PERSPECTIVES ON PROCESS DOCUMENTATION
A Case Study

Jörg Becker, Christian Janiesch, Patrick Delfmann
European Research Center for Information Systems, University of Münster, Leonardo-Campus 3, Münster, Germany

Wolfgang Fuhr
Bayer Business Services GmbH, Leverkusen, Germany

Keywords: Process Documentation, Process Modeling, Configuration, Conceptual Modeling, Multi-Perspective Information Modeling, Case Study

Abstract: The documentation of IT projects is of paramount importance for the lasting benefit of a project's outcome. However, different forms of documentation are needed to comply with the diverse needs of users. In order to avoid the maintenance of numerous versions of the same documentation, an integrated method from the field of reference modeling creating perspectives on configurable models is presented and evaluated against a case in the field of health care. The proposal of a holistic to-be model for process documentation provides useful hints towards the need of presenting a model that relates to a specific user's perspective. Moreover, it helps to evaluate the applicability of configurable, company-specific models concerning the relative operating efficiency.

1 RESEARCH APPROACH AND CASE SCENARIO

The documentation of IT projects, e. g. software development or process reengineering, is of paramount importance for the lasting benefit of a project's outcome. But different forms of documentation are needed to comply with the diverse needs of users who use information model for different purposes. A system engineer for instance is in need of different information than a manager or a trainee.

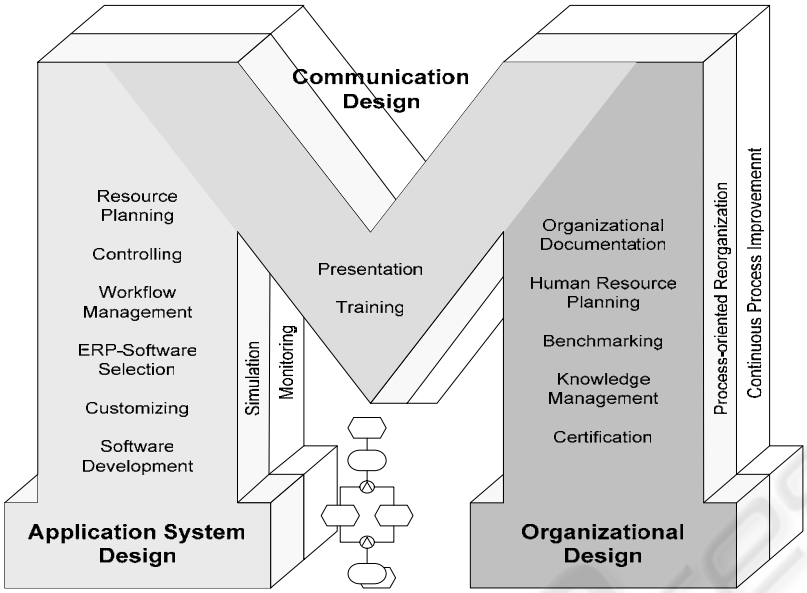
These problems are similar to those from the field of reference modeling where large overall process models have to be adapted to company-specific contexts. To assist this model adjustment several model customization techniques have been discussed that allow the adaptation for various purposes. However, the applicability to large company-specific models has not been further investigated. Thus, these configuration techniques are discussed mainly in the field of reference modeling. Their applicability to company-specific models in terms of process documentation for process management purposes seems to be promising nonetheless.

In the year 1996 the Bayer AG, a Germany-based global enterprise in the fields of health care, nutrition, and innovative materials, settled on a comprehensive framework for a corporate-wide roll-out of the standard software SAP R/3. In the run-up all major processes were analyzed and documented. This provided an ideal basis for a thorough ex-post analysis and allowed meaningful propositions for a future appearance of the process documentation that allow the utilization of the information for different purposes. The Bayer Business Services GmbH assisted us greatly in the analysis of their documentation and provided us with any input requested. We thankfully acknowledge their support in this project.

Thus, the research questions for the following are in detail:

- Which possibilities exist to allow a context-oriented preparation of process documentations or process models?
- In which way can they be applied at the Bayer AG?
- Is the utilization of context-oriented process documentations beneficial for the Bayer AG? If so, does the concept sound promising for other companies as well?

Becker J., Janiesch C., Delfmann P. and Fuhr W. (2005).
PERSPECTIVES ON PROCESS DOCUMENTATION - A Case Study.
In *Proceedings of the Seventh International Conference on Enterprise Information Systems*, pages 46-56
DOI: 10.5220/0002543900460056



Cf. (Rosemann et al., 2005).

Figure 1: Specific Purposes of Process Models

The structure of the paper mirrors this. At first, the idea of configurative modeling and its related work is elaborated upon. Then a comprehensive as-is analysis is conducted whose findings result in the proposition of a holistic to-be model. Hereon the need for configurable models at the Bayer AG is identified as well as the application of possible occurrences is presented and discussed in detail.

2 CONFIGURATIVE MODELING AND RELATED WORK

2.1 Perspectives on Process Models

According to the Total Quality Management (TQM) approach, the quality of a product is determined by its *fitness-for-use* for the consumer and his requirements (Ishikawa, 1985). When transferred to process models, their quality depends on the fitness-for-use concerning the requirements of particular users or user groups. User requirements result from their different perspectives on business processes (Rosemann et al., 2005), (Nissen et al., 1996), (Rosemann and Green, 2000). A perspective is determined by the deliberate and specific use of a business process model, the organizational role of a user as well as individual preferences on the conceptual and representational design of business process models (Becker et al., 2002). See Figure 1 for an overview of specific purposes of process models.

The more effective the process model meets the requirements of a particular perspective, the higher is its quality. Ideally, each identified perspective should be provided with a tailor-made version of a process model. This approach is called *multi-perspective process modeling* (Darke and Shanks, 1996), (Rosemann, 1998), (Becker et al., 2002).

2.2 Related Work on Model Adaptation

In order to enable multi-perspective information modeling, different approaches of model adaptation have been developed in the past. Some approaches focus on *model transformation*, as they are proclaimed by the Model Driven Architecture (MDA) (Soley and OMG Staff Strategy Group, 2000)). Implementations of model transformation mechanisms can be found in the form of so-called Meta CASE Tools like the Generic Modeling Environment (GME) (Agrawal et al., 2002), (Ledeczi et al., 2001) and Metaview (Findeisen, 1994). Model transformation aims at generating a destination model out of an original model, whereas the languages of both models can diverge extensively. Structural patterns are identified in the model of the initial modeling language via an algorithmic search and they are transformed into equivalent patterns of a model of the targeted modeling language. Transformations are performed by using transformation rules that are defined for each combination of the original and destination language (Engels et al., 1997). Model transformation approaches are characterized by a high universality of the operators used for the definition of transformation rules (e. g. *Create New, Re-*

place, *Same*, *Create Reference*, *Create Link*, *Delete*, *Refer else Create*, *Create inside*, *Refer to*) which makes high user competencies necessary.

Transformations are usually employed in the software industry to adapt software to different operating systems or computer platforms. In the field of process modeling it is not necessarily required to transform models.

Other types of approaches focus on building views onto a model system. These views are then considered as perspectives which result from user requirements. Exemplary approaches of this type are the Semantic Object Model (SOM) (Ferstl and Sinz, 1998), the Architecture of Integrated Information Systems (ARIS) (Scheer, 2000), the Zachman Framework (Zachman, 1987), the Open Systems Architecture for Computer Integrated Manufacturing (CIM-OSA) (ESPRIT Consortium AMICE, 1989), MEMO (Frank, 1994), and Viewpoints (Finkelstein et al., 1992). A common characteristic of these approaches is that the realization of multiple perspectives is restricted to providing different modeling views which result in different model types. In the case of ARIS, these views are e. g. the data, the functional, the organizational and the process view which are represented by Entity-Relationship Models (ERM) (Chen, 1976), Function Trees, Organizational Charts, and Event-driven Process Chains (EPC) (Scheer, 2000).

The approach which will be adopted here is based on the latter of the approaches mentioned, but provides extended configuration mechanisms instead that are not restricted to modeling views.

2.3 Configuration Techniques for Information Models

The most significant problem that results from a multiplicity of perspective specific, tailor-made models is the need to manage possible redundancies inside the model itself. This leads to increased modeling and maintenance cost and the danger of inconsistencies within the model base.

In order to enable an efficient multi-perspective process modeling, redundancies have to be overcome. A modeling methodology which enables the user to avoid redundancies and to consider multiple perspectives within the model base is called configurative process modeling (for the following refer to (Becker et al., 2004), (Becker et al., 2002)). The approach is based on the concept of model projection. A configurable information model that provides all relevant information for each perspective contains constraints that determine to which perspective each model element belongs. By this means redundancies are avoided and, simultaneously, multi-perspective modeling is made possible. When a configuration is performed, each element is hidden that does not belong to the selected perspective. This implies that the core modeling is conducted using the model base and as such can only be performed by modeling experts that are properly trained. Thus, the distributed modeling of the base model still causes problems since inconsistencies may occur.

In order to reduce modeling complexity for the individual user, it makes sense to provide configuration mechanisms with different effectiveness. First, coarse granular configuration mechanisms that operate on whole model sections, second, mechanisms that operate on single model elements should be provided. Hence, we distinguish configuration mechanisms that are based on meta model projection or model projection respectively. Using meta model projection on the one hand, the user is enabled to create perspective-specific models that differ in the expressive power of the underlying modeling method (e. g. by hiding model elements of a specific object type). On the other hand, using model projection, particular model elements can be hidden (e. g. process branches that are of no relevance for the regarded perspective). Model projections are language extensions in the sense of Domain-Specific Modeling (Nordstrom et al., 1999), which are particularly adapted to the requirements of multi-perspective information modeling.

3 THE BAYER CASE

3.1 Initial Situation

Since 1983 the Bayer AG used SAP R/2 systems in several parts of the company. In the year 1996 a comprehensive framework for a corporate-wide roll-out of the ERP software SAP R/3 was resolved upon. In the run-up all major processes were analyzed and if necessary redesigned. The original idea was to conduct a complete redesign utilizing the concept of business reengineering (Hammer and Champy, 1993). However, the idea had to be neglected later on for several reasons; mainly the size of the project in connection with established structures disallowed the necessary changes. See chapter 3.2 for further factors that hindered the project's development and documentation.

Whenever possible, two perspectives were used in the process: one with a more managerial and one with a more technical focus. A large number of external consultants were part of the project teams.

The documentation of the processes was conducted with several plug-ins of a Lotus Notes groupware environment, the so-called Electronic

Project Notebook (EPN). The documentation is structured in three perspectives: a function-oriented view, a process-oriented view and a technical view. The function view's elements are detailed in *Process*, *Subprocess* and *Activity Profile*, the process-oriented view that spans multiple organizational units is arranged in *Business Scenario Cluster (BSC)*, *Business Scenario* and *Business Scenario Flow (BSF)* (see Figure 2, all other perspectives are modeled similarly). The technical view which is of minor importance to the overall documentation is arranged in *IT Solution Design Document*, *Configuration Document* and *Activity Script* as well as the *Repository Objects* which contain application source code. Connected to every node in every hierarchy level there is a document that is detailed in the level below. All three hierarchy levels as well as the three views have to be matched manually against each other whenever there is a change.

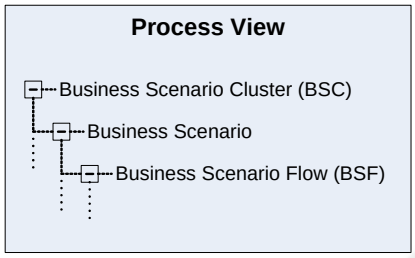


Figure 2: Structure of the Process View

Parallel to the reengineering project a quality management system was developed that documents process-design processes. It combines several information sources in one portal and its core idea is to describe those meta processes. Again, the arrangement is function-oriented and the matching has to be conducted manually.

The EPN and the quality management system, both have next to no support with information models at all; for the most part they only contain textual descriptions. Solely several PowerPoint slides exist that depict some aspects of the system in forms of processes and application dependence diagrams using informal models. The models only serve to present a minimal overview and – since they have not been developed with an integrated modeling tool – have to be matched manually against change in the three views to persist in a consistent state.

Since the maintenance of this form of documentation over time exceeds any sensible IT budget, a more integrated approach is favorable. In order to depict most of the scenarios attributes the *Direct Business* process was chosen since it is relevant as well for the applications system as organizational design. In addition to that, four variants of the process exist that contain special functions for external customers and for internal use. The process is located in the *BSC Direktgeschäft (Direct Business)* of the EPN.

3.2 As-Is-Analysis of the Case Process

As indicated above, the original intention of the modeling was to assist a process-oriented reorganization of the corporation focusing the software customizing for an ERP implementation. Now, the main focus is a continuous process management to monitor and improve the current processes. In addition to that, options for the utilization of the documentation for workflows and for training purposes is explored. In the near future, further use in the field of quality management is desirable. These different purposes also require different perspectives for the users involved since a modeling expert does have other requirements than the process owner.

The Direct Business process deals with the direct sales to customers or other Bayer AG companies. Two general variants exist: *Intercompany* and *External Customer* each with one special case; i. e. for Intercompany the *Bayer AG to Bayer Distribution Company via IDOC* process and for external customers the *Direct Business via Letter of Credit (LC)* process.

The process always starts with a customer order and ends with the managing of accounts receivable. If planning software is utilized for internal use, it generates the respective customer order at the delivering company.

See Table 1 for the original process documentation of the *BSF Direct Sales (External Customer)*. The table is an excerpt of the respective BSF. Some columns of lesser interest are omitted: *SAP Transaction/ Script (Optional)*, *Information Object Characteristics (Optional)*, *Processed by Partner (Optional)* as well as *Remarks*. The other content is still in its original format except for minor anonymization of numbers and codes. The other three process variant descriptions are of similar build and not depicted here in detail.

The analysis of the process was complicated in particular by the following factors:

- The storage in the processes in the EPN is not consistent.
- The sequence of process functions can only be determined when BSF and Business Scenario, both are explored.
- The matching of documentation techniques does not only consist of documents from the three hierarchy levels but also their attached documents.
- The documentation language is not uniform on any level of documentation.

Table 1: BSF Direct Sales (External Customer)

Decisive criteria for BS Flow: xxx				
Nr.	Short Description of Task	Activity	Work-field	Input/Output Information Objects (Optional)
1	Kundenauftrag anlegen	Life Science O: Create/Change Order	8	--Order type --Sales organization --Distribution channel --Division --Sold-to-party --Purchase Order no. --Material number --Quantity
2	Auftragsfertigung	Life Science BS Auftragsfertigung	7	
3	Lieferung anlegen	Life Science MM: Process Delivery of Line Items	8	Versandstelle
4	Dispoliste drucken	Life Science MM: Pack orders for shipment & Plan packing material	8	Shipping point and output type
5	Etikettendruck	Life Science MM: Label Goods for Shipping	8	-- Delivery no. -- Delivery item -- Batch no.
6	Warenausgang zur Lieferung	Life Science BS Auslieferung abwickeln	6 8	
7	Rechnung erstellen	Support O: Process invoice	8	
8	Legal Services	Support BSF Declaration to authorities und BSF Zollabwicklung	8 12	
9	FI/CO Zahlungseingang	Support Subprocess FA Manage Account Receivables	9	

Consistency problems: All four variants of the process are attached to the same BSC but there are two names used simultaneously in different areas of the corporation: *BSC Direct Business* and *BSC Direct Sales/ Direktgeschäft*. An automated synchronization of names or an integrated system could take care of this.

Sequence problems: Apart from the tabular process documentation in the BSF some more aggregated information in forms of PowerPoint slides is saved in the superordinated Business Scenario. The slides depict the sequence on a very rough granular scale in forms of column-oriented informal process models. They represent the only hints on the sequence of process functions, in particular whether they are executed alternatively or in a parallel fashion.

Attached document problems: Not only the above mentioned PowerPoint slides but also Excel Documents that aggregate the content of the tables in the Lotus Notes documentation have to be matched manually (against all levels and views). This led to minor inconsistencies in the past that will aggravate in the future when more views are to be implemented.

Language problems: The documentation is composed in English and German interchangeably. This led to a non-uniform naming of hierarchy levels and processes as well as their functions. Textual descriptions are partly composed in English and German, too. On the one hand English naming facilitates the identification of the SAP transactions involved. On the other hand this leads to naming inconsistencies and problems with the matching of abbreviations. In addition to that it disrupts the general train of reading.

However, when criticizing the systems layout, the factors that led to the current state of operations have to be considered. They do not excuse the current state but explain the development of the as-is system design. Time, cost and size of the project led to the decision that an integrated modeling tool was not commissioned. It was regarded as too big a cost factor and too time-consuming to train all involved personnel, especially since there was a considerable

amount of external consultants involved. After starting the documentation in English the unequal educational background impeded a proper completion of the documentation in a foreign language. It was decided to continue in German in an easy-to-use Lotus Notes environment to at least maintain a certain set of documentation guidelines. However, these very same factors led to the fact the current system is neither able to provide proper perspectives for different uses nor is cost-efficient. It foremost purpose at this point is to be a legal lifeline that complies with German law for the documentation of health care company software.

3.3 To-Be Model Proposition

For the construction of a to-be model all four process variants are integrated into one process with alternative paths. It is modeled with the EPC technique to show the benefits of a well structured graphical representation that allows the integration of further techniques like for instance the ERM.

See Figure 3 for the complete to-be model proposition. The use of events is abstained from as far as possible to improve the readability of the model. This does not interfere with its semantics since events have not been documented in the first place. The omission does also apply for the following figures.

The integration of all four variants into one model allows an easier maintenance of the process documentation since no matching has to take place to adapt changes to other documents. However, the combination of four variants into one integrated model leads to a graphical representation with lots of XOR-connectors. This can be difficult to comprehend by the casual user, especially when he or she is not familiar with the configuration techniques at the connectors. Since they describe under which circumstances which process alternative has to be followed, it is essential to understand their working in order to execute a process variant. Exemplarily four XOR-connectors have been equipped with configuration rules to allow process variant execution. Moreover, the enrichment of the model with further elements like organizational roles or application systems would most certainly not enhance the readability but have a contrary effect. That is why they have not been included in Figure 3.

Therefore it is necessary to use perspectives or views on this integrated model so that it can be used even by the casual user to serve his purpose. These perspectives allow the enhancement of the model and the meta model with additional elements and omit non relevant process variants by a further model configuration. These mechanisms permit the use even by a casual user who has at least a minimal understanding of graphical process modeling. Since all configurations are solely projections of the integrated original model, its consistency is not in question. The definition of these configuration points however has to be done by a method expert since their complexity exceeds the casual user's abilities.

3.4 Configurable To-Be Models

A configuration for the organizational design of the variant direct sales (external customer) is shown in Figure 4.

Regarding model projection all non relevant process threads have been masked so that only relevant functions are displayed. In this way, an easy-to-read process model is displayed that only shows the desired variant. Apart from this model configuration a meta model projection was applied to integrate relevant further model types into the model, i. e. an Organizational Chart and a Technical Term Model. The utilization of their model elements assists the organizational design and enriches the model so that additional information becomes explicitly available. Exemplarily, elements of each modeling technique have been linked with a dotted line to show that it is indeed the same object.

A corresponding configuration for the application system design of the same variant is shown in Figure 5.

In this case as well, the model is configured so that only the relevant process thread is displayed. Further model types that are employed via meta model projection are the ERM and an Application System Model. By using element types of both modeling techniques the application system design can be assisted since the explanatory power of the model is increased by this enrichment, e. g. by displaying abundant SAP modules. For system engineering it is more relevant when conducting a process analysis which modules of an ERP system are linked to certain functions than the role of a person that executes them. As a next step the accordant SAP transaction and the program data of the technical documentation can be added to the model to let the system engineer go further into the documentation. Another interesting option is the linking of process elements for the administration of test cases. The tests conducted can be directly associated with the corresponding function, thus allowing a simple but powerful management of test cases. Through configuration mechanisms critical test runs can be separated from routine tests. In this way testing for processes can be clustered with the process model. In addition to that, results could be clustered as well to single out deviations that exceed defined safety limits.

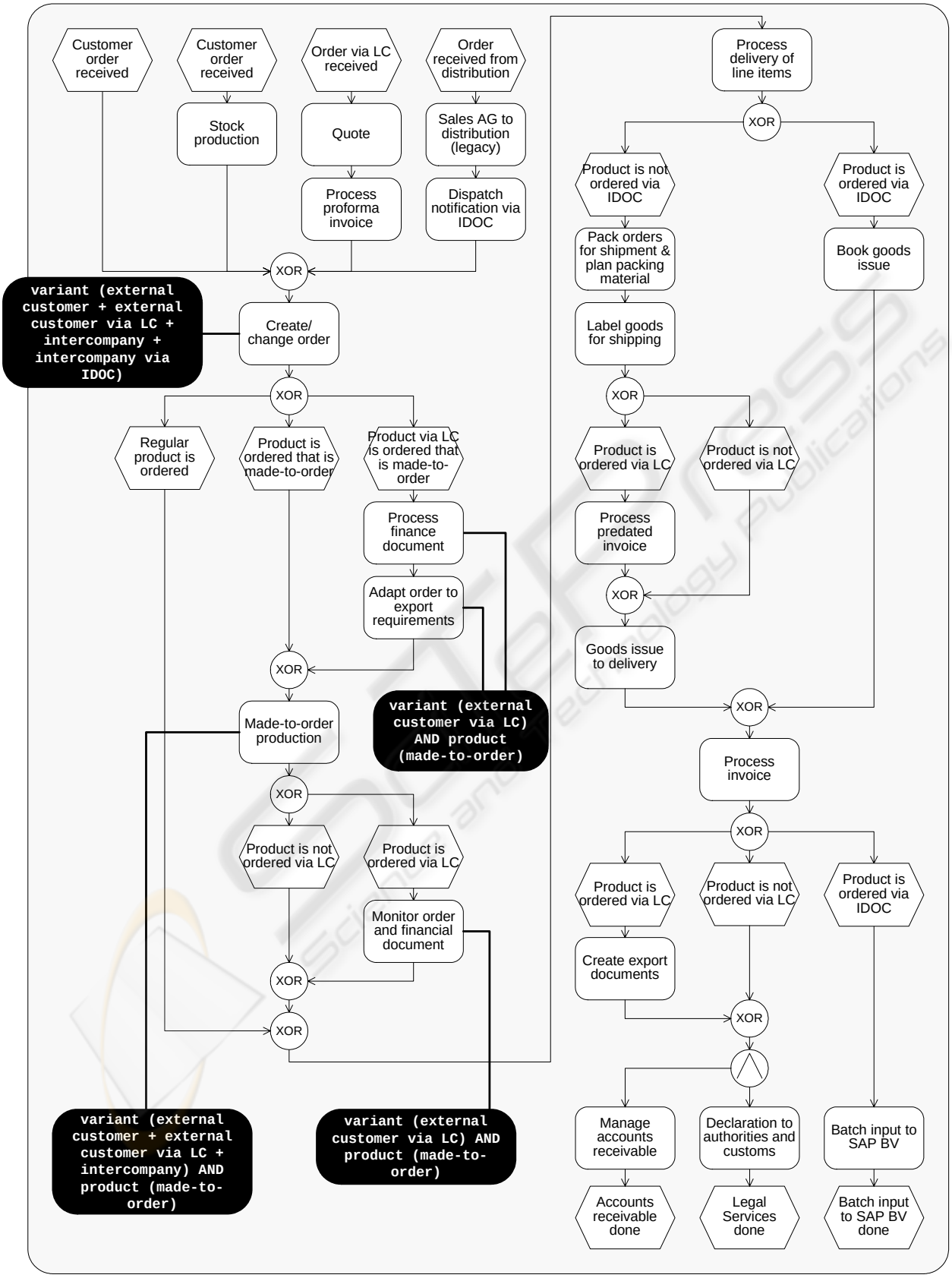


Figure 3: To-be Model Proposition

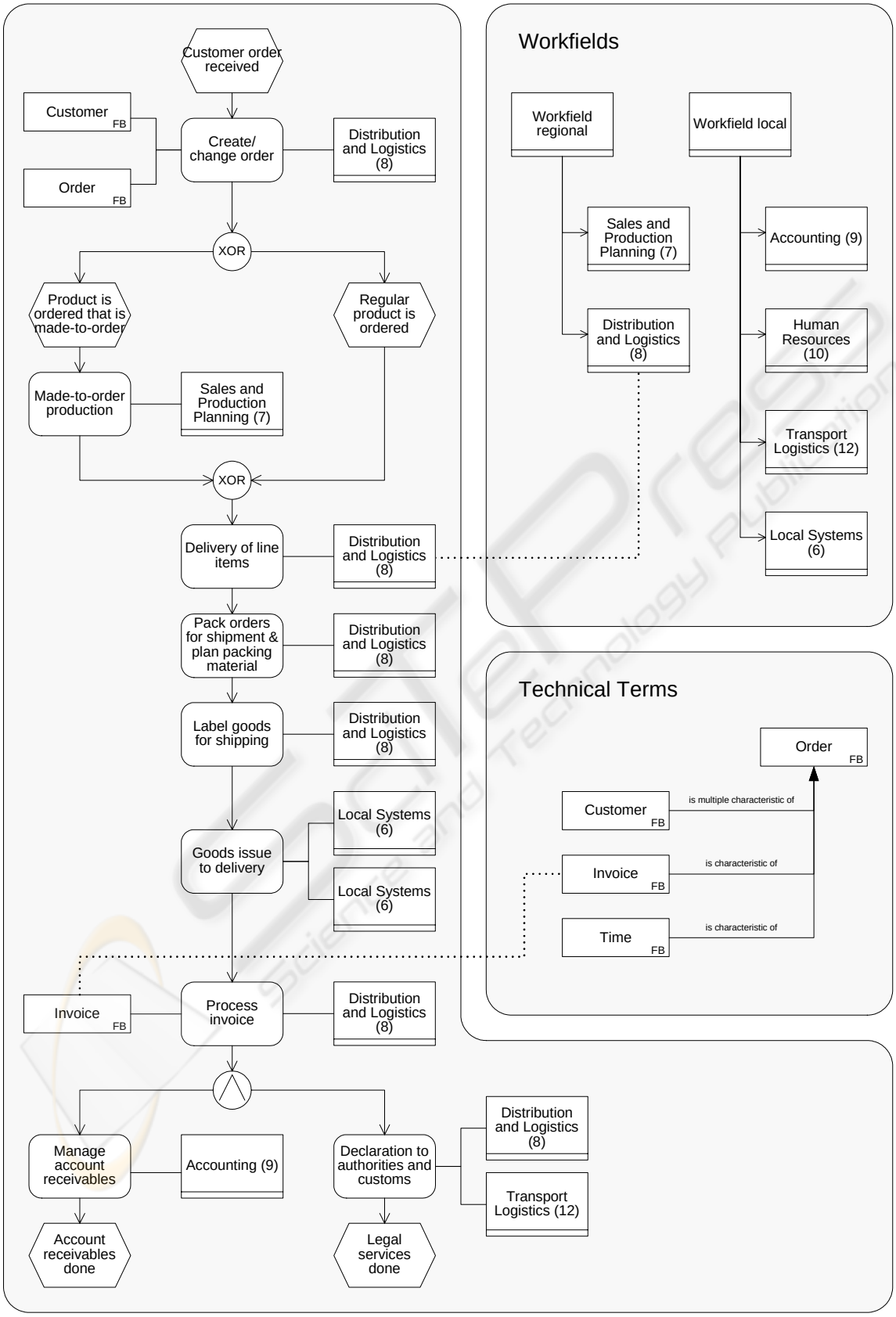


Figure 4: Model Projection for Organizational Design

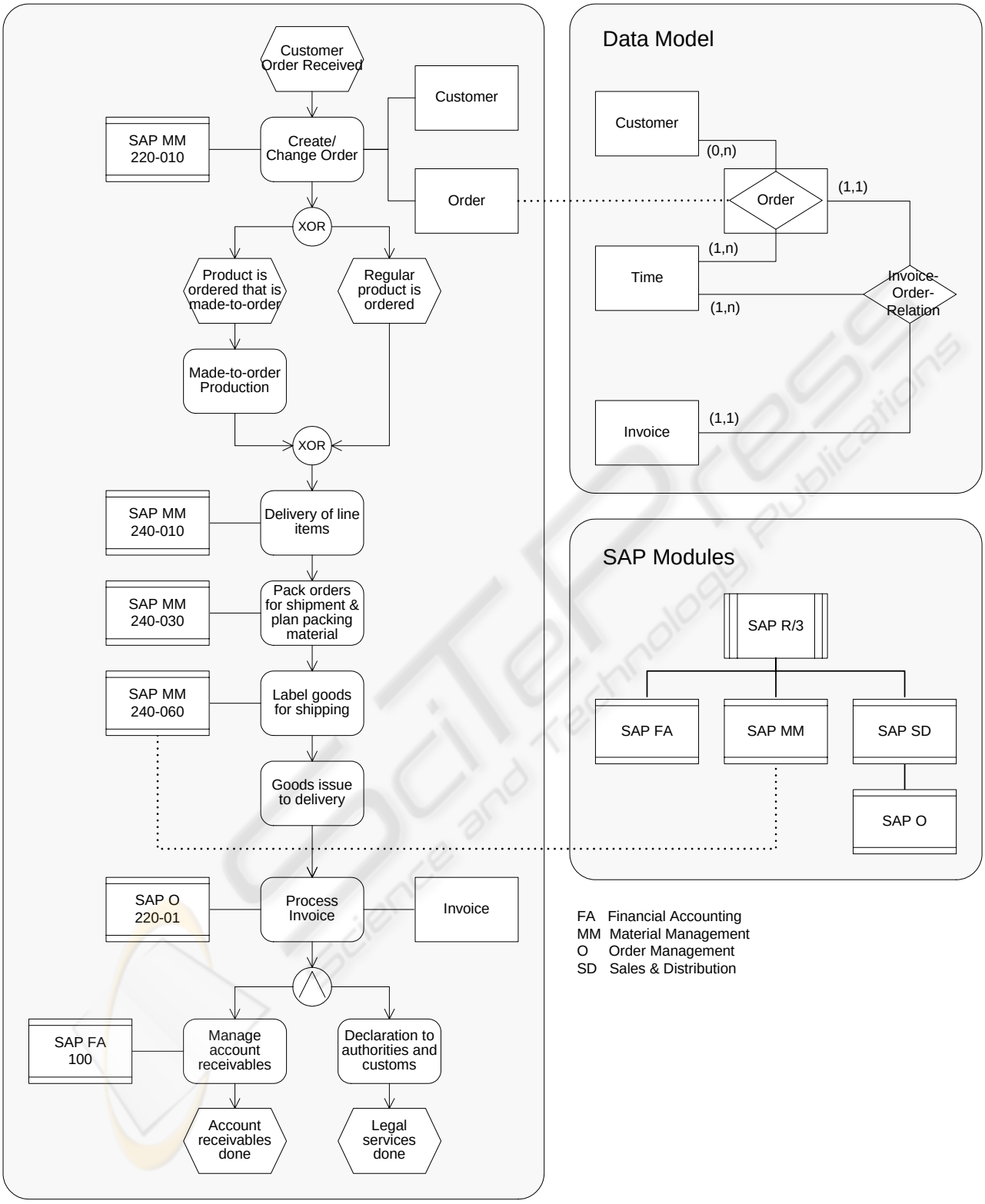


Figure 5: Model Projection for Application System Design

A projection of processes for communication support, like presentations or training uses, seemingly needs to provide colorful and pictographic, yet simple built element types – or rather just icons. The projection of the model is preferably directly usable with presentation software so that no further converting has to be carried out.

The design and layout might have to vary considerably from the representation of the other two configurations discussed above since a communication model's main contribution is to present a simple and understandable figure. The unambiguity of the process model and thus the complying with a given syntax is of minor importance as long as the simplification does not lead to inconsistencies in the understanding. Depending on the context, different graphical designs can and should be chosen to assist the specific purpose. In this way the original Bayer AG documentation models that are ordered in columns, could even be recreated. The model projected can be generally classified as an informal representation of the model base. Its applicability is strictly limited to communication uses since the model does not allow the derivation of any formal specification.

3.5 Case Evaluation

This case study proves exemplarily that there is a multitude of practical circumstances which benefit from configurable information models and that they are virtually indispensable when an integrated approach is followed.

In comparison to the textual descriptions of the original documentation the advantages of a graphical representation clearly show. Through the use of graphical elements the depiction of the real world is structured and intuitively accessible; textual description with a similar level of abstraction cannot compete. Especially the initial training on the documentation and the work with the processes, both become easier. Even though the process models discussed in the previous chapter do not contain all the information of the textual description, it is quite obvious that a consistent representation proves to be beneficial. However, without further thoughts about the configuration of models, no real benefit in terms of clarity can be achieved as Figure 3 shows.

Regarding configurable models more achievements, e. g. concerning the ease of use and usability of models for different purposes can be made. This does apply to the example of the direct business process as well as to other contexts. For example, an adaptation of the granularity could allow the managerial as well as the technical process owner to work with the same model because only the relevant model elements and element types are displayed through recipient-specific model and meta model projection. The integration of other modeling techniques like ERM or Organizational Charts provides an overview with additional information that was not possible before.

It is not only of interest for the Bayer AG to replace the old system with such an integrated approach of perspectives on process documentation but also any new system could benefit therefrom. Critical success factors that have to be kept in mind though, are the initial costs for the procurement, roll-out, model creation and pre-configuration, training, and the maintenance of such an integrated model. In contrast to this, the current maintenance costs to keep the documentation consistent have to taken into consideration as well as the benefit in productivity the users have when working with integrated and configurable models. In the ideal case – after defining his or her perspective – anyone can work with the system and it almost does explain itself for training purposes. However these advantages are hard to quantify since factors like non-productive time due to inconsistent, incorrect documentation in connection with prolonged retrieval time have to be included in the calculation. Therefore, a decision has to be taken on both, the current and the intended purposes of utilization, the expected useful life, and the employee's potential engagement of system use.

4 CONCLUSION AND OUTLOOK

In this case study we show how the approach of configurative modeling from the domain of reference modeling can be applied to company-specific process documentation.

The integration of different process variants into one holistic model does not prove to be beneficial at first since the sheer amount of elements and branches hinders the understanding of the model. However, superior clarity is achieved through the projection and configuration of the respective model and meta model. This adaptation of the model allows the application to various uses that can be roughly categorized into application system design, organizational design, and communication design.

In other respects, the economic evaluation stays on a relative level since only a thorough quantitative analysis can produce meaningful results that – however – have to be reviewed against qualitative factors that are to be explored yet. Questions to be addressed include but are not limited to sustainability metrics for information models, flexibility vs. robustness metrics and maintainability issues. All these consideration are, of course, to be made in combination with the model's economic efficiency.

During the last years Bayer has developed and improved its process engineering framework, having been investigated by this work, in its specification and documentation parts. Further on, Bayer has researched techniques in collaboration with scientific institutes to proceed with the automation of the process development life cycle. The main topics are UML specification, UML-based automated testing, and tool-based process analysis.

REFERENCES

Agrawal, A., Levendovszky, T., Sprinkle, J., Shi, F. and Karsai, G., 2002. Generative Programming via Graph Transformations in the Model-Driven Architecture. In *Workshop on Generative Techniques in the Context of Model Driven Architecture (OOPSLA).* Seattle, pp. 1-11.

Becker, J., Delfmann, P., Dreiling, A., Knackstedt, R. and Kuropka, D., 2004. Configurative Process Modeling - Outlining an Approach to Increased Business Process Model Usability. In *Information Resources Management Association Conference (IRMA).* New Orleans, pp. 615-619.

Becker, J., Delfmann, P., Knackstedt, R. and Kuropka, D., 2002. Konfigurative Referenzmodellierung. In *Wissensmanagement mit Referenzmodellen*, (Eds, Becker, J. and Knackstedt, R.) Physica-Verlag, Heidelberg, pp. 25-144.

Chen, P. P.-S., 1976. The Entity-Relationship Model. Toward a Unified View of Data. *ACM Transactions on Database-Systems*, 1, pp. 9-36.

Darke, P. and Shanks, G., 1996. Stakeholder Viewpoints in Requirements Definition. *Requirements Engineering*, 1, pp. 88-105.

Engels, G., Heckel, R., Taentzer, G. and Ehrig, H., 1997. A View-Oriented Approach to System Modelling Based on Graph Transformation. *ACM SIGSOFT Software Engineering Notes*, 22, pp. 327-343.

ESPRIT Consortium AMICE, 1989. *CIM-OSA. Open System Architecture for CIM*, Springer-Verlag, Berlin et. al.

Ferstl, O. K. and Sinz, E. J., 1998. SOM Modeling of Information Systems. In *Handbook on Architectures of Information Systems*, Vol. I (Eds, Bernus, P., Mertins, K. and Schmidt, G.) Springer-Verlag, pp. 339-358.

Findeisen, P., 1994. *The Metaview System*, Alberta.

Finkelstein, A., Kramer, J., Nuseibeh, B., Finkelstein, L. and Goedicke, M., 1992. Viewpoints: a framework for integrating multiple perspectives in system development. *International Journal of Software Engineering and Knowledge Engineering*, 2, pp. 31-57.

Frank, U., 1994. *Multiperspektivische Unternehmensmodellierung. Theoretischer Hintergrund und Entwurf einer objektorientierten Entwicklungsumgebung*, Oldenbourg, München, Wien.

Hammer, M. and Champy, J., 1993. *Reengineering the Corporation. A Manifesto for Business Revolution*, HarperBusiness, New York.

Ishikawa, K., 1985. *What is Total Quality Control? The Japanese Way*, Prentice Hall, Englewood Cliffs.

Ledeczi, A., Maroti, M., Bakay, A., Karsai, G., Garrett, J., Thomason, C., Nordstrom, G., Sprinkle, J. and Volgyesi, P., 2001. The Generic Modeling Environment. In *Workshop on Intelligent Signal Processing.* Budapest, pp. 19-25.

Nissen, H. W., Jeusfeld, M., Jarke, M., Zemanek, G. V. and Huber, H., 1996. Managing Multiple Requirements Perspectives with Metamodels. *IEEE Software*, 13, pp. 37-48.

Nordstrom, G., Sztipanovits, J., Karsai, G. and Ledeczi, A., 1999. Metamodeling - Rapid Design and Evolution of Domain-Specific Modeling Environments. In *IEEE ECBS Conference.* Nashville, pp. 68-74.

Rosemann, M., 1998. Managing the Complexity of Multiperspective Information Models using the Guidelines of Modeling. In *3rd Australian Conference on Requirements Engineering.* Geelong, pp. 101-118.

Rosemann, M. and Green, P., 2000. Integrating multiperspective views into ontological analysis. In *21st International Conference on Information Systems.* Brisbane, pp. 618-627.

Rosemann, M., Schwegmann, A. and Delfmann, P., 2005. Preparation of Process Modeling. Appears in *Process Management. A Guide for the Design of Business Processes*, (Eds, Becker, J., Kugeler, M. and Rosemann, M.) Springer-Verlag, Berlin et al., 2nd Edition.

Scheer, A.-W., 2000. *ARIS - Business Process Modeling*, Springer-Verlag, Berlin, 3rd Edition.

Soley, R. and OMG Staff Strategy Group, 2000. *Model Driven Architecture (White Paper)*, Object Management Group, Needham.

Zachman, J. A., 1987. A Framework for Information Systems Architecture. *IBM Systems Journal*, 26, pp. 277-293.