to be taken	Server	Send an XML or JSON message to specific entity accordingly to the following conditions: • To the dedicated end-user device, if time of blister to be taken is between 10 and 20 minutes compared to current time and blister was not taken yet. Notification. • To the nurse/nursing manager logged in, if time of blister to be taken is more than 20 minutes and less than 30 minutes compared to current time and blister was not taken yet. Alarm.	Request: message status, number of blisters to be taken Response: status feedback	Server is able to push XML or JSON files
Log blister taking	Server	After receiving an XML (?) message about the usage of a specific blister, insert the associated data to the database	Request: current time, medication time, person, number of blisters taken Response: status feedback	Server is able to handle incoming XML or JSON messages
Point out blister taking to the occupant	Web front-end	If XML file (?) arrives at the nurses' computer having the web front-end connected to the cloud web service, a toaster in the browser and a desktop notification open to provide information	Request: message status, number of blisters to be taken Response: feedback	Smart Watch is attached to the occupant

Table 1: Example process extracted from use-case

The human readable table of business processes can now be translated to target blueprints. As follows, we exemplary apply the first process to the most elaborated blueprint XSD template explained in [Ng13] and the XML implementation explained in [Ng12]. A brief implementation example is presented in Figure 3.

```
BlisterUsageCheck-CoreBlueprint.xml
<basic_information_section>
        <blueprintID>1</blueprintID>
        <blueprintName>Check for blister to be taken</blueprintName>
        <description> Every 10 minutes match current time against time
        the blister needed to be taken by specific person stored in a
        database table </description>
        <ownership>OpSIT</ownership>
        <status>unresolved</status>
</basic_information_section>
<requirements_section>
        <Requirement>
                <requirementID>1</requirementID>
                <requirementName>Regular script handling</requirementName>
                <requirementType>SaaS</requirementType>
        </Requirement>
        <Requirement>
                <requirementID>2</requirementID>
                <requirementName>Database</requirementName>
                <requirementType>PaaS</requirementType>
        </Requirement>
</requirements_section>
```

Figure 3: BSL core module for the blister usage check

By means of compilers theory, it would be feasible to develop a converter, able transform directly from BPMN notation to BSL language. However, even if it seems a trivial task, it requires some advanced semantic artificial intelligence processing, plus a large and dynamically growing and structured dataset of specific requirements associated to certain actions/interactions/cases. This dataset can be designed to grow by the application of semi-automatic machine learning techniques, being required human experts in the initial enrichment phases, but becoming autonomous eventually. This way, the idea of a translator able to interpret the semantics of BPMN could check the cited dataset to infer the most promising requirements according to the particular cases, outcoming automatically a proper BSL description. Nevertheless, this approach is strongly dependent on the quality, complexity and completeness of the requirements dataset.

In this work we do not want to focus in the idea of a translator. Besides, we have considered its implementation in a later work, as we think it may improve a lot the conversion process, and can enrich the knowledge about the semantics between BPMN, RE and BSL.

Due to the very flexible structure of the blueprint model, we hereby confirm the

application of business processes extracted from BPMN models to the blueprint XSD template. Using the XSD template obviously demands a precise definition of requirements. Summarized, our translation approach shows the importance of a clear definition of processes and its requirements already at the modelling level.

5 Conclusions and future work

In this paper, we highlighted the main features of BSL, and proposed a standard classification for RE. In order to create a sample blueprint for a given use case, we explained how the business processes modelled in BPMN can be translated to a Cloud Blueprint. With a simple example, we could emphasize previous statements which explain that the extensible design of the blueprint template is able to include more requirements for the engineering of service-based applications [Ng12] [Ng13]. Furthermore, we strongly recommend the integration of requirements following a standard classification as this allows to enhance the interoperability with other existing models, increasing the semantic concept of the solution, and reducing potential risks derived from an unstructured analytics development phase. Also, we believe that such integration may lead to much more engagement in the scientific community on the cloud blueprint model, which makes it even more applicable for cloud marketplaces, developers and service providers.

Acknowledgements

This publication is based on the research project “OpSIT” which received financial funding from the ministry of education, science, research and technology (BMBF) under the funding sign 16SV6048 within the programme „IKT 2020 - Forschung für Innovationen“. The authors are responsible for the content.

Bibliography

[Ac11] Accorsi, R.: Business process as a service: Chances for remote auditing. In: *Computer Software and Applications Conference Workshops (COMPSACW) IEEE 35th Annual*. 2011.. S. 398-403.

[CWW15] Chang, V.; Walters, R.J.; Wills, G.: Cloud Computing and Frameworks for Organisational Cloud Adoption. *Delivery and Adoption of Cloud Computing Services in Contemporary Organizations* (1), 2015.

[Ec12] Eclipse Process Framework: *Checklist: System-Wide Requirements (FURPS+)*. http://epf.eclipse.org/wikis/openup/core.tech.common.extend_supp/guidances/checklists/system_wide_rqmts_furps_3158BF2F.html, 2012.

[Ga12] Garcia-Gomez, S.: 4CaaSt: Comprehensive Management of Cloud Services through a PaaS. In: *10th International Symposium on Parallel and Distributed Processing with Applications*. 2012.. S. 494-499.

[Gr92] Grady, R.B.: *Practical software metrics for project management and process improvement*. Prentice-Hall, 1992.

[Hö09] Höing, A.: An orchestration as a service infrastructure using grid technologies and WS-BPEL. In *Service-Oriented Computing*. Berlin Heidelberg: Springer. S. 301-315, 2009.

[LBM12] Lau, C.; Birsan, V.; Madapusi, B.: *IBM Developer Works*. IBM. http://www.ibm.com/developerworks/websphere/library/techarticles/1203_lau/1203_lau.html, 2012. zuletzt geprüft am 06.08.2015.

[Li01] Lightsey, B.: *Systems engineering fundamentals*. (Report) DTIC., 2001.

[Ma94] Mazza, C. et al.: *Software engineering standards*. Prentice-Hall, 1994.

[MG09] Mell, P.; Grance, T.: The NIST definition of cloud computing. *Natl. Inst. Stand. Technol*, 53, 6 (2009), 50.

[Mo11] Moscato, F.: An analysis of mosaic ontology for cloud resources annotation. In: *Federated Conference on Computer Science and Information Systems*. 2011.. S. 973-980.

[Ng11] Nguyen, D.K.: Blueprint template support for engineering cloud-based services. In *Towards a Service-Based Internet*. Berlin Heidelberg: Springer. S. 26-37, 2011.

[Ng12] Nguyen, D.K.: Blueprinting Approach in Support of Cloud Computing. *Future Internet*, 4. S. 322-346, 2012.

[Ng13] Nguyen, D.K.: *Blueprint model and language for engineering cloud applications*. (Dissertation) Tilburg: CentER, Center for Economic Research., 2013.

[PH11] Papazoglou, M.P.; van den Heuvel, J.W.: Blueprinting the cloud. *IEEE Internet Computing* (6). S. 74-79, 2011.

[SBA13] Saavedra, R.; Ballejos, L.; Ale, M.: Software Requirements Quality Evaluation: State of the art and research challenges. In: *14th Argentine Symposium on Software Engineering*. 2013..

[SSY14] Sun, Y.; Su, J.; Yang, J.: *Separating execution and data management: a key to Business-Process-as-a-Service (BPaaS)*., 2014.

[Ta12] Taher, Y.: On engineering cloud applications-state of the art, shortcomings analysis, and approach. *Scalable Computing: Practice and Experience*, 3 (13). S. 215-231, 2012.

[Va08] Vaquero, M.: A break in the clouds: towards a cloud definition. *ACM SIGCOMM Computer Communication Review*, 1 (39). S. 50-55, 2008.

[Zh12] Zhang, L.J.: Editorial: Big services era: Global trends of cloud computing and big data. *IEEE Transactions on Services Computing* (4). S. 467-468, 2012.

Werkzeugpräsentation

Hans-Georg Fill, Agnes Koschmider

Ziel des Tracks „Werkzeugpräsentation“ war es, Modellierungswerkzeuge zu präsentieren, die im wissenschaftlichen Umfeld entwickelt wurden und werden. Die Leitung für diesen Track haben PD Dr. Hans-Georg Fill und PD Dr. Agnes Koschmider übernommen. Vorgestellt wurden sechs Modellierungswerkzeuge, die einen interessanten Einblick in die aktuellen Entwicklungen im Bereich Modellierungswerkzeuge geben.

Aus den sieben eingereichten Beiträgen wurden sechs Beiträge auf Basis von jeweils mindestens zwei Gutachten eines internationalen Programmkomitees ausgewählt. Die ausgewählten Werkzeuge bieten verschiedene Modellierungsunterstützungen. Es wurde ein Werkzeug für eine natürlichsprachliche Modellierungsassistenz und eines für die mobile Modellierung von Geschäftsprozessen vorgestellt. Eine weitere Demo zeigte eine service-orientierte (BPaaS) Modellierungsunterstützung und eine Mehrebenen-Modellierung. Das Werkzeug CAE ermöglicht eine kollaborative Modellierung von Web-Anwendungen. Zur Unterstützung von Wissensarbeit wurde der Knowledge Work Designer vorgestellt.

Die Realisierung der Werkzeugpräsentation wäre nicht ohne die Unterstützung von zahlreicher Seite möglich gewesen. Die Organisatoren möchten sich daher besonders bei den Autoren der Beiträge für die Einreichung der Arbeiten und die Demonstrationen der Tools sowie bei den Mitgliedern des Programmkomitees für die fristgerechte Anfertigung der Gutachten bedanken. Ebenso ergeht der Dank an die Organisatoren der Modellierung 2016 für die Ermöglichung des Tracks im Hauptprogramm der Tagung.

Die Werkzeugpräsentation fand am Donnerstag, den 03. März 2016 in Karlsruhe statt.

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 117

Flexible Deep Modeling with Melanee

Colin Atkinson and Ralph Gerbig[1]

Abstract: Multi-level modeling has gained increasing attention in recent years as the maturity of the supporting tools has grown. One of the most advanced tools for deep modeling is Melanee [Me16] which supports modeling through deep, multi-format, multi-notation user-defined languages. "Multi-format" refers to seamlessly editing a language in several formats in parallel (e.g. diagrammatic, textual and tabular) while "multi-notation" denotes the ability to mix notations arbitrarily (i.e. to show one part of a model in a general-purpose, UML-like, notation and one part in a domain-specific notation such as BPMN). The deep modeling component of the tool, underpinned by the orthogonal classification architecture and deep instantiation, allows models to contain as many classification levels as needed to concisely represent the domain in hand. This demonstration shows the capabilities of the Melanee tool in the context of defining a language to model the structure of an enterprise.

Keywords: Domain-specific Languages, Deep Modeling, Melanee, Tool Demonstration

1 Introduction

The market for domain-specific language engineering tools is strongly segmented by the set of features which modeling tools provide. For instance most tools focus exclusively on one explicit format (i.e. textual, diagrammatic, etc.) and are usually limited to support just two classification levels at a time (i.e. type level and instance level). An exception is Jetbrains MPS which specializes in supporting multi-format editing but lacks support for working with more than just two levels. However, no commercial tool today supports multi-format, multi-notation, domain modeling across multiple classification levels. This capability is advantageous in many domains, especially model execution [AGM15], enterprise language evolution [AGF15], cyber-physical systems modeling [At14], formal security policy modeling [At12] and many more.

In this demonstration, a prototype tool called Melanee which meets this need for multi-format, multi-notation domain-specific modeling will be presented. The implemented example revolves around the creation of a language capable of modeling the structure of an enterprise and demonstrates the following features: 1. multi-notation editing, 2. multi-format editing, 3. seamless multi-level editing, 4. deep, aspect-oriented concrete syntax definition 5. and deep context-sensitive languages.

2 Deep Modeling

Deep modeling is a form of multi-level modeling supporting the creation of models with arbitrary numbers of classification levels based on the Orthogonal Classification Architecture (OCA) [AK03] and deep instantiation [AK01]. An example of a how a deep enterprise model fits into the OCA is shown in Figure 1.

The OCA is implemented as two classification stacks aligned orthogonally to one another. One of these is the linguistic stack, labeled L_2 to L_0, and the other is the ontological stack,

[1] University of Mannheim, Chair of Software Engineering, 68159 Mannheim, {atkinson, gerbig}@informatik.uni-mannheim.de

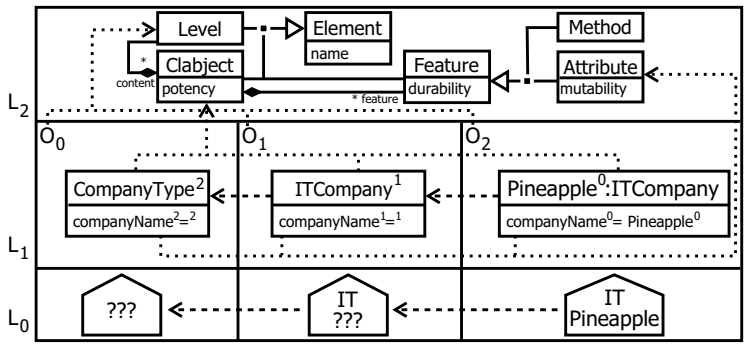


Figure 1: An illustration of the Orthogonal Classification Architecture.

labeled O_0 to O_2. Although this example shows an ontological stack with only three levels, the number of levels is not limited in general. The so called linguistic meta model, L_2, defines all constructs available in the deep modeling language for populating the ontological levels. Examples of these in Figure 1 are *Clabject* and *Feature*. *Clabject* is the superclass for entities and connections and *Feature* the superclass for *Method* and *Attribute* which characterize clabjects. Except for those in the most abstract ontological level, all clabjects have two types in a deep modeling environment — the ontological type (horizontal, dashed lines) indicating the clabject's type from the point of view of the problem domain and the linguistic type (vertical, dotted lines) used to represent a model element in the tool. The linguistic meta model is implemented as an Ecore meta model in Melanee.

Connections and entities are referred to as *Clabjects* because they play the role of types (class) and instances (object) at the same time. This becomes obvious in the middle ontological levels, e.g. *ITCompany* is an instance of *CompanyType* and a type for *Pineapple* at the same time in the example.

Deep instantiation is the capability to specify over how many subsequent levels a model element can influence other model elements. In other words, it represents the "deepness" of a model element. The concept of deep instantiation is implemented in Melanee through potencies which are attached to *Clabjects* (*potency*), *Features* (*durability*) and *Attribute* values (*mutability*). The rule for all potencies is that they have to be decreased by one when an instantiation takes place. Model elements with a potency smaller than 0 cannot exist. In Melanee, potencies are displayed next to the name of *Clabjects* and *Features*, and the *mutability* next to the value of *Attributes* as shown in Figure 1.

3 Melanee

The architecture of the Melanee tool is displayed in Figure 2. The tool is built on the *Eclipse Platform* using the *GMF*, *EMF*, *Epsilon* and *OCL* projects. The basic Melanee download is based on this technology stack. Its features are: 1. the *Linguistic Model* defining the deep modeling language 2. the diagrammatic *Deep Model Editor* featuring the default UML-like syntax for editing deep models 3. the *Visualization Search* algorithm which finds the notations and formats to visualize a model element 4. the *Emendation* service offering seamless deep model editing and 5. *Workbench Management* functionality such as storage of user preferences.

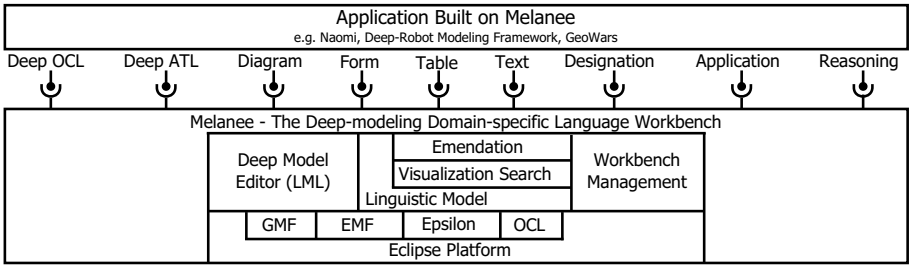


Figure 2: The Melanee architecture.

This core functionality can be extended by implementing extension points. At the time of writing the following extension points are available with reference implementations: 1. the *Deep OCL* constraint language 2. the *Deep ATL* transformation language supporting deep model to deep model transformations, ecore to deep model transformations and deep model to ecore transformations 3. *diagram*, *textual*, *tabular* and *form* supporting predefined and user-defined languages in their corresponding format 4. *designation* capabilities for the advanced naming of model elements 5. an *application* language supporting the modification of the modeling environment itself and 6. *Reasoning* services including model checking. For all of these extension points additional implementations can be provided by using standard Eclipse APIs which lowers the learning curve when extending Melanee.

The Melanee framework has been used to implement several prototypes demonstrating the capabilities of deep modeling. The orthographic software modeling environment Naomi [AGT13a] applies the deep modeling approach to store its central underlying data model and the views on this model using deep, predefined languages. Naomi also realizes transformations between the views and the central data model through the deep ATL [AGT13b] dialect. A prototype robot modeling language [At14] has been implemented which is extensible to different kinds of robots and can be used to create executable behavior by means of executing the C code produced by the textual, user-defined language feature. To demonstrate the advantages of deep modeling in the area of model execution a game, GeoWars [AGM15], has been implemented on top of the Melanee framework. In this demonstrator, a Melanee model is connected through sockets to a model execution engine. This bidirectional connection allows changes in the running game to be reflected in the Melanee model and vice versa. This prototype demonstrates amongst other things the advantages of distinct ontological levels for behavior modeling and behavior execution.

4 Building a User-Defined Language with Melanee

The Melanee workbench is shown in Figure 3. The workbench has a *Project Explorer* on the left hand side which is used for managing projects and the deep models they contain. The example shows a project to model a company called *Pineapple*. This project contains a deep model named *Employee Structure*. Below the *Project Explorer* the graphical *Outline* of the model currently opened in the diagram editor is displayed. Most of the space on the screen is occupied by the diagrammatic, deep model editor. In Figure 3 the *Employee Structure* model is opened. This screenshot shows a modeling language being defined. At this point in time the highest level, O_0 displays three types, *CompanyType*, *DepartmentType*

and *EmployeeType*. These clabjects with potency two have been instantiated at the next level, O_1, into the concepts of *ITCompany* and different *Departments*. The *Palette* on the right hand side of the editor provides the tools to build a deep model. Instantiation of model elements is achieved through the *DSL Elements* section which dynamically displays the types which can be added to the currently selected model element. A toolbar offering actions for a particular model element has been opened on the *Department* clabject and the notation "drop down" for the graphical (diagrammatic) format has been selected. The user-defined *Company* notation, the built-in *LML* notation or the notation selected by the model element container (*Derived*) are available for selection. The properties view at the bottom offers capabilities to edit linguistic attributes (*Linguistic* tab page) or ontological attributes (*Ontological* tab page). The *Visualization Editor* view to the right of the *Properties* view is used to define the visualization of clabjects in all formats at run-time.

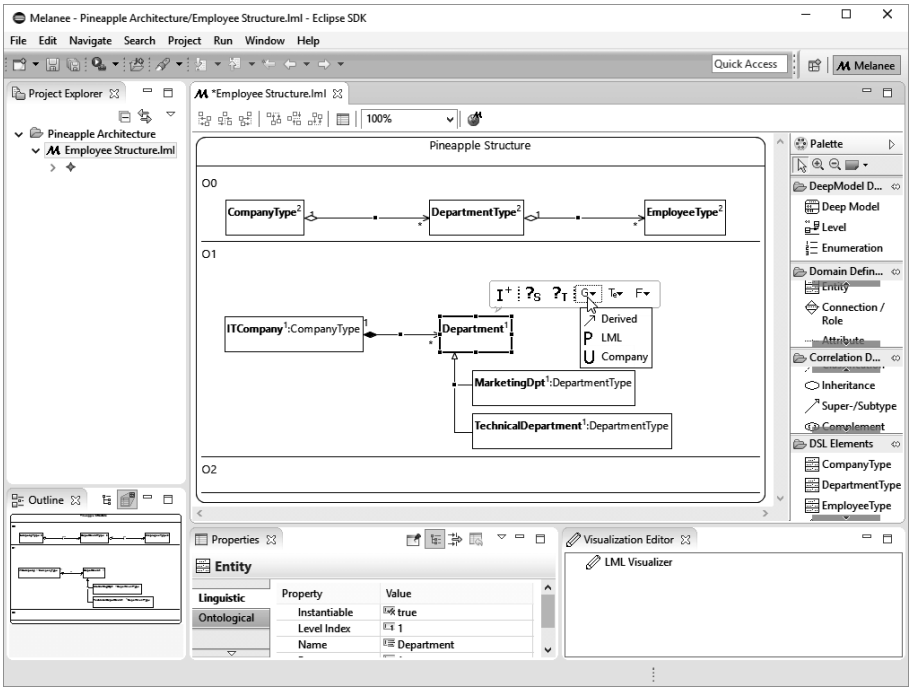


Figure 3: Building up the company structure example.

The final result created during the tool demonstration is displayed in Figure 4. The user-defined modeling language is used to model a company called *Pineapple* consisting of two departments and two employees. The model is displayed in a diagrammatic format (left), form-based format (top right) and textual format (below form editor). The model can be edited in all formats without one format negatively influencing another format.

5 Conclusions

In this tool demonstration we have shortly introduced the deep modeling approach, outlined the architecture of the Melanee tool and shown how a deep modeling language spanning three ontological levels can be defined. Additionally, the created model can be edited

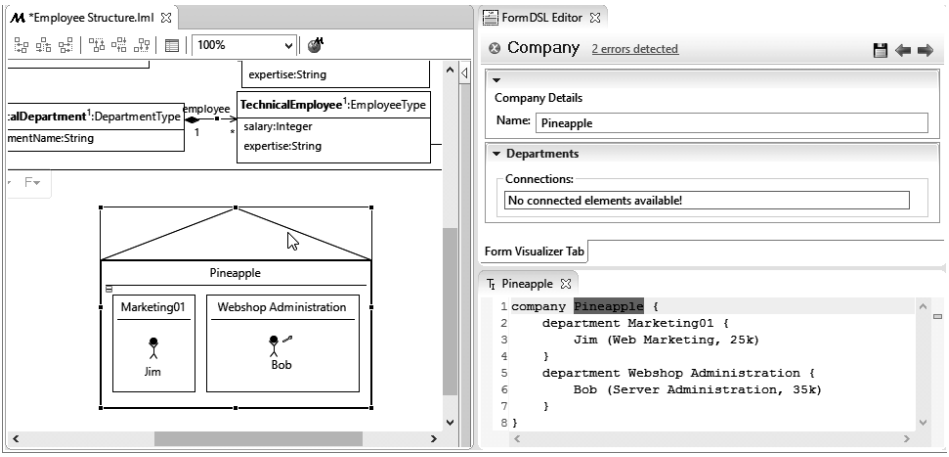


Figure 4: Displaying *TechnicalEmployee* in three fromats.

in three different formats. Melanee is the only tool at the time of writing which provides such deep, multi-format, multi-notation, user-defined modeling capabilities.

References

[AGF15] Atkinson, Colin; Gerbig, Ralph; Fritzsche, Mathias: A multi-level approach to modeling language extension in the Enterprise Systems Domain. Information Systems, 2015.

[AGM15] Atkinson, Colin; Gerbig, Ralph; Metzger, Noah: On the Execution of Deep Models. In (Mayerhofer, Tanja; Langer, Philip; Seidewitz, Ed; Gray, Jeff, eds): Proceedings of the 1st International Workshop on International Workshop on Executable Modeling. Exe 2015, 2015.

[AGT13a] Atkinson, Colin; Gerbig, Ralph; Tunjic, Christian: A Multi-level Modeling Environment for SUM-based Software Engineering. In: Proceedings of the 1st Workshop on View-Based, Aspect-Oriented and Orthographic Software Modelling. VAO '13, ACM, New York, NY, USA, pp. 2:1–2:9, 2013.

[AGT13b] Atkinson, Colin; Gerbig, Ralph; Tunjic, ChristianVjekoslav: Enhancing classic transformation languages to support multi-level modeling. Software & Systems Modeling, pp. 1–22, 2013.

[AK01] Atkinson, Colin; Kühne, Thomas: The Essence of Multilevel Metamodeling. In (Gogolla, Martin; Kobryn, Cris, eds): UML 2001. Springer, 2001.

[AK03] Atkinson, Colin; Kühne, Thomas: Model-Driven Development: A Metamodeling Foundation. IEEE Softw., 20(5):36–41, September 2003.

[At12] Atkinson, Colin; Barth, Florian; Gerbig, Ralph; Freiling, Felix; Schinzel, Sebastian; Hadasch, Frank; Maedche, Alexander; Muller, Benjamin: Reducing the Incidence of Unintended, Human-Caused Information Flows in Enterprise Systems. In: 16th International Enterprise Distributed Object Computing Conference Workshops. 2012.

[At14] Atkinson, Colin; Gerbig, Ralph; Markert, Katharina; Zrianina, Mariia; Egurnov, Alexander; Kajzar, Fabian: Towards a Deep, Domain Specific Modeling Framework for Robot Applications. MORSE '14. CEUR-WS.org, pp. 4–15, 2014.

[Me16] Melanee: , Project Website. `http://www.melanee.org`, 2016.

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 123

Community Application Editor: Collaborative Near Real-Time Modeling and Composition of Microservice-based Web Applications

Peter de Lange[1], Petru Nicolaescu[1], Michael Derntl[2], Matthias Jarke[1,3], Ralf Klamma[1]

Abstract: Research shows a gap in terms of requirements elicitation between developers and end-users. Due to the low technical expertise of some members of online communities, they often cannot collaborate efficiently with developers and cannot provide continuous feedback during application development processes. However, collaborative modeling processes can play an important role in education, enforcing best-practices, support rapid prototyping and lower the communication and collaboration barriers between developers and end-users. This paper presents a tool for collaborative modeling of Web applications in near real-time and their automatic generation. Early evaluation with end-users in simulated community settings show promising results for the interplay of modeling and collaboration in requirements gathering and Web application design and development. We claim that near real-time modeling on the Web has the potential to bring together stakeholders during design and development and offers a new perspective on model-based Web Engineering.

Keywords: Near Real-time Modeling, Conceptual Models, Model Driven Web Engineering, Microservices, Web Widgets

1 Introduction

In many disciplines modeling is a key activity in defining abstract representations of the target domain. Models obtain meaning through creative social processes, which are driven by different perspectives of involved stakeholders [DFK02]. Modeling of Web applications [GCP01], model-based code generation and methods for Web Engineering with respect to Web applications [AK03] and application flow [KKK07] have been thoroughly analyzed during the past decades. However, the impact of near real-time (NRT) collaborative modeling onto requirements elicitation, information systems design and implementation with the purpose to bring together developers and end-users has not been studied so far in the context of the NRT Web 2.0. Therefore, this work presents the Community Application Editor (CAE), a tool for the development of Web applications based on a NRT collaborative modeling approach. Using a given Web application metamodel, end-users and developers involved in Communities of Practice [We98] can model together a desired application and easily generate modular code for both server-side (using microservices) and client-side (using Web widgets). The entire software used and generated is open

[1] RWTH Aachen University, Chair for Information Systems and Databases, Ahornstr. 55, 52074 Aachen, Germany, {lastname}@dbis.rwth-aachen.de
[2] Eberhard Karls Universität Tübingen, eScience-Center, Wilhelmstr. 32, 72074 Tübingen, Germany, michael.derntl@uni-tuebingen.de
[3] Fraunhofer FIT, Schloss Birlinghoven, Konrad-Adenauer-Straße, 53754 Sankt Augustin, Germany

source and targets online communities that can take advantage of NRT collaborative technologies which allow free, concurrent shared editing. Section 2 gives a short summary of the approach used for collaborative conceptual modeling on the Web. Section 3 presents the collaborative modeling process and the tool realization.

2 Near Real-time Modeling on the Web

So far, the conceptual modeling literature has emphasized little on the opportunities and challenges of NRT collaboration for conceptual modeling and model-driven application development. For the design phases of information systems, models result from the collaboration between different stakeholders. Although there are many metamodeling and modeling tools available, few of those support synchronous Web-based collaboration and are published under open source licenses using open libraries and protocols. Closing this gap, we have developed the metamodeling framework SyncMeta [De14, De15], which enables the collaborative creation of metamodels and the generation of collaborative model editors from the defined metamodels. It supports NRT collaborative (meta-) modeling in the Web browser and is implemented as open source[4] using widely known Web protocols. SyncMeta was successfully used to create (meta-) models of various conceptual modeling languages (e.g. entity relationship diagrams, i*, IMS LD). The framework was developed based on ROLE SDK, a widget-based platform offering user management and communication and collaboration between multiple users directly in the browser. It consists of multiple widgets [De14], the modeling logic and the collaborative (meta-) model editing being implemented entirely as decentralized client-side features. Web Widgets are simple interface elements that offer a single, clear-cut functionality and can be embedded in various Web applications. As a further step, this work demonstrates the power of NRT collaborative modeling for achieving modern Web applications through the active participation of online communities members with various technical background. Using a well-defined metamodel for Web applications and NRT collaborative modeling as communication and negotiation means (e.g. for an implicit requirements elicitation and the architecture specification of the designed software), developers and end-users can benefit from a structured approach to (re)design and implement Web applications. Together with model-based code generation features, benefits of such an approach are rapid prototyping scenarios, a well-designed software architecture landscape throughout the communities software stack and new opportunities for technology adoption and education means.

3 The Community Application Editor

CAE offers the means to co-design and implement Web applications with model driven Web engineering techniques. Resulting applications are based on a componentized and scalable architecture consisting of Web widgets (client-side) and microservices (server-side). Mirroring the widget components, microservices[5] are scalable server components with a clear-cut functionality which can run independently on multiple infrastructures.

[4] https://github.com/rwth-acis/syncmeta

[5] http://martinfowler.com/articles/microservices.html

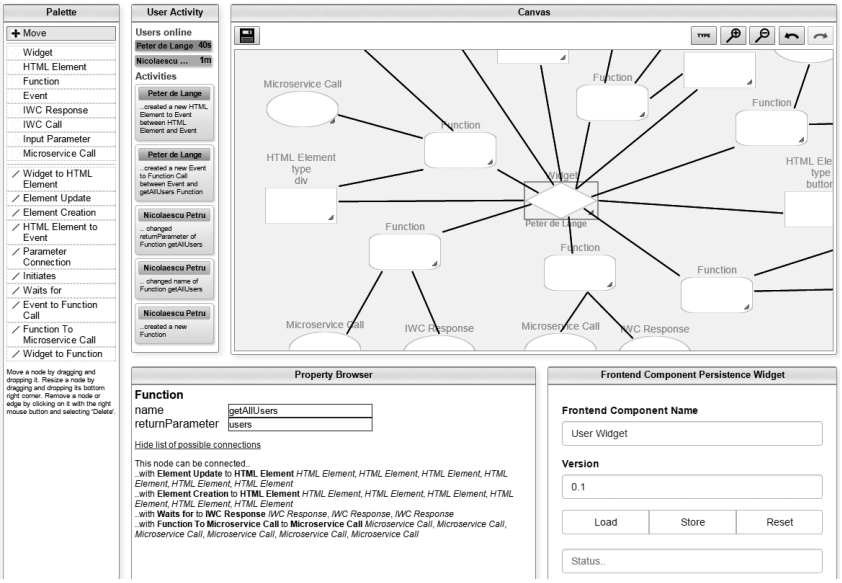


Fig. 1: Frontend Component Modeling Space

Since the target groups for our tool are online communities, users have various roles, such as developer, software architect or non-technical community member. Any community member can join a collaboration session to design and generate a Web application. Using SyncMeta, they can model in NRT an application model. The modeling process is based on a predefined metamodel, reflecting the complete application, split up into three different "views" to allow for a componentized architecture that can be developed separately or in parallel. A view is dedicated to the client-side, where the widgets and the user-interface application flow (e.g. functions, events, elements) are defined. The second view represents the server-side part of the application model, where the microservices are defined, together with the database and the service APIs. The third view, partially overlapping with the previous two is used for the communication between the various components. In this view, the application can be mashed up together using the already specified components. Once a widget or microservice is collaboratively specified, it can be persisted. While being saved, the respective component model is also transformed to code and pushed into an open source code repository, using a template structure together with the model information to generate the source code of the component reflected by the model. Optional (manual) code refinements can be done afterwards, before the complete application is mashed up from the generated components. The mash-up model view contains the dependencies between microservice and widgets and the inter-microservice and inter-widget communication. Upon agreement on the content of the three views composing the application model (i.e. the requirements are fulfilled), the complete application can be persisted. A repository gets created for the application code, which can be later used for deployment.

Figure 1 shows the CAE frontend component modeling space, which realizes the view on a single component of the client-side. It consists of five widgets. Modelers use the *Palette*

widget to select the different objects defined by the frontend component metamodel. These objects are then placed in the *Canvas* widget and connected according to the metamodel definitions. The canvas also gives information about currently selected objects by other users, raising the awareness of the modeling community. Another awareness related feature is realized by the *User Activity* widget, which shows recent changes in the model of each user, for example adding of edges or moving of objects. The *Property Browser* widget is used to display additional information about an object selected in the canvas. It shows both the attributes of an object, which can be modified by each user, as well as a list of objects the selected object can be connected to. All changes done in the modeling canvas as well as the property browser are propagated in NRT to all users. Finally, the *Frontend Component Persistent Widget* can be used to both store the model in a database and generate code from it, which is then automatically pushed to a code repository. It can also be used to load existing models for further editing.

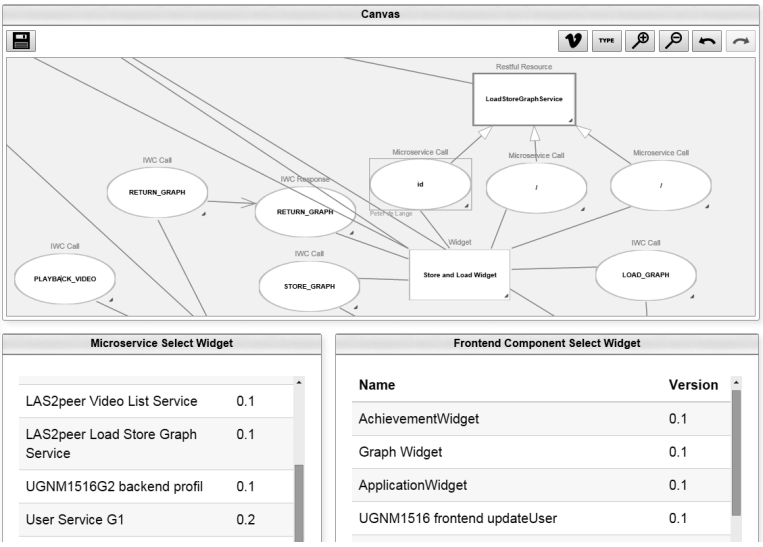


Fig. 2: Mash-Up Modeling Space

Figure 2 shows a screenshot of third view of the CAE's metamodel, the mash-up modeling space. The difference from the frontend component modeling space is the absence of the palette widget, which is replaced by a list of available frontend and microservices. The modelers can select those and place them on the canvas. After saving the application model, a so called communication view is calculated by the backend, which shows the dependencies and interrelationships of the single components. The last modeling space, which realizes the server-side (microservice) view of an application, is similar to the frontend component space, with the difference in the available objects and dependencies for modeling, corresponding to the underlying metamodel part.

We successfully used the CAE to redesign an existing collaborative Web application used for graph-based storytelling[6]. This follows a simple use-case, where members of a cultural

[6]https://github.com/rwth-acis/CAE-Example-Application

heritage community want to develop a simple system for linking videos in a graph-based manner and visualize individual videos. Helped by developers, they model in NRT a video list and a graph microservice and the corresponding widgets: a graph-rendering canvas with video element nodes, a list for graphs and videos and a video player widget. Upon saving the models, the code is automatically generated using the templates. Finally, the developers will finalize the functionality and improve the user interface presentation style. Based on this, the CAE demonstration showcases the generation of a complete Web application, similar to the already existing YouTube demonstration video[7]. We have performed a user study in a simulated community setting, using groups of two or three users consisting of at least one developer and one user with no technical background. After modeling a trivial social (blog-like) application, the feedback was gathered using an online survey and user interviews. Our user evaluation showed promising results which will be presented in future publications. The sources of the CAE can be found on GitHub[8] [9] [10] [11] [12]. The generated applications can be found in the CAE's GitHub organization[13].

Acknowledgments

This research was funded by the EU Commission in the project "Layers" (FP7-318209).

References

[AK03] Atkinson, C.; Kühne, T.: Model-Driven Development: A Metamodeling Foundation. IEEE Software, 20(5):36–41, 2003.

[De14] Derntl, M.; Erdtmann, S.; Nicolaescu, P.; Klamma, R.; Jarke, M.: Echtzeitmetamodellierung im Web-Browser. In (H.G. Fill; D. Karagiannis; U. Reimer, eds): Modellierung 2014, pp. 65–80. Gesellschaft fur Informatik e.V., 2014.

[De15] Derntl, M.; Nicolaescu, P.; Erdtmann, S.; Klamma, R.; Jarke, M.: Near Real-Time Collaborative Conceptual Modeling on the Web. In: Conceptual Modeling. volume 9381. Springer International Publishing, pp. 344–357, 2015.

[DFK02] Dittrich, Y.; Floyd, C.; Klischewski, R.: Social Thinking–Software Practice. MIT Press, Cambridge and MA, 2002.

[GCP01] Gomez, J.; Cachero, C.; Pastor, O.: Conceptual Modeling of Device-Independent Web Applications. IEEE Multimedia, 8(2):26–39, 2001.

[KKK07] Kraus, A.; Knapp, A.; Koch, N.: Model-Driven Generation of Web Applications in UWE. In: 3rd International Workshop on Model-Driven Web Engineering (MDWE), volume 261. CEUR-WS, 2007.

[We98] Wenger, E.: Communities of Practice: Learning, Meaning, and Identity. Learning in doing. Cambridge University Press, Cambridge, UK, 1998.

[7] https://www.youtube.com/watch?v=Vuyj2e32ePk
[8] https://github.com/rwth-acis/CAE-Code-Generation-Service
[9] https://github.com/rwth-acis/CAE-Model-Persistence-Service
[10] https://github.com/rwth-acis/CAE-Templates
[11] https://github.com/rwth-acis/CAE-Simple-Model-Representation
[12] https://github.com/rwth-acis/CAE-SyncMeta-Additions
[13] https://github.com/CAE-Community-Application-Editor

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 129

Kollaborative Modellierung von Geschäftsprozessen mit kontrollierter natürlicher Sprache

Timm Caporale[1]

Abstract: Organisationen benötigen ein effektives und effizientes Geschäftsprozessmanagement, um ihre Ablauforganisation an den ständigen Wandel externer Rahmenbedingungen anzupassen. Das in diesem Beitrag präsentierte Werkzeug stellt hierzu zwei neue Artefakte zur Geschäftsprozessmodellierung vor. Zunächst wird eine Methode beschrieben, die durch die Verwendung von Satzschablonen aus kontrollierter natürlicher Sprache automatisch Geschäftsprozessmodelle erzeugt. Darauf aufbauend wird ein Szenario präsentiert, das den Modellierungsprozess durch den Versand von E-Mails kollaborativ gestaltet. Die Kombination der beiden Methoden soll im Rahmen dieses Beitrags neue Möglichkeiten für Modellierungsaktivitäten verdeutlichen.

Keywords: BPM, business process modeling, natural language processing, collaborative modeling

1 Einleitung

Externe Rahmenbedingungen wie beispielsweise der globale Wettbewerbsdruck, komplexe Geschäftsmodelle und der Wunsch nach einer stärkeren Kundenorientierung führen dazu, dass Organisationen ihre Strategie und damit auch ihre Geschäftsprozesse ständig anpassen müssen. Methoden für diese Anpassung bietet das Geschäftsprozessmanagement (BPM). Das Vorgehensmodell der meisten existierenden Ansätze sieht im Allgemeinen vor, dass in einem ersten Schritt die Geschäftsprozessmodellierer das Prozesswissen einer Organisation durch zum Beispiel (un-)strukturierte Experteninterviews oder Workshops von den Wissensträgern extrahieren und daraus Geschäftsprozessmodelle ableiten. Diese Erhebungstechnik ist für viele Situationen sehr gut geeignet. Probleme können allerdings auftreten, wenn z.B. zwischen Wissensträgern und Modellierern große Barrieren vorhanden sind oder in der Anwendungsdomäne die Prozesse in einem hohen Maße von Erfahrungswissen abhängen. Dieser Beitrag stellt ein prototypisches Werkzeug vor, um den Wissensträger in die Geschäftsprozessmodellierung einzubeziehen.[2]

2 Werkzeugpräsentation

Das vorzustellende Werkzeug wurde als Webapplikation entwickelt und basiert auf dem ASP.NET MVC Web Application Framework (http://www.asp.net/mvc). Das Framework wurde benutzt, da es viele Vorteile bei der Trennung von Datenbank, Datenmodell, Verarbeitungslogik und User Interface bietet und so eine Weiterentwicklung einzelner Module

[1] Karlsruher Institut für Technologie (KIT), Institut für Angewandte Informatik und Formale Beschreibungsverfahren (AIFB), Kaiserstr. 89, 76133 Karlsruhe, timm.caporale@kit.edu

[2] Der Prototyp wird unter https://bpm.caporale.eu zur Verfügung gestellt.

relativ einfach möglich ist. Die Applikation kann durch die Verwendung eines flexiblen User Interfaces sowohl auf Desktopgeräten als auch auf mobilen Endgeräten ausgeführt werden. Darüber hinaus bietet das verwendete Framework die Möglichkeit, eine Office-App zu entwickeln, die eine Integration der Anwendung in die Offie-Produkte (Word, Excel, PowerPoint und Outlook) als Seitenleiste ermöglicht. Die Integration in Office-Produkte ist insofern interessant, als dass viele Informationen über Geschäftsprozesse entweder bereits in Office-Produkten vorhanden sind (z.B. in E-Mails, Word-Dokumenten, Präsentationen oder Excel-Dateien) oder Office-Anwendungen zur Kommunikation und Präsentation von Geschäftsprozessmodellen benutzt werden.

2.1 Erzeugung von Prozessmodellen aus kontrollierter natürlicher Sprache

Verwandte Ansätze, die sich mit der Analyse von natürlicher Sprache beschäftigen (z.B. [FMP11, LMP14]), analysieren meistens Geschäftsprozessdokumentationen und versuchen aus diesen anschließend Geschäftsprozessmodelle zu erzeugen. Die hier vorgestellte Methode basiert im Gegensatz dazu auf der Verwendung von dynamischen Satzschablonen, die bei der Erstellung solcher Dokumentationen verwendet werden sollen. Satzschablonen dienen dazu, die natürliche Sprache einzuschränken und Formulierungen kontrolliert und bewusst zu verwenden. (Statische) Satzschablonen werden beispielsweise im Requirements Engineering verwendet, um Softwarefunktionen zu spezifizieren [Po10]. Während im Requirements Engineering jede Anforderung für sich steht und diese idealerweise auch vollständig beschreibt, ist jeder Teil einer textuellen Beschreibung eines Geschäftsprozesses für sich kontextsensitiv. So beschreibt der Satz ”Sobald die Lieferung versendet wurde, kann die Rechnung im Buchungssystem verbucht werden.” nur einen Ausschnitt aus einem Geschäftsprozess und ist für sich genommen abhängig vom Kontext der Aktivitäten ”Lieferung versenden” und ”Rechnung verbuchen”. Das Beispiel soll zeigen, dass Satzschablonen, wie sie im Requirements Engineering verwendet werden, nicht ohne kontextsensitive Informationen für die Beschreibung von Geschäftsprozessen benutzt werden können. Die Satzschablonen, die im Werkzeug verwendet werden, werden daher zur Laufzeit dynamisch an den aktuellen Kontext angepasst.

Das entwickelte Werkzeug zeigt dem Benutzer zur Kontrolle der natürlichen Sprache eine Satzschablone an, die er benutzen muss, um Aktivitäten in einem Textfeld zu beschreiben. Abb. 1 zeigt eine englische Satzschablone im rechten Bereich der Webapplikation und das Eingabefeld (Description) im linken Bereich. Momentan wird die Beschreibung im Werkzeug durch Texteingabe erstellt, eine optionale Spracheingabe ist allerdings in Entwicklung, um die Eingabe vor allem auf mobilen Endgeräten in Zukunft komfortabler zu gestalten.

Sobald der Anwender mit der Eingabe beginnt, wird der Beschreibungskontext ausgewertet und in ein Geschäftsprozessmodell transformiert. Die Transformation der textuellen Beschreibung wird dabei durch einen Text-Parser realisiert. Der im Werkzeug verwendete Parser wurde mit ANTLR[3] erstellt und basiert auf der Arbeit von [Ke14]. ANTLR

[3] http://www.antlr.org

verwendet zur Erzeugung des Parsers eine Grammatik in angepasster erweiterter Backus-Naur-Form. Die verwendete Grammatik repräsentiert dabei ein generisches Petri-Netz und beschreibt die Kontrollflusspattern Sequenz, Alternative, Parallel Split, Synchronisation und Simple Merge. Ein Auszug der Grammatik wurde in [Ko15] Abschnitt 3.2 veröffentlicht. Der mit ANTLR erstellte Text-Parser erzeugt im Werkzeug einen Abstract Syntax Tree (AST), aus dem das Geschäftsprozessmodell erzeugt wird. Jeder Knoten im AST repräsentiert dabei ein Kontrollflusskonstrukt, aus dem durch den entsprechenden Knotentest im Werkzeug Stellen, Transitionen und Kanten eines Petri-Netzes erzeugt werden. Die Erzeugung eines einfachen BPMN-Modells ist ohne Anpassung der Grammatik möglich und wird noch implementiert. Das zugehörige Geschäftsprozessmodell wird als Grafik erzeugt und im unteren Bereich des Werkzeugs angezeigt (vgl. Abb.1). Zur Grafikerzeugung wird Graphviz verwendet[4].

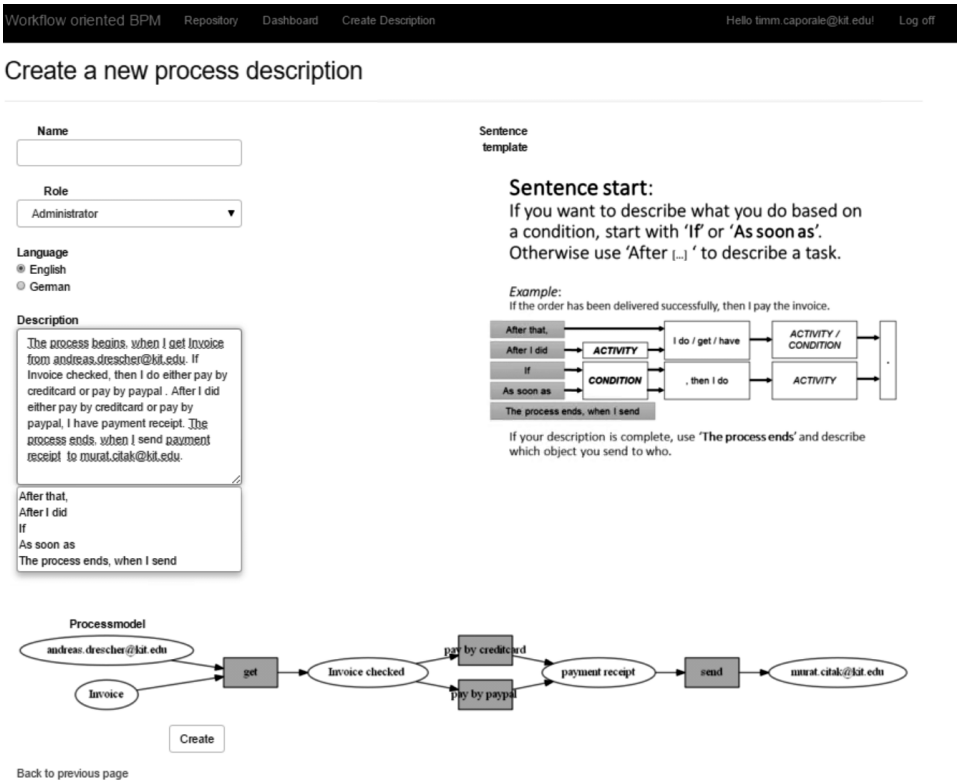


Abb. 1: Screenshot des Werkzeugs als Webapplikation im Browser

Neben der Transformation der textuellen Beschreibung in ein Geschäftsprozessmodell führt das Werkzeug auch eine Analyse der verwendeten Grammatik im aktuellen Kontext durch. Nach jedem eingegebenen Wort wird dabei die Satzschablone, auf Grundlage der Parsergrammatik, an den aktuellen Beschreibungskontext dynamisch angepasst. Das Ergebnis der Analyse ist dabei eine Vorhersage zu möglichen Folgeknoten, welche in der

[4] http://www.graphviz.org

Webapplikation als Auto-Vervollständigung-Funktion realisiert sind und unter dem Eingabefeld auftauchen (Abb.1). Der Benutzer sieht hier eine Liste möglicher Formulierungen, die als nächstes benutzt werden können.

Die Analyse der textuellen Beschreibung findet auf Serverseite statt. Die Kommunikation zwischen Client- und Server ist dabei mit JavaScript und AJAX-Anfragen realisiert. Hier werden JSON-Objekte mit dem Server ausgetauscht und das Ergebnis auf Clientseite angezeigt. Es ist geplant die Analyselogik in einer späteren Version auf dem Client durchzuführen um so eine Offline-Funktionalität zu realisieren.

2.2 Szenario zur kollaborativen Modellierung von Geschäftsprozessen

Die zweite Methode, die in dem vorgestellten Werkzeug umgesetzt wurde, adressiert kollaborative Modellierungsaspekte. Mit Kollaboration ist dabei weniger eine synchrone Zusammenarbeit gemeint, sondern vielmehr die gegenseitige Unterstützung und Motivation der Mitarbeiter im Modellierungsprozess. Das kollaborative Szenario sieht vor, dass zu jeder Prozessbeschreibung Meta-Informationen über Eingangsbedingung und Ausgangsbedingung angegeben werden. Diese Informationen stellen im weitesten Sinne Ressourceninformationen dar. Als Eingangsbedingungen sollen im Szenario Informationen über den Prozessauslöser angegeben werden. Ein Beispiel ist, dass ein Mitarbeiter ein Ms Excel Dokument mit Performance-Kennzahlen zur Analyse per E-Mail zugeschickt bekommt. In diesem Szenario werden durch das Werkzeug die Informationen über das Ms Excel-Dokument und über den Mitarbeiter, von dem der Auftrag kommt, abgefragt und gespeichert. Als Ausgangsbedingung werden im Szenario dieselben Informationen abgefragt, wie zur Eingangsbedingung. Im Speziellen könnten das Informationen darüber sein, welche Dokumente oder Produkte an wen verschickt oder übergeben werden. Eine Beschreibung des eigentlichen Prozesses (hier: Analyse der Performance-Kennzahlen) kann dann wie im vorherigen Abschnitt beschrieben durchgeführt werden.

In dem geschilderten Szenario beschreibt weiterhin jeder Wissensträger zunächst nur seine eigenen Aktivitäten, die er zu einem Geschäftsprozess beiträgt, angereichert mit der Angabe von Eingangs- und Ausgangsbedingung. Das kollaborative Szenario entsteht, indem auf Werkzeugseite zu jeder Prozessbeschreibung, die im System angelegt wird, E-Mails an die beteiligten Ressourcen verschickt werden. Wird beispielsweise der Mitarbeiter Bob in einer Prozessbeschreibung von Alice erwähnt, wird er vom Werkzeug per E-Mail darüber in Kenntnis gesetzt und gebeten seinen Beitrag zu dem von Alice beschriebenen Prozess zu dokumentieren. An dieser Stelle wird auch die Möglichkeit der Werkzeugintegration in die Office-Produktfamilie interessant, indem aus der E-Mail heraus das Werkzeug im E-Mail-Programm ausgeführt werden kann. Im Werkzeug können die Informationen über Eingangs- und Ausgangsbedingung durch eine Anpassung der Grammatik im Text-Parser ebenfalls in natürlicher Sprache angegeben werden. Die Prozessgrafik stellt diese Bedingungen dann als Stellen am Anfang und am Ende des Prozesses dar (vgl. Abb.1).

Die im Werkzeug implementierte Methode erzeugt zu jeder im Beschreibungstext angegebenen Humanressource einen eindeutigen Link, und versendet diesen zusammen mit der

E-Mail. Durch Aufrufen des Links wird auf Werkzeugseite eine individuelle Seite für den Benutzer erzeugt und die dem System bereits bekannten Informationen zum Prozesskontext dargestellt. Einem neuen Benutzer, der per E-Mail dazu gebeten wird Informationen zu seinen Tätigkeiten einzutragen, wird so möglichst leichtgewichtig in die Modellierung eingeführt.

3 Zusammenfassung und Ausblick

Das beschriebene Werkzeug mit den beiden implementierten Artefakten soll neue Möglichkeiten im Bereich der Geschäftsprozessmodellierung aufzeigen. Es bindet durch die Entwicklung als Webapplikation auf mobilen und stationären Endgeräten die Anwender schnell und einfach in die Modellierungsaktivitäten mit ein. Sie können so leichtgewichtig ihre Tätigkeiten in natürlicher Sprache beschreiben und bekommen zu jedem Zeitpunkt die zu ihrem Text korrespondierende grafische Darstellung des Prozesses als Prozessmodell angezeigt. Das workflowbasierte Versenden von E-Mails, die zur Modellierung auffordern und für jede Prozessbeschreibung versendet werden, stellt weiterhin einen neuen Kollaborationsaspekt dar. Eine Integration des Werkzeuges in Ms Office-Produkte vermeidet darüber hinaus einen Medienbruch.

Als Ausblick ist denkbar, dass durch die textuelle Eingabe neue Anwendungsfelder entstehen. Im medizinischen Bereich beispielsweise, wo Ärzte ohnehin mit vorgefertigten Formulierungen ihre Argumentation für eine Diagnose aufstellen, könnten mit dem vorgestellten Ansatz viele Prozessmodelle automatisch generiert und anschließende analysiert werden. Das kollaborative Szenario entspricht weiterhin einem Bottom-Up Ansatz, der zur Dokumentation und zum Verstehen interner Abläufe beiträgt.

Die Entwicklung des Werkzeuges als Prototyp ist soweit fortgeschritten, dass die Funktionalität präsentiert werden kann. Als kommende Schritte sollen erste Evaluationen durchgeführt und damit Feedback zu den beschriebenen Methoden eingeholt werden, um so schrittweise weitere Module und die Oberfläche zu verbessern.

Literaturverzeichnis

[FMP11] Friedrich, Fabian; Mendling, Jan; Puhlmann, Frank: Process model generation from natural language text. In: CAiSE 2011. Springer, S. 482–496, 2011.

[Ke14] Keuter, Björn: Bidirektionale Abbildung zwischen Geschäftsprozessmodellen und IT-Kommunikationssystemen. KIT Scientific Publishing, 2014.

[Ko15] Koschmider, Agnes; Caporale, Timm; Fellmann, Michael; Lehner, Jonas; Oberweis, Andreas: Business Process Modeling Support by Depictive and Descriptive Diagrams. In: EMISA 2015. LNI, S. 31–44, 2015.

[LMP14] Leopold, Helmut; Mendling, Jan; Polyvyanyy, Artem: Supporting process model validation through natural language generation. Transactions on Software Engineering, 40(8):818–840, 2014.

[Po10] Pohl, Klaus: Requirements engineering: fundamentals, principles, and techniques. Springer, 2010.

The Knowledge Work Designer - Modelling Process Logic and Business Logic

Knut Hinkelmann[1], Arianna Pierfranceschi[2], Emanuele Laurenzi[3]

Abstract: The Knowledge Work Designer is a tool that implements a modelling method for knowledge work. It is based on two principles: (1) the separation of business logic and process logic and (2) the support of both structured and unstructured knowledge. Process logic can be represented in a structured way in BPMN and in a non-structured way with CMMN. For deep integration of business processes and case a new model type is offered. Business logic can be represented in a structured way using decision tables. Unstructured business logic can be represented in documents.

Keywords: modelling method, process model, case management, decision modeling, knowledge work, process logic, business logic

1 Introduction

The Knowledge Work Designer is a tool that implements a modeling method, which supports processes that involve knowledge work. It is based on the following two principles, which allow to cover a broad spectrum of knowledge work: (1) modelling process logic and business logic and (2) support of knowledge work with different degrees of structure.

In a business process one can distinguish between process logic and business logic.

- Process logic is the knowledge *about* the process, in particular the process flow with events and activities, the involved participants and resources. The process logic is typically represented in a business process diagram.
- The business logic is the knowledge *in* the process. It corresponds to the practice aspect of Davenport (2010) and is about how the work is actually done. Understanding business logic means to understand how individual workers or applications respond to the real world of work and accomplish their assigned tasks.

Both process logic and business logic should be considered equally important. The

[1]FHNW University of Applied Sciences and Arts Northwestern Switzerland, School of Business, Riggenbachstrasse 16, CH-4600 Olten , knut.hinkelmann@fhnw.ch
[2] FHNW University of Applied Sciences and Arts Northwestern Switzerland, School of Business, Riggenbachstrasse 16, CH-4600 Olten , arianna.pierfranceschi@gmail.com
[3] FHNW University of Applied Sciences and Arts Northwestern Switzerland, School of Business, Riggenbachstrasse 16, CH-4600 Olten , emanuele.laurenzi@fhnw.ch

balance between process logic and business logic is an important consideration for anyone attempting to address knowledge work Davenport (2010).

About 60% of a knowledge worker's day is spent in un-structured and often unpredictable work patterns, only about 40% is structured, predictable and automatable (Palmer 2011). Gadatsch (2012, p.43) distinguishes three types of processes with respect to their degree of structure: structured processes, cases and ad hoc processes. While adhoc processes cannot be modelled at all, there are modelling languages for structured processes and cases:

- For structured processes, the activities and the conditions for their execution are known in advance. The Knowledge Work Designer uses the Business Process Model and Notation BPMN 2.0 (OMG 2011) to model structured business processes.
- Case processes contain both structured and ad-hoc parts. Human judgment and external events determine how to proceed (McCauley 2010). Case Management has been proposed as an alternative approach for the management of case processes (Palmer 2011). The Case Management Model and Notation (CMMN) is a modelling language specific for case management (OMG 2014).

The distinction between different degrees of structure is not only relevant for process logic, but also for business logic.

- Business rules can be represented in natural language or in a semi-structured form like the SBVR Structured English Notation (OMG 2008 Annex C).
- Decision making often is based on a fixed number of decision criteria which can be represented in a structured way using decision tables, which are part of the Decision Model and Notation DMN (OMG 2015).

2 Relevance of Knowledge Work Designer for the Community

The Knowledge Work Designer contributes to the community with respect to three aspects:

1. it supports the balance between process logic and business logic by providing model types for both. This allows to model decision-aware business processes, which "distinguish between tasks that perform work (i.e., process tasks) and tasks that come to conclusions based on business logic (i.e., decision tasks)" (von Halle & Goldberg 2010, p.66).
2. it supports the different structure degree of process logic (i.e. structured processes and case processes) by providing a new model type called BPCMN (Business Process and Case Management Notation).
3. it supports the different structure degree of business logic by providing a document model type and a DMN model type respectively.

3 Model Types of the Knowledge Work Designer

The Knowledge Work Designer tool is available in the following link: http://knut.hinkelmann.ch/download/kwd.zip. It has been implemented in ADOxx (http://www.adoxx.org) and uses the information retrieval, model analysis and simulation features of ADOxx. Figure 1 shows the user interface of the modelling tool with a BPMN sample process.

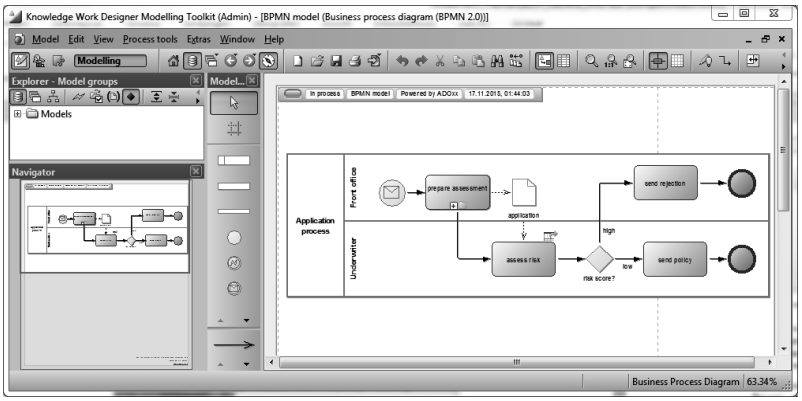


Figure 1. Screenshot of a business process model in the Knowledge Work Designer

Figure 2 shows an example of a case management model in the Knowledge Work Designer tool. The diamonds on the boundaries of tasks are called Sentries. Sentries define the criteria according to which the plan items are enabled and terminated.

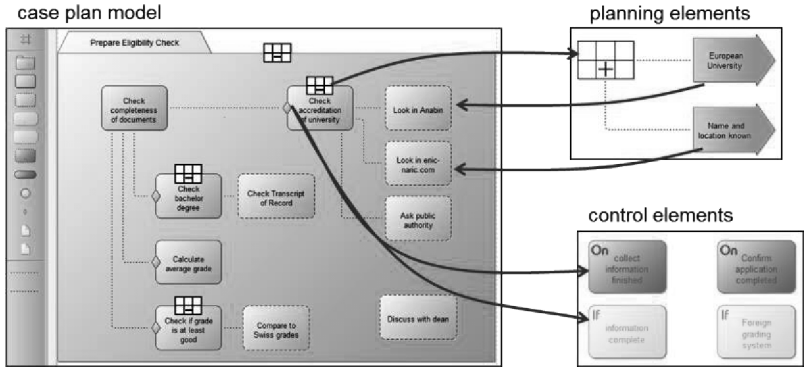


Figure 2. A sample case plan model with references to control and planning elements

A sentry is a combination of an event and/or a condition. An On-Part specifies the event that serves as a trigger. The If-Part specifies a condition that evaluates over the Case File. In order to enable reuse, conditions and events of sentries are modelled in a separate model type - the control elements model (see at the lower right-hand corner of

Figure 2). Furthermore, the case worker is supported in his/her planning by applicability rules. The applicability rules are modelled in a separate model to enable reuse for different discretionary tasks.

While case management is often considered as different from conventional business process management (Palmer 2011), in reality they cannot be strictly separated. The BPCMN model type deeply integrates modelling of structured processes and cases (Figure 3). Flexibility of process execution is represented by the discretionary tasks, whose execution depends on the judgment of the individual worker. Furthermore, it is possible to add tasks, which are not part of the sequence flow and thus can be executed as soon as their sentry evaluates to true.

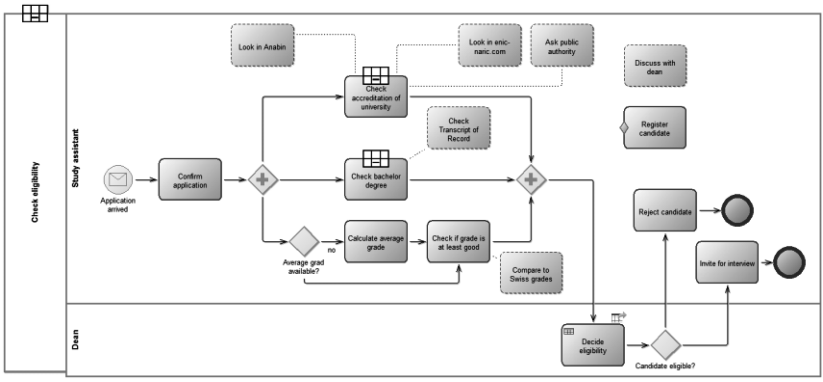
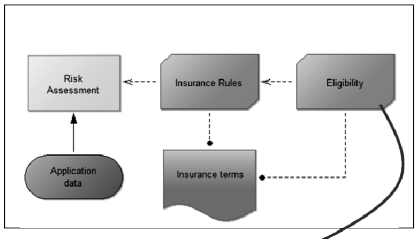


Figure 3. A BPCMN model with control flow and discretionary tasks

To model decision logic, our tool supports the Decision Model and Notation (DMN) from the OMG (2015). The left part of Figure 4 shows a Decision Requirements Diagram consisting of four elements: Decision, Business Knowledge, Knowledge Source and Input Data.



Eligibility Check			
	Age	Residence	Eligibility
	number		*yes, no*
1	<18		no
2	>=18	Switzerland	yes
3	>=18	Liechtenstein	yes
4	>=18	not in {Switzerland, Liechtenstein}	no

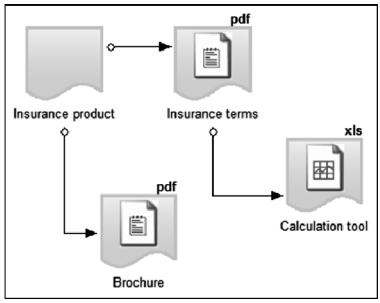


Figure 4. Decision model and document model for representing business logic

The decision rules can be represented in many different ways. A decision table is a formal representation, which can be interpreted by humans and can be translated into code for a rule engine. The document model can be used to represent non-structured business logic, knowledge sources and documents of a case file. To represent decision-aware business processes (von Halle & Goldberg 2010, p.66ff), the Knowledge Work Designer tool supports referencing of decisions and documents from tasks (see Figure 5).

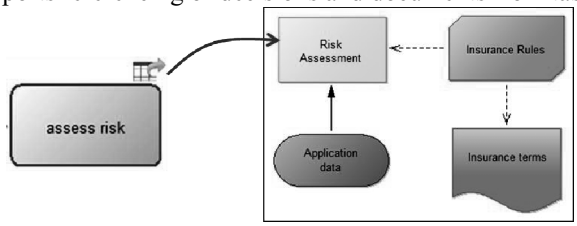


Figure 5. Referencing decisions from process tasks

To develop the Knowledge Work Designer modelling method we analysed a concrete case - the admission process of FHNW - from which we derived requirements, in particular for the combination of CMMN and BPMN. For evaluation purposes, the method was then applied to the same scenario as can be seen in the screenshots.

References

Davenport, T.H., 2010. Process Management for Knowledge Work. In J. vom Brocke & M. Rosemann, eds. *Handbook on Business Process Management 1*. Berlin, Heidelberg: Springer, pp. 17–36.

Gadatsch, A., 2012. *Grundkurs Geschäftsprozess-Management* 7. Auflage., Wiesbaden: Springer Vieweg.

von Halle, B. & Goldberg, L., 2010. *The Decision Model: A Business Logic Framework Linking Business and Technology*, CRC Press Auerbach Publications.

McCauley, D., 2010. Achieving Agility. In Layna Fischer, ed. *Mastering the Unpredictable: How Adaptive Case Management Will Revolutionize The Way That Knowledge Workers Get Things Done*. Future Strategies Inc.

OMG, 2011. *Business Process Model and Notation (BPMN) Version 2.0*, Needham, MA: Object Management Group OMG. Available at: http://www.omg.org/spec/BPMN/2.0/PDF/.

OMG, 2014. *Case Management Model and Notation Version 1.0*, Needham, MA: Object Management Group OMG. Available at: http://www.omg.org/spec/CMMN/1.0/PDF.

OMG, 2015. *Decision Model and Notation Version 1.0*, Needham, MA: Object Management Group OMG. Available at: http://www.omg.org/spec/DMN/1.0/PDF.

OMG, 2008. *Semantics of Business Vocabulary and Business Rules (SBVR) v1.0*, Available at: http://www.omg.org/spec/SBVR/1.0/PDF.

Palmer, N., 2011. BPM and ACM. In L. Fischer, ed. *Taming the Unpredictable*. Lighthouse Point, FL, pp. 77–86.

BPaaS Modelling: Business and IT-Cloud Alignment based on ADOxx

Robert Woitsch[1]

Abstract: Business Process as a Service (BPaaS) is a new paradigm in Cloud Computing using domain-specific business processes as a mediator for business and IT-Cloud alignment. Therefore, business process models are extended with cloud-specific concepts. This paper introduces the modelling concepts and mechanisms to bridge the semantic distance between domain-specific business processes and IT-Cloud deployable workflows. A prototype has been developed in the H2020 project CloudSocket, where the current status of the modelling tool is available for the research community on ADOxx.org.

Keywords: Business IT Alignment, Semantic Lifting, Business Processes as a Service, Cloud

1 Introduction in BPaaS Modelling

This paper demonstrates a modelling tool that supports the business and IT-cloud alignment. The business process designer can model business-related decisions such as buying strategies for the cloud, domain specific requirements on data or organizational compliance rules. A technician can derive sufficient information out of the extended business process model, in order to select appropriate service end points, configure appropriate virtual machines (VM), create deployment rules or specify the service objectives (SO) for a particular infrastructure. The proposed semantic lifting envisions a semi-automatic support of this model-based communication.

Business Process as a Service (BPaaS) is based on the BPMS paradigm [Ka95], distinguishing between the (a) design, (b) allocation, (c) execution, and (d) evaluation phase. The technical discussion on the separation of concerns and the introduction of the marketplace can be found in the technical architecture of CloudSocket [Cl15a].

BPaaS Design Environment implemented a semantic lifting that enables the annotation of business process models [OMG11] with ontology concepts. Based on Zachmann [Za14] and ArchiMate [TOG12], the enterprise modelling ontology ArchiMEO [HMS] has been provided to semantically lift the business process. This enables to align business processes with workflows deployed in the cloud in a semi-automatic way.

This paper introduces (a) the service descriptions model reducing the semantic gap between business processes and workflows, as well as (b) the semantic lifting that had been implemented on ADOxx [AD16].

[1] BOC Asset Management, Operngasse 20B, 1040 Wien, robert.woitsch@boc-eu.com

2 Required Concepts to realise BPaaS Modelling

The modelling method specification language [WEK15] is used to define the meta-model. In the following the modelling stack is introduced that shows business process relevant models like (a) business process models, (b) organizational model, (c) document model and (d) process maps. The workflow is seen as a separate concern although workflows and business processes use BPMN notation. Key performance indicator (KPI) model and decision model are out of scope of this paper. For further information, please refer to the BPaaS Modelling Framework [Cl15b].

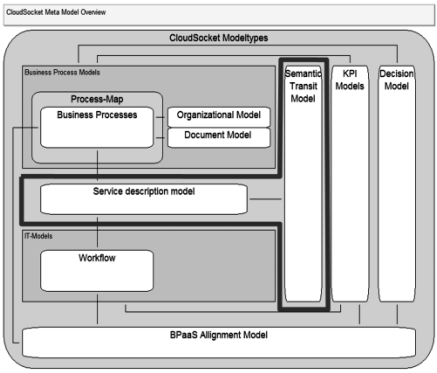


Fig 1 BPaaS Meta Model Stack

The focus is on the so-called "Service description model" consisting of the service-requirement construct that describes the cloud-specific properties: (a) service description (b) functional description, (c) input and output parameter, (d) non-functional requirements, (e) business description, (f) regulatory description.

The semantic transit model consists of one concept representing an ontology class, and hence, enables the different forms of semantic lifting.

The so-called "BPaaS Alignment Model" is an interface that enables the access of all relevant models in a structure way. Focus of this paper is the semantic lifting of the Service description model, which is highlighted in Fig.1.

2.1 Service Description Model

The service descriptions model is introduces that aims to improve the communication between the business process designer and the workflow engineer. It is based on the FODA approach [FOD05], according to which each business process activity is analyzed depending on the specific IT requirements. Currently, the vertical weaving from business process to workflow is performed due to intellectual manual modelling, it is expected that semantic support can be introduced, when the aforementioned attributes are semantically enriched. Following properties have been indicated and implemented to describe the requirements of a service:

- Service Requirement enables a name, a responsible author and a textual description.
- Functional Description indicates the general functionality, possible functional requirements, keywords or even exact ontological description of a certain function.

- Input / Output Description describes the expected data format by enabling generally descriptions – like distinction between parameters or documents – as well as enabling detailed specification on data format and protocol standard level.
- Non-Functional Requirements indicate (a) the reliability based on error rates, the (b) availability like targeted availability time, (c) sample service that explains the developer the intended service interaction with mock-ups, prototypes or similar services, as well as (d) indication on the scheduling and planning.
- Business Description indicate (a) vendor criteria elaborating on potential vendor locks, helpdesk or onsite visits, (b) security and trust criteria describe relationships or standards, (c) preferred payment method, (d) costs and required contractual obligations as well as (e) comments on business intension in general.
- Regulatory Description indicate (a) data location to ensure data privacy enforcement, (b) certification of the vendor according standards, (d) domain specific data protection and cloud maturity concerns as well as (c) a relevant list of regulation that needs to be considered.

For the full representation of the meta-model in FDMM notation, please refer to [Cl15b].

2.2 Semantic Lifting

Semantic lifting can be implemented on ADOxx in different forms. A full representation can be found on ADOxx.org, in the CloudSocket development space. Here the different implementations for human-based annotations are introduced:

Non-Supported direct linkage uses a text attribute for manual entries of ontology concepts. This is suitable for inflexible modelling languages that cannot be changed.

Supported pre-defined linkage uses a flat list to select pre-defined ontology concepts. In ADOxx it can be implemented using enumerations that correspond to the ontology. It is suitable for top-level concepts that do not evolve.

Supported direct linkage using a semantic tunnel for flexible enumeration accesses a third party ontology and provides the result in the modelling tool. Hence the user has the impression to work in one tool, whereas a part of the information is provided by the third party ontology system. This is suitable for flexible ontologies, but due to the built-in presentation is only appropriate for a small set of concepts.

Indirect linkage using a semantic transit model imports the ontology, hence holds the ontology concepts redundant and provides a fully structured ontology representation. This is appropriate in case of using highly complex ontologies. With respect to flexibility, this approach is only for moderately flexible ontologies, as the redundancy handling only pays off in case of not too many changes.

Direct and indirect linkage can be combined via (a) the semantic tunnel and (b) the

transit model. The flexible part of the ontology is accessed via aforementioned tunnel whereas the static part of the ontology is accessed via semantic transit. The combination of the two techniques enables hence the handling of complex and flexible ontologies.

3 BPaaS Modelling - Prototype

The BPaaS Modelling prototype has been developed in the H2020 project CloudSocket [Cl15] and can be downloaded from the development space in ADOxx.org [ADS15].

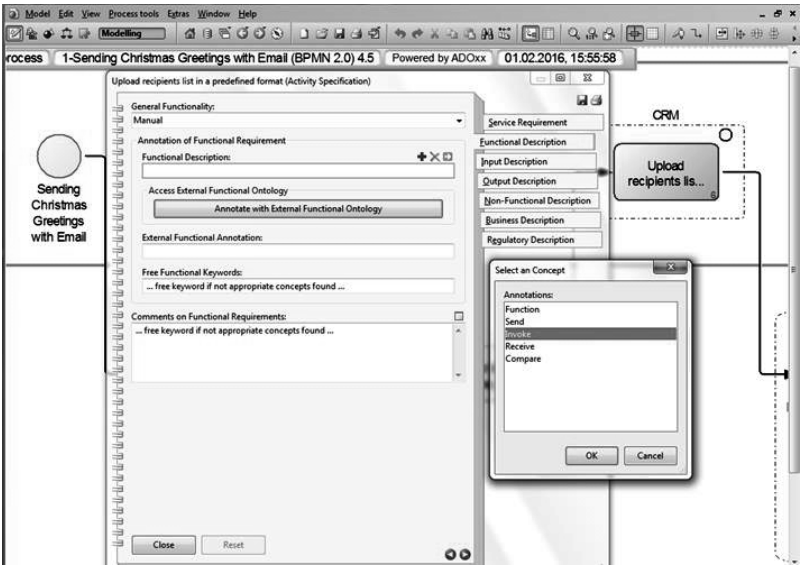


Fig 2 Screen shot of semantic lifting of services requirement description

The notebook shows a four-step semantic annotation, starting with (a) a pre-defined enumeration describing the general functionality, (b) details of the description with an indirect linkage to parts of the ontologies and, (c) detail those parts again by using the semantic tunnel accessing the ontology directly – indicated in the separate window.

In order to allow flexibility, free keywords are also allowed realizing the non-supported direct link. Finally, a feedback possibility is foreseen, to improve the alignment.

The Current prototype is going to be validated by two BPaaS Brokers who models their business process offerings for cloud deployment. First introductory sample on sending Christmas Card via emails already raised several issues like (a) how to ensure that the text of a card is not illegal, (b) how to ensure that no forbidden symbols are used when uploading an image, (c) how to ensure data privacy when uploading the recipient list or (d) how to communicate the different virtual machine settings, when sending all emails

on the day before Christmas. After the first feedback on this simple sample, the BPaaS Broker are now modelling more sophisticated business processes on e.g. newspaper distribution logistics, internet recherché for offers or customer relationship management.

The user feedback is continuously provided at the developer space on ADOxx.org.

Literaturverzeichnis

[Ka95] Karagiannis, D., 1995. BPMS: Business Process Management Systems: Concepts, Methods and Technologies, SIGOIS Special Issue, SIGOIS Bulletin 10-13

[OMG11] Object Management Group, Business Process Modelling and Notation BPMN, (2011) www.bpmn.org, access: 20.01.2016

[OMG15] Object Management Group, Decision Model and Notation DMN, (2015), http://www.omg.org/spec/DMN/, access: 20.01.2016

[Za14] Zachman Institute for Framework Architecture, Enterprise Architecture: A Framework, John A. Zachman, http://www.zifa.com/framework.pdf, access: 16.03.2014

[HMS] Hinkelmann, K., Martin, A., Nikles, S., & Thönssen, B. (n.d.). ArchiMEO : Formal Semantics for ArchiMate

[WEK15] Woitsch R., Efendioglu N., Karagiannis D., Modelling Method Design: A Model-Driven Approach, conference proceeding 17th Int. Conference on Information Integration and Web-based Applications & Services, iiwas, 2015

[FOD05] FODA-Approach, http://www.sei.cmu.edu/domain-engineering/FODA.html, access: 02.12.05

[ADS15] ADOxx.org Development Space for CloudSocket, www.adoxx.org/live/web/cloudsocket-developer-space/space, access: 20.10.2016

[Cl15] CloudSocket Project, www.cloudsocket.eu, access: 20.01.2016

[TOG12] The Open Group. (2012). ArchiMate 2.1 Specification. The Open Group. http://pubs.opengroup.org/architecture/archimate2-doc/ access: 3.11.2015

[Cl15b] CloudSocket, D3.1 Modelling Framework for BPaaS, (2015) https://www.cloudsocket.eu/documents/10182/20690/CloudSocket-D3.1-BPaaS+Design+Environment+Research/91a3c2ae-6394-482a-940e-d0186e82f7f6, access: 20.01.2016

[Cl15a] CloudSocket Consortium, D4.1 First Technical Architecture, 2015 https://www.cloudsocket.eu/documents/10182/20690/CloudSocket-D4.1-First+CloudSocket+Architecture.pdf/96bb7053-074b-4991-b8df-d1fbf2f06471, access: 20.01.2016

[AD16] ADOxx.org Community, www.adoxx.org, access: 20.01.2016

Stefanie Betz, Ulrich Reimer (Hrsg.): Modellierung 2016 Workshopband,
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2016 147

Werkzeug zur mobilen Modellierung von Geschäftsprozessen mittels Petri-Netzen

Sascha Alpers[1] und Stefan Hellfeld[1]

Abstract: Der mobile Petri-Netz-Editor pne.fzi.de ist ein Werkzeug zur Anzeige, Erstellung und Bearbeitung von Petri-Netz-basierten Geschäftsprozessen. Das Werkzeug pne.fzi.de wurde so konzipiert, dass es eine orts- und geräteunabhängige Modellierung ermöglicht. Darüber hinaus unterstützt der pne.fzi.de die kontinuierliche Weiterarbeit an einem Geschäftsprozessmodell durch intelligente Synchronisierungsmechanismen auch bei einem Gerätewechsel. Zur Umsetzung wurden aktuelle Standards wie die fünfte Version der Hypertext Markup Language (HTML5) verwendet. Um Anwendern den Einsatz des Werkzeugs zu erleichtern, wurden Mechanismen zur intuitiven Bedienbarkeit und guten Benutzererfahrung (engl. User Experience) als weitere Konzeptionsziele definiert und im Rahmen der Umsetzung berücksichtigt. Beispiele sind die gestenbasierte Modellierung von Geschäftsprozessen sowie ein Token-Spiel zur Verbesserung des Verständnisses des Ablaufs eines Geschäftsprozesses bei Fachanwendern.

Keywords: Modellierungswerkzeug, Petri-Netz, Geschäftsprozessmanagement, Geräteunabhängigkeit, Ortsunabhängigkeit

1 Einleitung

Im Zusammenhang mit der ortsunabhängigen Modellierung von Geschäftsprozessen kommen immer häufiger unterschiedliche und vornehmlich mobile Geräte zum Einsatz. Diese verfügen selten über die bekannten Eingabemethoden wie Tastatur und Maus. Um bei der Modellierung von Geschäftsprozessen verschiedene Geräte in unterschiedlichen Situationen zu unterstützen, wurde der mobile Petri-Netz-Editor pne.fzi.de (ein Screenshot der Anwendung ist in Abbildung 1 dargestellt) als Werkzeug zur Erfassung, Anzeige und Bearbeitung von Petri-Netz-basierten Geschäftsprozessen entwickelt. Nachfolgend werden im zweiten Abschnitt die orts- und geräteunabhängige Modellierung und im dritten Abschnitt die intuitive gestenbasierte Modellierung sowie die Unterstützung der Anwender im Verständnis der Geschäftsprozessmodelle vorgestellt. Im vierten Abschnitt wird auf die Speicherung der Geschäftsprozessmodelle eingegangen, bevor abschließend im fünften Abschnitt ein Ausblick auf die Weiterentwicklung des Werkzeugs gegeben wird.

[1] FZI Forschungszentrum Informatik, Haid-und-Neu-Str. 10–14, 76131 Karlsruhe,
{alpers | hellfeld | oberweis}@fzi.de

2 Unterstützung von orts- und geräteunabhängiger Modellierung

Typischerweise wird die Aufnahme und Modellierung von Geschäftsprozessen an unterschiedlichen Orten durchgeführt. Die Aufnahme eines Geschäftsprozesses erfolgt in der Regel vor Ort bzw. an der Örtlichkeit, an welcher der Geschäftsprozess ausgeführt wird, die Nachbereitung und Verbesserung am Arbeitsplatz im Büro bzw. in Besprechungen [Al14]. Weil die Geschäftsprozessaufnahme vor Ort oft mit Papier und Bleistift durchgeführt wird, kann es zu einem Medienbruch bei der Digitalisierung des Geschäftsprozessmodells kommen. Um diesem Medienbruch entgegenzuwirken bzw. diesen zu vermeiden, war eine Anforderung an das Werkzeug, dass dieses sowohl vor Ort als auch im Büro und in Besprechungen eingesetzt werden kann. Dementsprechend wurde das Werkzeug für mobile Geräte als auch für herkömmliche Personal Computer konzipiert. So kann bspw. ein Android-Tablet unterwegs und ein Desktop-PC im Büro als Plattform für das Werkzeug genutzt werden. Unterbricht der Anwender seine Arbeit an einem Gerät, so kann er aufgrund intelligenter Synchronisierungsmechanismen, die den aktuellen Arbeitsstand geräteunabhängig zwischenspeichern, die Arbeit an einem neuen Gerät an der Stelle im Werkzeug fortsetzen, an der er sie unterbrochen hat.

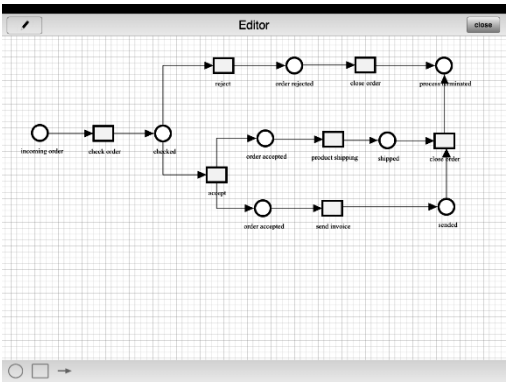


Abbildung 1: Screenshot des Werkzeugs, hier auf einem Apple iPad 2 ausgeführt

Dementsprechend wurde das Werkzeug als web-basierte Anwendung (sogenannte Web-Applikation) entwickelt. Hierzu wurden aktuelle Standards wie die Hypertext Markup Language in der fünften Version (HTML5), Cascading Stylesheets in der dritten Version (CSS3) und JavaScript verwendet.[2] Web-basierte Anwendungen, die basierend auf diesen Standards entwickelt wurden, können durch dafür vorgesehene Programme (sog. Brow-

[2] HTML5 und CSS3 wurden vom World Wide Web Consortium (W3C, www.w3.org) standardisiert. JavaScript wurde von Ecma International standardisiert (www.ecma-international.org), diverse Programmierschnittstellen (engl. application programming interface, API) der Browser, die mittels eigener Skripte in der Sprache JavaScript genutzt werden können, sind für die Entwicklung des Werkzeugs auch relevant und wurden wiederum vom W3C standardisiert. Beispielsweise wurde die Programmierschnittstellen zur Manipulation des Document Object Model verwendet.

ser) interpretiert werden und erzielen eine vergleichbare User Experience wie native Anwendungen, die explizit für die Zielplattform entwickelt wurden. Browser existieren für den Großteil der mobilen Geräte und Betriebssysteme sowie für Personal Computer. Getestet wurde das Werkzeug mit den Browsern für Personal Computer Internet Explorer in Version 9 bis Version 11, Microsoft Edge, Firefox in den Versionen 10 bis 43, Chrome in den Versionen 26 bis 47 und dem Safari Browser in der Version 6 und 7. Auf mobilen Geräten wurde das Werkzeug im Browser des jeweiligen Betriebssystems unter Apple iOS in den Versionen 4 bis 9 und Google Android in Versionen 2 bis 6 getestet. Auf allen Geräten war das Werkzeug fehlerfrei ausführbar und besaß das gleiche Verhalten.

Da das Werkzeug als eine web-basierte Anwendung entwickelt wurde, ist keine Installation auf den Geräten der Anwender erforderlich. Zum erstmaligen Start benötigt es eine Internetverbindung, für die spätere Verwendung kann die Anwendung lokal auf dem jeweiligen Gerät zwischengespeichert werden. Dadurch eignet sich das Werkzeug auch zur Aufnahme von Geschäftsprozessen an Orten, an denen keine zuverlässige Internetverbindung zur Verfügung steht. Wird das Werkzeug bei vorhandener Internetverbindung neu gestartet, wird geprüft, ob eine neuere Version auf dem zentralen Server bereitgestellt wurde. Falls dies der Fall ist, wird die installierte Version automatisch aktualisiert. Durch dieses Vorgehen ist gesichert, dass auf jedem Gerät, spätestens nachdem das Werkzeug bei vorhandener Internetverbindung neu gestartet wurde, immer die aktuellste Version des Werkzeugs verwendet wird. So können Sicherheitslücken umgehend geschlossen oder Fehlverhalten zeitnah korrigiert werden.

3 Unterstützung intuitiver Modellierung und verbessertem Modellverständnis

Aufgrund der Beteiligung unterschiedlicher Personen wie Modellierer, Prozessbeteiligte, etc. an der Geschäftsprozesserfassung war die intuitive Bedienbarkeit des Werkzeugs eine wesentliche Anforderung an dasselbe. Darüber hinaus ist die Bedienbarkeit einer Anwendung auf einem mobilen Gerät eine Anforderung, die aufgrund der Verwendung des Geräts in unterschiedlichen Situationen (z. B. einer einhändigen Bedienung oder auch der Interaktion während einer zweiten Tätigkeit) nicht vernachlässigt werden darf. Eine derartige Bedienbarkeit wird erreicht, indem der Anwender die Kernfunktionalität der Anwendung sehr einfach verwenden kann und während der Benutzung nach und nach weitere Funktionalitäten entdeckt und erlernt.

Für viele Anwender ist es intuitiver, Symbole zu zeichnen, statt Symbole per Drag-and-drop-Technik[3] zu platzieren [Ri09]. Kreise, Rechtecke und Pfeile (die Notationselemente von Petri-Netzen) können mit Ein-Strich-Gesten effektiv gezeichnet werden. Zur Gestenerkennung verwendet das Werkzeug den $1-Algorithmus [WWL07]. Das Werkzeug nutzt

[3] Auswahl eines Symbols durch Berühren des Bildschirms an der Position des dargestellten Symbols mit einem Finger. Im Anschluss kann das Symbol mit dem Finger an die gewünschte Stelle verschoben und dort durch Anheben des Fingers platziert. Alternativ kann statt einem Finger eine Maus verwendet werden.

dazu das Webapp Innovation Kit (WINK) Framework, welches den Algorithmus kapselt. Der Anwender zeichnet eine Geste mit dem Finger auf einem Touchscreen (Abbildung 2, links) oder alternativ mit der Maus auf einem PC. Nachdem eine Geste erkannt wurde, wird das dazugehörige Symbol auf der Oberfläche platziert.

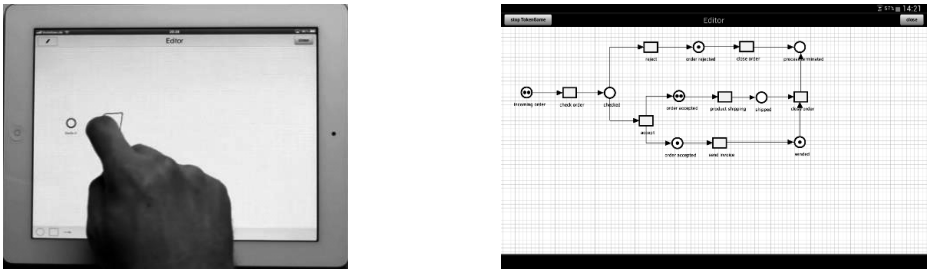


Abbildung 2: Links: Gestenbasierte Erfassung einer Transition.
Rechts: Screenshot eines Token-Spiels auf einem Samsung Galaxy 10.1 Android-Tablet

Die gestenbasierte Erfassung von Notationselementen und somit von Geschäftsprozessmodellen wurde im Rahmen einer Studie evaluiert. Den Probanden wurde eine textuelle Beschreibung eines Geschäftsprozesses zur Urlaubsbeantragung vorgelegt. Aufgabe der Probanden war die Modellierung des Geschäftsprozesses mit dem Werkzeug, welches auf einem Apple iPad 2 ausgeführt wurde. 77 % der Probanden haben die Modellierung innerhalb von 10 Minuten erfolgreich beendet, 23 % der Probanden haben länger benötigt oder waren nicht erfolgreich. In der anschließenden Befragung wurden Schwierigkeiten mit der Gestenerkennung angegeben, weil die vordefinierten Gesten im Erleben dieser Probanden „nicht passend“ waren. Aufgrund des Studienergebnisses wurde das Werkzeug weiterentwickelt und der Anwender kann in der neuen Version des Werkzeugs seine eigenen Gesten definieren und das Werkzeug dadurch an seine bevorzugten Gesten anpassen (z. B. eine T-Geste statt eine Rechteck-Geste für eine Transition). Zusätzlich bietet das Werkzeug die Möglichkeit, die Symbole per Drag-and-drop-Technik zu platzieren, falls dies bevorzugt wird.

Zur Analyse eines Petri-Netz-basierten Geschäftsprozesses unterstützt das Werkzeug die diskrete Simulation in Form eines Token-Spiels (Abbildung 2, rechts). Das Token-Spiel hilft dem Anwender die Ablauflogik des Geschäftsprozesses zu überprüfen, indem er die unter Umständen unterschiedlichen Abläufe „durchspielt“ und mit seinen Erwartungen abgleicht. Dazu initiiert der Anwender das Feuern einer aktivierten Transition durch Klicken bzw. Antippen derselben und beobachtet den dadurch ausgelösten Markenfluss (Entnahme von Marken aus den Eingangsstellen, Hinzufügen von Marken in die Ausgangsstellen). Insbesondere im Fall von komplexen Geschäftsprozessmodellen, die eine Vielzahl an unterschiedlichen Abläufen besitzen, kann durch die diskrete Simulation eine Hilfestellung zum Verständnis des Petri-Netz-basierten Geschäftsprozesses auch für Fachanwender gegeben werden.

4 Speicherung der Geschäftsprozessmodelle

Die Geschäftsprozessmodelle werden innerhalb des Werkzeugs sowohl lokal als auch in einer Sicherungsdatenbank auf dem Server gespeichert. Es wird eine SQL-basierte Datenbank zur Speicherung verwendet. Damit der Anwender die erstellten Modelle in anderen Werkzeugen (z. B. dem Horus Business Modeler) weiterverarbeiten kann, bietet das Werkzeug die Möglichkeit des Exports von Dateien, die in der Petri Net Markup Language (PNML) [WK03] formatiert sind. Auch der Import von Geschäftsprozessmodellen ist, sofern sie in PNML beschrieben sind, möglich. Serverseitige wird in einer Kombination von SQL und der Skriptsprache PHP in Version 5 auf die Datenbank zugegriffen.

5 Ausblick

Im Unternehmen existieren unterschiedliche Sichten auf die Geschäftsprozesse (dargestellt in Abbildung 3). Die Implementierung der unterschiedlichen Sichten stellt eine der geplanten Weiterentwicklungen für das Werkzeug dar. Darüber hinaus soll zukünftig das Werkzeug mithilfe des Konzepts der Micro-Services [Al15] erweitert werden, so dass auch andere Modellarten und Modellierungssprachen im Werkzeug verwendet werden können. Beispielsweise soll die Business Process Model and Notation (BPMN) als zusätzliche Modellierungssprache für Geschäftsprozesse unterstützt werden. Durch obengenannte Integration weiterer Sichten ist auch angestrebt, gemäß der Horus-Methode [Sc11] eine ganzheitliche Betrachtung von Unternehmen mittels des Werkzeugs zu ermöglichen.

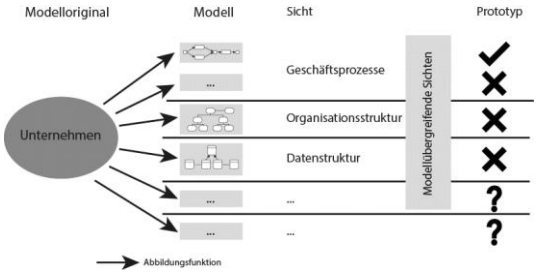


Abbildung 3: Weiterentwicklung Werkzeug durch neue Sichten

Zusätzlich sind weitere Funktionen für die existierende Sicht der Geschäftsprozesse geplant wie bspw. die mittels Micro-Services zu realisierende Einbindung existierender, in der Programmiersprache PROLOG geschriebener Analysekomponenten. Auch die Integration der Ortsinformationen in die Modelle zur späteren Analyse von z. B. Eigenschaften der Informationssicherheit [De11] oder eine Steuerung einer synchronen Simulation eines real existierenden Modells (eine sog. Plastische Simulation) im Rahmen von semirealen Evaluationsumgebungen für mobile Anwendungen sind geplant [ABE15]. In diesem Kontext führt das Feuern einer Transition sowohl zu einem Markenfluss im Geschäftsprozessmodell als auch zu einer Aktion im physischen Modell. Auch sprachbasierte

Modellierung von Geschäftsprozessen [Ca16] soll mittels Micro-Services realisiert werden.

Das Werkzeug wird im Living Lab mobile IT / mobile Business, Teil des FZI House of Living Labs, fortlaufend weiterentwickelt und evaluiert. Der Aufbau einer Community durch Veröffentlichung des Quellcodes über GitHub unter einer Open-Source-Lizenz ist geplant.

Literaturverzeichnis

[ABE15] Alpers, Sascha; Becker, Christoph; Eryilmaz, Esmahan: Semi-real evaluation environments for mobile applications. In: The 29th Annual European Simulation and Modelling Conference 2015. eurosis, Leicester, S. 357–362, 2015.

[Al14] Alpers, Sascha; Eryilmaz, Esmahan; Hellfeld, Stefan; Oberweis, Andreas: Mobile Modeling Tool Based on the Horus Method. In: International Workshop on Advanced Information Systems for Enterprises. IEEE, Tunis, S. 65–71, 2014.

[Al15] Alpers, Sascha; Becker, Christoph; Oberweis, Andreas; Schuster, Thomas: Microservice Based Tool Support for Business Process Modelling. In: 2015 IEE 19th International Enterprise Distributed Object Computing Workshop. IEEE, Adelaide, S. 71–78, 2015.

[Ca16] Caporale, Timm: A Tool for Natural Language Oriented Business Process Modeling. In: Proceedings of the 8th Central-European Workshop on Services and their Composition (ZEUSS 2016). CEUR Workshop Proceedings, Wien, 2016.

[De11] Decker, Michael: Modellierung ortsabhängiger Zugriffskontrolle für mobile Geschäftsprozesse. KIT Scientific Publishing, Karlsruhe, 2011.

[De14] Demant, Christian: User Interfaces im Smartphone-Zeitalter. In: Erfolgreich ein Software-Startup gründen. Springer, Berlin u. a., S. 263–271, 2014.

[Ri09] Rittgen, Peter: Collaborative modeling – a design science approach. In: Proceedings of the 42nd Hawaii International Conference on System Sciences. IEEE, Hawaii, S. 1–10, 2009.

[Sc11] Schönthaler, Frank; Vossen, Gottfried; Oberweis, Andreas; Karle, Thomas: Geschäftsprozesse für Business Communities: Modellierungssprachen, Methoden, Werkzeuge. Oldenbourg Wissenschaftsverlag, München, 2011.

[WK03] Weber, Michael; Kindler, Ekkart: The Petri net markup language. In: Petri Net Technology for Communication-Based Systems. Springer, Berlin u. a., S 124–144, 2003.

[WWL07] Wobbrock, Jacob; Wilson, Andrew; Li, Yang: Gestures without libraries, toolkits or training: a $1 recognizer for user interface prototypes. In: Proceedings of the 20th annual ACM symposium on User interface software and technology. ACM, Newport, S. 159–168, 2007.

GI-Edition Lecture Notes in Informatics

P-1 Gregor Engels, Andreas Oberweis, Albert Zündorf (Hrsg.): Modellierung 2001.

P-2 Mikhail Godlevsky, Heinrich C. Mayr (Hrsg.): Information Systems Technology and its Applications, ISTA'2001.

P-3 Ana M. Moreno, Reind P. van de Riet (Hrsg.): Applications of Natural Lan-guage to Information Systems, NLDB'2001.

P-4 H. Wörn, J. Mühling, C. Vahl, H.-P. Meinzer (Hrsg.): Rechner- und sensorgestützte Chirurgie; Workshop des SFB 414.

P-5 Andy Schürr (Hg.): OMER – Object-Oriented Modeling of Embedded Real-Time Systems.

P-6 Hans-Jürgen Appelrath, Rolf Beyer, Uwe Marquardt, Heinrich C. Mayr, Claudia Steinberger (Hrsg.): Unternehmen Hochschule, UH'2001.

P-7 Andy Evans, Robert France, Ana Moreira, Bernhard Rumpe (Hrsg.): Practical UML-Based Rigorous Development Methods – Countering or Integrating the extremists, pUML'2001.

P-8 Reinhard Keil-Slawik, Johannes Magenheim (Hrsg.): Informatikunterricht und Medienbildung, INFOS'2001.

P-9 Jan von Knop, Wilhelm Haverkamp (Hrsg.): Innovative Anwendungen in Kommunikationsnetzen, 15. DFN Arbeitstagung.

P-10 Mirjam Minor, Steffen Staab (Hrsg.): 1st German Workshop on Experience Management: Sharing Experiences about the Sharing Experience.

P-11 Michael Weber, Frank Kargl (Hrsg.): Mobile Ad-Hoc Netzwerke, WMAN 2002.

P-12 Martin Glinz, Günther Müller-Luschnat (Hrsg.): Modellierung 2002.

P-13 Jan von Knop, Peter Schirmbacher and Viljan Mahni_ (Hrsg.): The Changing Universities – The Role of Technology.

P-14 Robert Tolksdorf, Rainer Eckstein (Hrsg.): XML-Technologien für das Semantic Web – XSW 2002.

P-15 Hans-Bernd Bludau, Andreas Koop (Hrsg.): Mobile Computing in Medicine.

P-16 J. Felix Hampe, Gerhard Schwabe (Hrsg.): Mobile and Collaborative Business 2002.

P-17 Jan von Knop, Wilhelm Haverkamp (Hrsg.): Zukunft der Netze –Die Verletzbarkeit meistern, 16. DFN Arbeitstagung.

P-18 Elmar J. Sinz, Markus Plaha (Hrsg.): Modellierung betrieblicher Informationssysteme – MobIS 2002.

P-19 Sigrid Schubert, Bernd Reusch, Norbert Jesse (Hrsg.): Informatik bewegt – Informatik 2002 – 32. Jahrestagung der Gesellschaft für Informatik e.V. (GI) 30.Sept.-3. Okt. 2002 in Dortmund.

P-20 Sigrid Schubert, Bernd Reusch, Norbert Jesse (Hrsg.): Informatik bewegt – Informatik 2002 – 32. Jahrestagung der Gesellschaft für Informatik e.V. (GI) 30.Sept.-3. Okt. 2002 in Dortmund (Ergänzungsband).

P-21 Jörg Desel, Mathias Weske (Hrsg.): Promise 2002: Prozessorientierte Methoden und Werkzeuge für die Entwicklung von Informationssystemen.

P-22 Sigrid Schubert, Johannes Magenheim, Peter Hubwieser, Torsten Brinda (Hrsg.): Forschungsbeiträge zur "Didaktik der Informatik" – Theorie, Praxis, Evaluation.

P-23 Thorsten Spitta, Jens Borchers, Harry M. Sneed (Hrsg.): Software Management 2002 – Fortschritt durch Beständigkeit

P-24 Rainer Eckstein, Robert Tolksdorf (Hrsg.): XMIDX 2003 – XML-Technologien für Middleware – Middleware für XML-Anwendungen

P-25 Key Pousttchi, Klaus Turowski (Hrsg.): Mobile Commerce – Anwendungen und Perspektiven – 3. Workshop Mobile Commerce, Universität Augsburg, 04.02.2003

P-26 Gerhard Weikum, Harald Schöning, Erhard Rahm (Hrsg.): BTW 2003: Datenbanksysteme für Business, Technologie und Web

P-27 Michael Kroll, Hans-Gerd Lipinski, Kay Melzer (Hrsg.): Mobiles Computing in der Medizin

P-28 Ulrich Reimer, Andreas Abecker, Steffen Staab, Gerd Stumme (Hrsg.): WM 2003: Professionelles Wissensmanagement – Er-fahrungen und Visionen

P-29 Antje Düsterhöft, Bernhard Thalheim (Eds.): NLDB'2003: Natural Language Processing and Information Systems

P-30 Mikhail Godlevsky, Stephen Liddle, Heinrich C. Mayr (Eds.): Information Systems Technology and its Applications

P-31 Arslan Brömme, Christoph Busch (Eds.): BIOSIG 2003: Biometrics and Electronic Signatures

P-32 Peter Hubwieser (Hrsg.): Informatische Fachkonzepte im Unterricht – INFOS 2003

P-33 Andreas Geyer-Schulz, Alfred Taudes (Hrsg.): Informationswirtschaft: Ein Sektor mit Zukunft

P-34 Klaus Dittrich, Wolfgang König, Andreas Oberweis, Kai Rannenberg, Wolfgang Wahlster (Hrsg.): Informatik 2003 – Innovative Informatikanwendungen (Band 1)

P-35 Klaus Dittrich, Wolfgang König, Andreas Oberweis, Kai Rannenberg, Wolfgang Wahlster (Hrsg.): Informatik 2003 – Innovative Informatikanwendungen (Band 2)

P-36 Rüdiger Grimm, Hubert B. Keller, Kai Rannenberg (Hrsg.): Informatik 2003 – Mit Sicherheit Informatik

P-37 Arndt Bode, Jörg Desel, Sabine Rathmayer, Martin Wessner (Hrsg.): DeLFI 2003: e-Learning Fachtagung Informatik

P-38 E.J. Sinz, M. Plaha, P. Neckel (Hrsg.): Modellierung betrieblicher Informationssysteme – MobIS 2003

P-39 Jens Nedon, Sandra Frings, Oliver Göbel (Hrsg.): IT-Incident Management & IT-Forensics – IMF 2003

P-40 Michael Rebstock (Hrsg.): Modellierung betrieblicher Informationssysteme – MobIS 2004

P-41 Uwe Brinkschulte, Jürgen Becker, Dietmar Fey, Karl-Erwin Großpietsch, Christian Hochberger, Erik Maehle, Thomas Runkler (Edts.): ARCS 2004 – Organic and Pervasive Computing

P-42 Key Pousttchi, Klaus Turowski (Hrsg.): Mobile Economy – Transaktionen und Prozesse, Anwendungen und Dienste

P-43 Birgitta König-Ries, Michael Klein, Philipp Obreiter (Hrsg.): Persistance, Scalability, Transactions – Database Mechanisms for Mobile Applications

P-44 Jan von Knop, Wilhelm Haverkamp, Eike Jessen (Hrsg.): Security, E-Learning. E-Services

P-45 Bernhard Rumpe, Wofgang Hesse (Hrsg.): Modellierung 2004

P-46 Ulrich Flegel, Michael Meier (Hrsg.): Detection of Intrusions of Malware & Vulnerability Assessment

P-47 Alexander Prosser, Robert Krimmer (Hrsg.): Electronic Voting in Europe – Technology, Law, Politics and Society

P-48 Anatoly Doroshenko, Terry Halpin, Stephen W. Liddle, Heinrich C. Mayr (Hrsg.): Information Systems Technology and its Applications

P-49 G. Schiefer, P. Wagner, M. Morgenstern, U. Rickert (Hrsg.): Integration und Datensicherheit – Anforderungen, Konflikte und Perspektiven

P-50 Peter Dadam, Manfred Reichert (Hrsg.): INFORMATIK 2004 – Informatik verbindet (Band 1) Beiträge der 34. Jahrestagung der Gesellschaft für Informatik e.V. (GI), 20.-24. September 2004 in Ulm

P-51 Peter Dadam, Manfred Reichert (Hrsg.): INFORMATIK 2004 – Informatik verbindet (Band 2) Beiträge der 34. Jahrestagung der Gesellschaft für Informatik e.V. (GI), 20.-24. September 2004 in Ulm

P-52 Gregor Engels, Silke Seehusen (Hrsg.): DELFI 2004 – Tagungsband der 2. e-Learning Fachtagung Informatik

P-53 Robert Giegerich, Jens Stoye (Hrsg.): German Conference on Bioinformatics – GCB 2004

P-54 Jens Borchers, Ralf Kneuper (Hrsg.): Softwaremanagement 2004 – Outsourcing und Integration

P-55 Jan von Knop, Wilhelm Haverkamp, Eike Jessen (Hrsg.): E-Science und Grid Adhoc-Netze Medienintegration

P-56 Fernand Feltz, Andreas Oberweis, Benoit Otjacques (Hrsg.): EMISA 2004 – Informationssysteme im E-Business und E-Government

P-57 Klaus Turowski (Hrsg.): Architekturen, Komponenten, Anwendungen

P-58 Sami Beydeda, Volker Gruhn, Johannes Mayer, Ralf Reussner, Franz Schweiggert (Hrsg.): Testing of Component-Based Systems and Software Quality

P-59 J. Felix Hampe, Franz Lehner, Key Pousttchi, Kai Ranneberg, Klaus Turowski (Hrsg.): Mobile Business – Processes, Platforms, Payments

P-60 Steffen Friedrich (Hrsg.): Unterrichtskonzepte für inforrmatische Bildung

P-61 Paul Müller, Reinhard Gotzhein, Jens B. Schmitt (Hrsg.): Kommunikation in verteilten Systemen

P-62 Federrath, Hannes (Hrsg.): „Sicherheit 2005“ – Sicherheit – Schutz und Zuverlässigkeit

P-63 Roland Kaschek, Heinrich C. Mayr, Stephen Liddle (Hrsg.): Information Systems – Technology and ist Applications

P-64 Peter Liggesmeyer, Klaus Pohl, Michael Goedicke (Hrsg.): Software Engineering 2005

P-65 Gottfried Vossen, Frank Leymann, Peter Lockemann, Wolffried Stucky (Hrsg.): Datenbanksysteme in Business, Technologie und Web

P-66 Jörg M. Haake, Ulrike Lucke, Djamshid Tavangarian (Hrsg.): DeLFI 2005: 3. deutsche e-Learning Fachtagung Informatik

P-67 Armin B. Cremers, Rainer Manthey, Peter Martini, Volker Steinhage (Hrsg.): INFORMATIK 2005 – Informatik LIVE (Band 1)

P-68 Armin B. Cremers, Rainer Manthey, Peter Martini, Volker Steinhage (Hrsg.): INFORMATIK 2005 – Informatik LIVE (Band 2)

P-69 Robert Hirschfeld, Ryszard Kowalcyk, Andreas Polze, Matthias Weske (Hrsg.): NODe 2005, GSEM 2005

P-70 Klaus Turowski, Johannes-Maria Zaha (Hrsg.): Component-oriented Enterprise Application (COAE 2005)

P-71 Andrew Torda, Stefan Kurz, Matthias Rarey (Hrsg.): German Conference on Bioinformatics 2005

P-72 Klaus P. Jantke, Klaus-Peter Fähnrich, Wolfgang S. Wittig (Hrsg.): Marktplatz Internet: Von e-Learning bis e-Payment

P-73 Jan von Knop, Wilhelm Haverkamp, Eike Jessen (Hrsg.): “Heute schon das Morgen sehen“

P-74 Christopher Wolf, Stefan Lucks, Po-Wah Yau (Hrsg.): WEWoRC 2005 – Western European Workshop on Research in Cryptology

P-75 Jörg Desel, Ulrich Frank (Hrsg.): Enterprise Modelling and Information Systems Architecture

P-76 Thomas Kirste, Birgitta König-Riess, Key Pousttchi, Klaus Turowski (Hrsg.): Mobile Informationssysteme – Potentiale, Hindernisse, Einsatz

P-77 Jana Dittmann (Hrsg.): SICHERHEIT 2006

P-78 K.-O. Wenkel, P. Wagner, M. Morgenstern, K. Luzi, P. Eisermann (Hrsg.): Land- und Ernährungswirtschaft im Wandel

P-79 Bettina Biel, Matthias Book, Volker Gruhn (Hrsg.): Softwareengineering 2006

P-80 Mareike Schoop, Christian Huemer, Michael Rebstock, Martin Bichler (Hrsg.): Service-Oriented Electronic Commerce

P-81 Wolfgang Karl, Jürgen Becker, Karl-Erwin Großpietsch, Christian Hochberger, Erik Maehle (Hrsg.): ARCS´06

P-82 Heinrich C. Mayr, Ruth Breu (Hrsg.): Modellierung 2006

P-83 Daniel Huson, Oliver Kohlbacher, Andrei Lupas, Kay Nieselt and Andreas Zell (eds.): German Conference on Bioinformatics

P-84 Dimitris Karagiannis, Heinrich C. Mayr, (Hrsg.): Information Systems Technology and its Applications

P-85 Witold Abramowicz, Heinrich C. Mayr, (Hrsg.): Business Information Systems

P-86 Robert Krimmer (Ed.): Electronic Voting 2006

P-87 Max Mühlhäuser, Guido Rößling, Ralf Steinmetz (Hrsg.): DELFI 2006: 4. e-Learning Fachtagung Informatik

P-88 Robert Hirschfeld, Andreas Polze, Ryszard Kowalczyk (Hrsg.): NODe 2006, GSEM 2006

P-90 Joachim Schelp, Robert Winter, Ulrich Frank, Bodo Rieger, Klaus Turowski (Hrsg.): Integration, Informationslogistik und Architektur

P-91 Henrik Stormer, Andreas Meier, Michael Schumacher (Eds.): European Conference on eHealth 2006

P-92 Fernand Feltz, Benoît Otjacques, Andreas Oberweis, Nicolas Poussing (Eds.): AIM 2006

P-93 Christian Hochberger, Rüdiger Liskowsky (Eds.): INFORMATIK 2006 – Informatik für Menschen, Band 1

P-94 Christian Hochberger, Rüdiger Liskowsky (Eds.): INFORMATIK 2006 – Informatik für Menschen, Band 2

P-95 Matthias Weske, Markus Nüttgens (Eds.): EMISA 2005: Methoden, Konzepte und Technologien für die Entwicklung von dienstbasierten Informationssystemen

P-96 Saartje Brockmans, Jürgen Jung, York Sure (Eds.): Meta-Modelling and Ontologies

P-97 Oliver Göbel, Dirk Schadt, Sandra Frings, Hardo Hase, Detlef Günther, Jens Nedon (Eds.): IT-Incident Mangament & IT-Forensics – IMF 2006

P-98 Hans Brandt-Pook, Werner Simonsmeier und Thorsten Spitta (Hrsg.): Beratung in der Softwareentwicklung – Modelle, Methoden, Best Practices

P-99 Andreas Schwill, Carsten Schulte, Marco Thomas (Hrsg.): Didaktik der Informatik

P-100 Peter Forbrig, Günter Siegel, Markus Schneider (Hrsg.): HDI 2006: Hochschuldidaktik der Informatik

P-101 Stefan Böttinger, Ludwig Theuvsen, Susanne Rank, Marlies Morgenstern (Hrsg.): Agrarinformatik im Spannungsfeld zwischen Regionalisierung und globalen Wertschöpfungsketten

P-102 Otto Spaniol (Eds.): Mobile Services and Personalized Environments

P-103 Alfons Kemper, Harald Schöning, Thomas Rose, Matthias Jarke, Thomas Seidl, Christoph Quix, Christoph Brochhaus (Hrsg.): Datenbanksysteme in Business, Technologie und Web (BTW 2007)

P-104 Birgitta König-Ries, Franz Lehner, Rainer Malaka, Can Türker (Hrsg.) MMS 2007: Mobilität und mobile Informationssysteme

P-105 Wolf-Gideon Bleek, Jörg Raasch, Heinz Züllighoven (Hrsg.) Software Engineering 2007

P-106 Wolf-Gideon Bleek, Henning Schwentner, Heinz Züllighoven (Hrsg.) Software Engineering 2007 – Beiträge zu den Workshops

P-107 Heinrich C. Mayr, Dimitris Karagiannis (eds.) Information Systems Technology and its Applications

P-108 Arslan Brömme, Christoph Busch, Detlef Hühnlein (eds.) BIOSIG 2007: Biometrics and Electronic Signatures

P-109 Rainer Koschke, Otthein Herzog, Karl-Heinz Rödiger, Marc Ronthaler (Hrsg.) INFORMATIK 2007 Informatik trifft Logistik Band 1

P-110 Rainer Koschke, Otthein Herzog, Karl-Heinz Rödiger, Marc Ronthaler (Hrsg.) INFORMATIK 2007 Informatik trifft Logistik Band 2

P-111 Christian Eibl, Johannes Magenheim, Sigrid Schubert, Martin Wessner (Hrsg.) DeLFI 2007: 5. e-Learning Fachtagung Informatik

P-112 Sigrid Schubert (Hrsg.) Didaktik der Informatik in Theorie und Praxis

P-113 Sören Auer, Christian Bizer, Claudia Müller, Anna V. Zhdanova (Eds.) The Social Semantic Web 2007 Proceedings of the 1st Conference on Social Semantic Web (CSSW)

P-114 Sandra Frings, Oliver Göbel, Detlef Günther, Hardo G. Hase, Jens Nedon, Dirk Schadt, Arslan Brömme (Eds.) IMF2007 IT-incident management & IT-forensics Proceedings of the 3rd International Conference on IT-Incident Management & IT-Forensics

P-115 Claudia Falter, Alexander Schliep, Joachim Selbig, Martin Vingron and Dirk Walther (Eds.) German conference on bioinformatics GCB 2007

P-116 Witold Abramowicz, Leszek Maciszek (Eds.) Business Process and Services Computing 1st International Working Conference on Business Process and Services Computing BPSC 2007

P-117 Ryszard Kowalczyk (Ed.) Grid service engineering and manegement The 4th International Conference on Grid Service Engineering and Management GSEM 2007

P-118 Andreas Hein, Wilfried Thoben, Hans-Jürgen Appelrath, Peter Jensch (Eds.) European Conference on ehealth 2007

P-119 Manfred Reichert, Stefan Strecker, Klaus Turowski (Eds.) Enterprise Modelling and Information Systems Architectures Concepts and Applications

P-120 Adam Pawlak, Kurt Sandkuhl, Wojciech Cholewa, Leandro Soares Indrusiak (Eds.) Coordination of Collaborative Engineering - State of the Art and Future Challenges

P-121 Korbinian Herrmann, Bernd Bruegge (Hrsg.) Software Engineering 2008 Fachtagung des GI-Fachbereichs Softwaretechnik

P-122 Walid Maalej, Bernd Bruegge (Hrsg.) Software Engineering 2008 - Workshopband Fachtagung des GI-Fachbereichs Softwaretechnik

P-123 Michael H. Breitner, Martin Breunig, Elgar Fleisch, Ley Pousttchi, Klaus Turowski (Hrsg.)
Mobile und Ubiquitäre Informationssysteme – Technologien, Prozesse, Marktfähigkeit
Proceedings zur 3. Konferenz Mobile und Ubiquitäre Informationssysteme (MMS 2008)

P-124 Wolfgang E. Nagel, Rolf Hoffmann, Andreas Koch (Eds.)
9th Workshop on Parallel Systems and Algorithms (PASA)
Workshop of the GI/ITG Speciel Interest Groups PARS and PARVA

P-125 Rolf A.E. Müller, Hans-H. Sundermeier, Ludwig Theuvsen, Stephanie Schütze, Marlies Morgenstern (Hrsg.)
Unternehmens-IT:
Führungsinstrument oder Verwaltungsbürde
Referate der 28. GIL Jahrestagung

P-126 Rainer Gimnich, Uwe Kaiser, Jochen Quante, Andreas Winter (Hrsg.)
10th Workshop Software Reengineering (WSR 2008)

P-127 Thomas Kühne, Wolfgang Reisig, Friedrich Steimann (Hrsg.)
Modellierung 2008

P-128 Ammar Alkassar, Jörg Siekmann (Hrsg.)
Sicherheit 2008
Sicherheit, Schutz und Zuverlässigkeit
Beiträge der 4. Jahrestagung des Fachbereichs Sicherheit der Gesellschaft für Informatik e.V. (GI)
2.-4. April 2008
Saarbrücken, Germany

P-129 Wolfgang Hesse, Andreas Oberweis (Eds.)
Sigsand-Europe 2008
Proceedings of the Third AIS SIGSAND European Symposium on Analysis, Design, Use and Societal Impact of Information Systems

P-130 Paul Müller, Bernhard Neumair, Gabi Dreo Rodosek (Hrsg.)
1. DFN-Forum Kommunikations-technologien Beiträge der Fachtagung

P-131 Robert Krimmer, Rüdiger Grimm (Eds.)
3rd International Conference on Electronic Voting 2008
Co-organized by Council of Europe, Gesellschaft für Informatik and E-Voting. CC

P-132 Silke Seehusen, Ulrike Lucke, Stefan Fischer (Hrsg.)
DeLFI 2008:
Die 6. e-Learning Fachtagung Informatik

P-133 Heinz-Gerd Hegering, Axel Lehmann, Hans Jürgen Ohlbach, Christian Scheideler (Hrsg.)
INFORMATIK 2008
Beherrschbare Systeme – dank Informatik
Band 1

P-134 Heinz-Gerd Hegering, Axel Lehmann, Hans Jürgen Ohlbach, Christian Scheideler (Hrsg.)
INFORMATIK 2008
Beherrschbare Systeme – dank Informatik
Band 2

P-135 Torsten Brinda, Michael Fothe, Peter Hubwieser, Kirsten Schlüter (Hrsg.)
Didaktik der Informatik –
Aktuelle Forschungsergebnisse

P-136 Andreas Beyer, Michael Schroeder (Eds.)
German Conference on Bioinformatics GCB 2008

P-137 Arslan Brömme, Christoph Busch, Detlef Hühnlein (Eds.)
BIOSIG 2008: Biometrics and Electronic Signatures

P-138 Barbara Dinter, Robert Winter, Peter Chamoni, Norbert Gronau, Klaus Turowski (Hrsg.)
Synergien durch Integration und Informationslogistik
Proceedings zur DW2008

P-139 Georg Herzwurm, Martin Mikusz (Hrsg.)
Industrialisierung des Software-Managements
Fachtagung des GI-Fachausschusses Management der Anwendungsentwick-lung und -wartung im Fachbereich Wirtschaftsinformatik

P-140 Oliver Göbel, Sandra Frings, Detlef Günther, Jens Nedon, Dirk Schadt (Eds.)
IMF 2008 - IT Incident Management & IT Forensics

P-141 Peter Loos, Markus Nüttgens, Klaus Turowski, Dirk Werth (Hrsg.)
Modellierung betrieblicher Informations-systeme (MobIS 2008)
Modellierung zwischen SOA und Compliance Management

P-142 R. Bill, P. Korduan, L. Theuvsen, M. Morgenstern (Hrsg.)
Anforderungen an die Agrarinformatik durch Globalisierung und Klimaveränderung

P-143 Peter Liggesmeyer, Gregor Engels, Jürgen Münch, Jörg Dörr, Norman Riegel (Hrsg.)
Software Engineering 2009
Fachtagung des GI-Fachbereichs Softwaretechnik

P-144 Johann-Christoph Freytag, Thomas Ruf, Wolfgang Lehner, Gottfried Vossen (Hrsg.)
Datenbanksysteme in Business, Technologie und Web (BTW)

P-145 Knut Hinkelmann, Holger Wache (Eds.)
WM2009: 5th Conference on Professional Knowledge Management

P-146 Markus Bick, Martin Breunig, Hagen Höpfner (Hrsg.)
Mobile und Ubiquitäre Informationssysteme – Entwicklung, Implementierung und Anwendung
4. Konferenz Mobile und Ubiquitäre Informationssysteme (MMS 2009)

P-147 Witold Abramowicz, Leszek Maciaszek, Ryszard Kowalczyk, Andreas Speck (Eds.)
Business Process, Services Computing and Intelligent Service Management
BPSC 2009 · ISM 2009 · YRW-MBP 2009

P-148 Christian Erfurth, Gerald Eichler, Volkmar Schau (Eds.)
9th International Conference on Innovative Internet Community Systems
I^{2}CS 2009

P-149 Paul Müller, Bernhard Neumair, Gabi Dreo Rodosek (Hrsg.)
2. DFN-Forum Kommunikationstechnologien
Beiträge der Fachtagung

P-150 Jürgen Münch, Peter Liggesmeyer (Hrsg.)
Software Engineering
2009 - Workshopband

P-151 Armin Heinzl, Peter Dadam, Stefan Kirn, Peter Lockemann (Eds.)
PRIMIUM
Process Innovation for Enterprise Software

P-152 Jan Mendling, Stefanie Rinderle-Ma, Werner Esswein (Eds.)
Enterprise Modelling and Information Systems Architectures
Proceedings of the 3rd Int'l Workshop EMISA 2009

P-153 Andreas Schwill, Nicolas Apostolopoulos (Hrsg.)
Lernen im Digitalen Zeitalter
DeLFI 2009 – Die 7. E-Learning Fachtagung Informatik

P-154 Stefan Fischer, Erik Maehle Rüdiger Reischuk (Hrsg.)
INFORMATIK 2009
Im Focus das Leben

P-155 Arslan Brömme, Christoph Busch, Detlef Hühnlein (Eds.)
BIOSIG 2009:
Biometrics and Electronic Signatures
Proceedings of the Special Interest Group on Biometrics and Electronic Signatures

P-156 Bernhard Koerber (Hrsg.)
Zukunft braucht Herkunft
25 Jahre »INFOS – Informatik und Schule«

P-157 Ivo Grosse, Steffen Neumann, Stefan Posch, Falk Schreiber, Peter Stadler (Eds.)
German Conference on Bioinformatics 2009

P-158 W. Claupein, L. Theuvsen, A. Kämpf, M. Morgenstern (Hrsg.)
Precision Agriculture Reloaded – Informationsgestützte Landwirtschaft

P-159 Gregor Engels, Markus Luckey, Wilhelm Schäfer (Hrsg.)
Software Engineering 2010

P-160 Gregor Engels, Markus Luckey, Alexander Pretschner, Ralf Reussner (Hrsg.)
Software Engineering 2010 – Workshopband
(inkl. Doktorandensymposium)

P-161 Gregor Engels, Dimitris Karagiannis Heinrich C. Mayr (Hrsg.)
Modellierung 2010

P-162 Maria A. Wimmer, Uwe Brinkhoff, Siegfried Kaiser, Dagmar Lück-Schneider, Erich Schweighofer, Andreas Wiebe (Hrsg.)
Vernetzte IT für einen effektiven Staat
Gemeinsame Fachtagung Verwaltungsinformatik (FTVI) und Fachtagung Rechtsinformatik (FTRI) 2010

P-163 Markus Bick, Stefan Eulgem, Elgar Fleisch, J. Felix Hampe, Birgitta König-Ries, Franz Lehner, Key Pousttchi, Kai Rannenberg (Hrsg.)
Mobile und Ubiquitäre Informationssysteme
Technologien, Anwendungen und Dienste zur Unterstützung von mobiler Kollaboration

P-164 Arslan Brömme, Christoph Busch (Eds.)
BIOSIG 2010: Biometrics and Electronic Signatures Proceedings of the Special Interest Group on Biometrics and Electronic Signatures

P-165 Gerald Eichler, Peter Kropf, Ulrike Lechner, Phayung Meesad, Herwig Unger (Eds.)
10th International Conference on Innovative Internet Community Systems (I^2CS) – Jubilee Edition 2010 –

P-166 Paul Müller, Bernhard Neumair, Gabi Dreo Rodosek (Hrsg.)
3. DFN-Forum Kommunikationstechnologien
Beiträge der Fachtagung

P-167 Robert Krimmer, Rüdiger Grimm (Eds.)
4th International Conference on Electronic Voting 2010
co-organized by the Council of Europe, Gesellschaft für Informatik and E-Voting.CC

P-168 Ira Diethelm, Christina Dörge, Claudia Hildebrandt, Carsten Schulte (Hrsg.)
Didaktik der Informatik
Möglichkeiten empirischer Forschungsmethoden und Perspektiven der Fachdidaktik

P-169 Michael Kerres, Nadine Ojstersek Ulrik Schroeder, Ulrich Hoppe (Hrsg.)
DeLFI 2010 - 8. Tagung der Fachgruppe E-Learning der Gesellschaft für Informatik e.V.

P-170 Felix C. Freiling (Hrsg.)
Sicherheit 2010
Sicherheit, Schutz und Zuverlässigkeit

P-171 Werner Esswein, Klaus Turowski, Martin Juhrisch (Hrsg.)
Modellierung betrieblicher Informationssysteme (MobIS 2010)
Modellgestütztes Management

P-172 Stefan Klink, Agnes Koschmider Marco Mevius, Andreas Oberweis (Hrsg.)
EMISA 2010
Einflussfaktoren auf die Entwicklung flexibler, integrierter Informationssysteme
Beiträge des Workshops der GI-Fachgruppe EMISA (Entwicklungsmethoden für Informationssysteme und deren Anwendung)

P-173 Dietmar Schomburg, Andreas Grote (Eds.)
German Conference on Bioinformatics 2010

P-174 Arslan Brömme, Torsten Eymann, Detlef Hühnlein, Heiko Roßnagel, Paul Schmücker (Hrsg.)
perspeGKtive 2010
Workshop „Innovative und sichere Informationstechnologie für das Gesundheitswesen von morgen“

P-175 Klaus-Peter Fähnrich, Bogdan Franczyk (Hrsg.)
INFORMATIK 2010
Service Science – Neue Perspektiven für die Informatik
Band 1

P-176 Klaus-Peter Fähnrich, Bogdan Franczyk (Hrsg.)
INFORMATIK 2010
Service Science – Neue Perspektiven für die Informatik
Band 2

P-177 Witold Abramowicz, Rainer Alt, Klaus-Peter Fähnrich, Bogdan Franczyk, Leszek A. Maciaszek (Eds.)
INFORMATIK 2010
Business Process and Service Science – Proceedings of ISSS and BPSC

P-178 Wolfram Pietsch, Benedikt Krams (Hrsg.)
Vom Projekt zum Produkt
Fachtagung des GI-Fachausschusses Management der Anwendungsentwicklung und -wartung im Fachbereich Wirtschafts-informatik (WI-MAW), Aachen, 2010

P-179 Stefan Gruner, Bernhard Rumpe (Eds.)
FM+AM`2010
Second International Workshop on Formal Methods and Agile Methods

P-180 Theo Härder, Wolfgang Lehner, Bernhard Mitschang, Harald Schöning, Holger Schwarz (Hrsg.)
Datenbanksysteme für Business, Technologie und Web (BTW)
14. Fachtagung des GI-Fachbereichs „Datenbanken und Informationssysteme“ (DBIS)

P-181 Michael Clasen, Otto Schätzel, Brigitte Theuvsen (Hrsg.)
Qualität und Effizienz durch informationsgestützte Landwirtschaft, Fokus: Moderne Weinwirtschaft

P-182 Ronald Maier (Hrsg.)
6th Conference on Professional Knowledge Management
From Knowledge to Action

P-183 Ralf Reussner, Matthias Grund, Andreas Oberweis, Walter Tichy (Hrsg.)
Software Engineering 2011
Fachtagung des GI-Fachbereichs Softwaretechnik

P-184 Ralf Reussner, Alexander Pretschner, Stefan Jähnichen (Hrsg.)
Software Engineering 2011
Workshopband
(inkl. Doktorandensymposium)

P-185 Hagen Höpfner, Günther Specht, Thomas Ritz, Christian Bunse (Hrsg.)
MMS 2011: Mobile und ubiquitäre Informationssysteme Proceedings zur 6. Konferenz Mobile und Ubiquitäre Informationssysteme (MMS 2011)

P-186 Gerald Eichler, Axel Küpper, Volkmar Schau, Hacène Fouchal, Herwig Unger (Eds.)
11th International Conference on Innovative Internet Community Systems (I^2CS)

P-187 Paul Müller, Bernhard Neumair, Gabi Dreo Rodosek (Hrsg.)
4. DFN-Forum Kommunikations-technologien, Beiträge der Fachtagung 20. Juni bis 21. Juni 2011 Bonn

P-188 Holger Rohland, Andrea Kienle, Steffen Friedrich (Hrsg.)
DeLFI 2011 – Die 9. e-Learning Fachtagung Informatik der Gesellschaft für Informatik e.V. 5.–8. September 2011, Dresden

P-189 Thomas, Marco (Hrsg.)
Informatik in Bildung und Beruf INFOS 2011
14. GI-Fachtagung Informatik und Schule

P-190 Markus Nüttgens, Oliver Thomas, Barbara Weber (Eds.)
Enterprise Modelling and Information Systems Architectures (EMISA 2011)

P-191 Arslan Brömme, Christoph Busch (Eds.)
BIOSIG 2011
International Conference of the Biometrics Special Interest Group

P-192 Hans-Ulrich Heiß, Peter Pepper, Holger Schlingloff, Jörg Schneider (Hrsg.)
INFORMATIK 2011
Informatik schafft Communities

P-193 Wolfgang Lehner, Gunther Piller (Hrsg.)
IMDM 2011

P-194 M. Clasen, G. Fröhlich, H. Bernhardt, K. Hildebrand, B. Theuvsen (Hrsg.)
Informationstechnologie für eine nachhaltige Landbewirtschaftung
Fokus Forstwirtschaft

P-195 Neeraj Suri, Michael Waidner (Hrsg.)
Sicherheit 2012
Sicherheit, Schutz und Zuverlässigkeit
Beiträge der 6. Jahrestagung des Fachbereichs Sicherheit der Gesellschaft für Informatik e.V. (GI)

P-196 Arslan Brömme, Christoph Busch (Eds.)
BIOSIG 2012
Proceedings of the 11th International Conference of the Biometrics Special Interest Group

P-197 Jörn von Lucke, Christian P. Geiger, Siegfried Kaiser, Erich Schweighofer, Maria A. Wimmer (Hrsg.)
Auf dem Weg zu einer offenen, smarten und vernetzten Verwaltungskultur
Gemeinsame Fachtagung Verwaltungsinformatik (FTVI) und Fachtagung Rechtsinformatik (FTRI) 2012

P-198 Stefan Jähnichen, Axel Küpper, Sahin Albayrak (Hrsg.)
Software Engineering 2012
Fachtagung des GI-Fachbereichs Softwaretechnik

P-199 Stefan Jähnichen, Bernhard Rumpe, Holger Schlingloff (Hrsg.)
Software Engineering 2012
Workshopband

P-200 Gero Mühl, Jan Richling, Andreas Herkersdorf (Hrsg.)
ARCS 2012 Workshops

P-201 Elmar J. Sinz Andy Schürr (Hrsg.)
Modellierung 2012

P-202 Andrea Back, Markus Bick, Martin Breunig, Key Pousttchi, Frédéric Thiesse (Hrsg.)
MMS 2012:Mobile und Ubiquitäre Informationssysteme

P-203 Paul Müller, Bernhard Neumair, Helmut Reiser, Gabi Dreo Rodosek (Hrsg.)
5. DFN-Forum Kommunikations-technologien
Beiträge der Fachtagung

P-204 Gerald Eichler, Leendert W. M. Wienhofen, Anders Kofod-Petersen, Herwig Unger (Eds.)
12th International Conference on Innovative Internet Community Systems (I2CS 2012)

P-205 Manuel J. Kripp, Melanie Volkamer, Rüdiger Grimm (Eds.)
5th International Conference on Electronic Voting 2012 (EVOTE2012)
Co-organized by the Council of Europe, Gesellschaft für Informatik and E-Voting.CC

P-206 Stefanie Rinderle-Ma, Mathias Weske (Hrsg.)
EMISA 2012
Der Mensch im Zentrum der Modellierung

P-207 Jörg Desel, Jörg M. Haake, Christian Spannagel (Hrsg.)
DeLFI 2012: Die 10. e-Learning Fachtagung Informatik der Gesellschaft für Informatik e.V.
24.–26. September 2012

P-208 Ursula Goltz, Marcus Magnor, Hans-Jürgen Appelrath, Herbert Matthies, Wolf-Tilo Balke, Lars Wolf (Hrsg.) INFORMATIK 2012

P-209 Hans Brandt-Pook, André Fleer, Thorsten Spitta, Malte Wattenberg (Hrsg.) Nachhaltiges Software Management

P-210 Erhard Plödereder, Peter Dencker, Herbert Klenk, Hubert B. Keller, Silke Spitzer (Hrsg.) Automotive – Safety & Security 2012 Sicherheit und Zuverlässigkeit für automobile Informationstechnik

P-211 M. Clasen, K. C. Kersebaum, A. Meyer-Aurich, B. Theuvsen (Hrsg.) Massendatenmanagement in der Agrar- und Ernährungswirtschaft Erhebung - Verarbeitung - Nutzung Referate der 33. GIL-Jahrestagung 20. – 21. Februar 2013, Potsdam

P-212 Arslan Brömme, Christoph Busch (Eds.) BIOSIG 2013 Proceedings of the 12th International Conference of the Biometrics Special Interest Group 04.–06. September 2013 Darmstadt, Germany

P-213 Stefan Kowalewski, Bernhard Rumpe (Hrsg.) Software Engineering 2013 Fachtagung des GI-Fachbereichs Softwaretechnik

P-214 Volker Markl, Gunter Saake, Kai-Uwe Sattler, Gregor Hackenbroich, Bernhard Mit schang, Theo Härder, Veit Köppen (Hrsg.) Datenbanksysteme für Business, Technologie und Web (BTW) 2013 13. – 15. März 2013, Magdeburg

P-215 Stefan Wagner, Horst Lichter (Hrsg.) Software Engineering 2013 Workshopband (inkl. Doktorandensymposium) 26. Februar – 1. März 2013, Aachen

P-216 Gunter Saake, Andreas Henrich, Wolfgang Lehner, Thomas Neumann, Veit Köppen (Hrsg.) Datenbanksysteme für Business, Technologie und Web (BTW) 2013 – Workshopband 11. – 12. März 2013, Magdeburg

P-217 Paul Müller, Bernhard Neumair, Helmut Reiser, Gabi Dreo Rodosek (Hrsg.) 6. DFN-Forum Kommunikations-technologien Beiträge der Fachtagung 03.–04. Juni 2013, Erlangen

P-218 Andreas Breiter, Christoph Rensing (Hrsg.) DeLFI 2013: Die 11 e-Learning Fachtagung Informatik der Gesellschaft für Informatik e.V. (GI) 8. – 11. September 2013, Bremen

P-219 Norbert Breier, Peer Stechert, Thomas Wilke (Hrsg.) Informatik erweitert Horizonte INFOS 2013 15. GI-Fachtagung Informatik und Schule 26. – 28. September 2013

P-220 Matthias Horbach (Hrsg.) INFORMATIK 2013 Informatik angepasst an Mensch, Organisation und Umwelt 16. – 20. September 2013, Koblenz

P-221 Maria A. Wimmer, Marijn Janssen, Ann Macintosh, Hans Jochen Scholl, Efthimios Tambouris (Eds.) Electronic Government and Electronic Participation Joint Proceedings of Ongoing Research of IFIP EGOV and IFIP ePart 2013 16. – 19. September 2013, Koblenz

P-222 Reinhard Jung, Manfred Reichert (Eds.) Enterprise Modelling and Information Systems Architectures (EMISA 2013) St. Gallen, Switzerland September 5. – 6. 2013

P-223 Detlef Hühnlein, Heiko Roßnagel (Hrsg.) Open Identity Summit 2013 10. – 11. September 2013 Kloster Banz, Germany

P-224 Eckhart Hanser, Martin Mikusz, Masud Fazal-Baqaie (Hrsg.) Vorgehensmodelle 2013 Vorgehensmodelle – Anspruch und Wirklichkeit 20. Tagung der Fachgruppe Vorgehensmodelle im Fachgebiet Wirtschaftsinformatik (WI-VM) der Gesellschaft für Informatik e.V. Lörrach, 2013

P-225 Hans-Georg Fill, Dimitris Karagiannis, Ulrich Reimer (Hrsg.) Modellierung 2014 19. – 21. März 2014, Wien

P-226 M. Clasen, M. Hamer, S. Lehnert, B. Petersen, B. Theuvsen (Hrsg.) IT-Standards in der Agrar- und Ernährungswirtschaft Fokus: Risiko- und Krisenmanagement Referate der 34. GIL-Jahrestagung 24. – 25. Februar 2014, Bonn

P-227 Wilhelm Hasselbring,
Nils Christian Ehmke (Hrsg.)
Software Engineering 2014
Fachtagung des GI-Fachbereichs Softwaretechnik
25. – 28. Februar 2014
Kiel, Deutschland

P-228 Stefan Katzenbeisser, Volkmar Lotz, Edgar Weippl (Hrsg.)
Sicherheit 2014
Sicherheit, Schutz und Zuverlässigkeit
Beiträge der 7. Jahrestagung des Fachbereichs Sicherheit der Gesellschaft für Informatik e.V. (GI)
19. – 21. März 2014, Wien

P-230 Arslan Brömme, Christoph Busch (Eds.)
BIOSIG 2014
Proceedings of the 13th International Conference of the Biometrics Special Interest Group
10. – 12. September 2014 in Darmstadt, Germany

P-231 Paul Müller, Bernhard Neumair, Helmut Reiser, Gabi Dreo Rodosek (Hrsg.)
7. DFN-Forum Kommunikationstechnologien
16. – 17. Juni 2014
Fulda

P-232 E. Plödereder, L. Grunske, E. Schneider, D. Ull (Hrsg.)
INFORMATIK 2014
Big Data – Komplexität meistern
22. – 26. September 2014
Stuttgart

P-233 Stephan Trahasch, Rolf Plötzner, Gerhard Schneider, Claudia Gayer, Daniel Sassiat, Nicole Wöhrle (Hrsg.)
DeLFI 2014 – Die 12. e-Learning Fachtagung Informatik
der Gesellschaft für Informatik e.V.
15. – 17. September 2014
Freiburg

P-234 Fernand Feltz, Bela Mutschler, Benoît Otjacques (Eds.)
Enterprise Modelling and Information Systems Architectures
(EMISA 2014)
Luxembourg, September 25-26, 2014

P-235 Robert Giegerich,
Ralf Hofestädt,
Tim W. Nattkemper (Eds.)
German Conference on Bioinformatics 2014
September 28 – October 1
Bielefeld, Germany

P-236 Martin Engstler, Eckhart Hanser, Martin Mikusz, Georg Herzwurm (Hrsg.)
Projektmanagement und Vorgehensmodelle 2014
Soziale Aspekte und Standardisierung
Gemeinsame Tagung der Fachgruppen Projektmanagement (WI-PM) und Vorgehensmodelle (WI-VM) im Fachgebiet Wirtschaftsinformatik der Gesellschaft für Informatik e.V., Stuttgart 2014

P-237 Detlef Hühnlein, Heiko Roßnagel (Hrsg.)
Open Identity Summit 2014
4.–6. November 2014
Stuttgart, Germany

P-238 Arno Ruckelshausen, Hans-Peter Schwarz, Brigitte Theuvsen (Hrsg.)
Informatik in der Land-, Forst- und Ernährungswirtschaft
Referate der 35. GIL-Jahrestagung
23. – 24. Februar 2015, Geisenheim

P-239 Uwe Aßmann, Birgit Demuth, Thorsten Spitta, Georg Püschel, Ronny Kaiser (Hrsg.)
Software Engineering & Management 2015
17.-20. März 2015, Dresden

P-240 Herbert Klenk, Hubert B. Keller, Erhard Plödereder, Peter Dencker (Hrsg.)
Automotive – Safety & Security 2015
Sicherheit und Zuverlässigkeit für automobile Informationstechnik
21.–22. April 2015, Stuttgart

P-241 Thomas Seidl, Norbert Ritter, Harald Schöning, Kai-Uwe Sattler, Theo Härder, Steffen Friedrich, Wolfram Wingerath (Hrsg.)
Datenbanksysteme für Business, Technologie und Web (BTW 2015)
04. – 06. März 2015, Hamburg

P-242 Norbert Ritter, Andreas Henrich, Wolfgang Lehner, Andreas Thor, Steffen Friedrich, Wolfram Wingerath (Hrsg.)
Datenbanksysteme für Business, Technologie und Web (BTW 2015) – Workshopband
02. – 03. März 2015, Hamburg

P-243 Paul Müller, Bernhard Neumair, Helmut Reiser, Gabi Dreo Rodosek (Hrsg.)
8. DFN-Forum Kommunikationstechnologien
06.–09. Juni 2015, Lübeck

P-244 Alfred Zimmermann,
Alexander Rossmann (Eds.)
Digital Enterprise Computing
(DEC 2015)
Böblingen, Germany June 25-26, 2015

P-245 Arslan Brömme, Christoph Busch ,
Christian Rathgeb, Andreas Uhl (Eds.)
BIOSIG 2015
Proceedings of the 14th International
Conference of the Biometrics Special
Interest Group
09.–11. September 2015
Darmstadt, Germany

P-246 Douglas W. Cunningham, Petra Hofstedt,
Klaus Meer, Ingo Schmitt (Hrsg.)
INFORMATIK 2015
28.9.-2.10. 2015, Cottbus

P-247 Hans Pongratz, Reinhard Keil (Hrsg.)
DeLFI 2015 – Die 13. E-Learning
Fachtagung Informatik der Gesellschaft
für Informatik e.V. (GI)
1.–4. September 2015
München

P-248 Jens Kolb, Henrik Leopold, Jan Mendling
(Eds.)
Enterprise Modelling and Information
Systems Architectures
Proceedings of the 6th Int. Workshop on
Enterprise Modelling and Information
Systems Architectures, Innsbruck, Austria
September 3-4, 2015

P-249 Jens Gallenbacher (Hrsg.)
Informatik
allgemeinbildend begreifen
INFOS 2015 16. GI-Fachtagung
Informatik und Schule
20.–23. September 2015

P-250 Martin Engstler, Masud Fazal-Baqaie,
Eckhart Hanser, Martin Mikusz,
Alexander Volland (Hrsg.)
Projektmanagement und
Vorgehensmodelle 2015
Hybride Projektstrukturen erfolgreich
umsetzen
Gemeinsame Tagung der Fachgruppen
Projektmanagement (WI-PM) und
Vorgehensmodelle (WI-VM) im
Fachgebiet Wirtschaftsinformatik
der Gesellschaft für Informatik e.V.,
Elmshorn 2015

P-251 Detlef Hühnlein, Heiko Roßnagel,
Raik Kuhlisch, Jan Ziesing (Eds.)
Open Identity Summit 2015
10.–11. November 2015
Berlin, Germany

P-252 Jens Knoop, Uwe Zdun (Hrsg.)
Software Engineering 2016
Fachtagung des GI-Fachbereichs
Softwaretechnik
23.–26. Februar 2016, Wien

P-253 A. Ruckelshausen, A. Meyer-Aurich,
T. Rath, G. Recke, B. Theuvsen (Hrsg.)
Informatik in der Land-, Forst- und
Ernährungswirtschaft
Fokus: Intelligente Systeme – Stand der
Technik und neue Möglichkeiten
Referate der 36. GIL-Jahrestagung
22.-23. Februar 2016, Osnabrück

P-254 Andreas Oberweis, Ralf Reussner (Hrsg.)
Modellierung 2016
2.–4. März 2016, Karlsruhe

P-255 Stefanie Betz, Ulrich Reimer (Hrsg.)
Modellierung 2016 Workshopband
2.–4. März 2016, Karlsruhe

The titles can be purchased at:

Köllen Druck + Verlag GmbH
Ernst-Robert-Curtius-Str. 14 · D-53117 Bonn
Fax: +49 (0)228/9898222
E-Mail: druckverlag@koellen.de

Gesellschaft für Informatik e.V. (GI)

publishes this series in order to make available to a broad public recent findings in informatics (i.e. computer science and information systems), to document conferences that are organized in cooperation with GI and to publish the annual GI Award dissertation.

Broken down into
• seminars
• proceedings
• dissertations
• thematics
current topics are dealt with from the vantage point of research and development, teaching and further training in theory and practice. The Editorial Committee uses an intensive review process in order to ensure high quality contributions.

The volumes are published in German or English.

Information: http://www.gi.de/service/publikationen/lni/

ISSN 1617-5468
ISBN 978-3-88579-649-7

"Modellierung 2016" is the fifteenth event in a conference series focusing on a broad range of modeling topics from a variety of perspectives. With its emphasis on lively discussions and cross-fertilization of academia and industry, it provides a valuable platform to further the state of the art in topics such as modeling foundations, methodologies, applications, and tools. This volume contains contributions from the workshops AQEMO, MoHoL, REBPM, as well as the tool presentations.