MDA-BASED SOFTWARE SUPPORT FOR FLEXIBLE INDUSTRIAL BUSINESS PROCESSES

Christian SEEL, Andreas MARTIN

Institute for Information Systems (IWi) at the

German Research Center for Artificial Intelligence (DFKI)

Stuhlsatzenhausweg 3, 66123, Saarbruecken, Germany

E-mail: {chris.seel|andreas.martin}@iwi.dfki.de

Keywords:

Business processes, industrial processes, business process software support, Model Driven Architecture (MDA)

1. INTRODUCTION: FLEXIBLE BUSINESS PROCESSES IN INDUSTRIAL ENTERPRISES

Today's markets are changing from a vendor to a customer-oriented view. Therefore industrial enterprises currently have the need to react to these market changes. This phenomenon leads to more competitive markets, changes of products, shorter product life cycles and new emerging markets [Klep97]. In addition to these changes of the products, sales channels are altered as well [Port01]. Technology-driven approaches summarised as E-Business lead to disintermediation [Port85], which means that intermediaries are skipped and the contact to the end customer gets closer [GKK99]. Furthermore, these new technologies combined with direct contact to the customers affect the production in form of new opportunities such as mass customization. For example the sportswear company Nike offers customers an online service via its website, which allows them to order individual customized sport shoes [Nike07].

Such changes do not only have an impact on the production itself, they lead to changes in the surrounding business processes as well. For instance customized products have to be allocated to exactly one customer, in the past however, products were produced for an anonymous mass market. Moreover, new information has to be stored, which affects the necessary data and their management as well.

In order to manage these complex business processes more and more IT systems have been introduced. Today the IT support of business processes is a crucial success factor [Sche02] [Mush99]. Thus the software systems that manage, execute and control business processes have to be changed in the same frequency as the business processes themselves do. As business processes are usually represented by information models, a fast and easy way of a model-driven adaptation of the supporting software is needed in order to keep up with the changing business processes. Therefore this paper presents a conceptual modelling language for business processes, which facilitates their implementation in a model driven way.

For that purpose first the underlying research methodology is depicted in section 2. In section 3 the importance and relevance of software support for business processes is regarded. In section 4 a short introduction into MDA is given and in section 5 the gap and research question regarding the CIM level is outlined. Section 6 presents the developed

modelling language for business processes on CIM level. The paper concludes in section 7 with a brief summary.

2. RESEARCH METHODOLOGY

Research in the field of information systems has two major research interests. On the one hand it is the discovery and explanation of currently existing phenomena in relation with information systems and on the other hand the development of new methods and recommendations of actions for the discovered problems. Corresponding to this division into two tasks Hevner et al. [HMPR04] identify the empirical and design science approach as the two possible types of research methods.

This contribution develops a solution for a known problem. Therefore it follows the design science paradigm. This means the presented concept is not based on empirical methods it is rather based on a comprehensible argumentation and enhancement of existing research work. In order to prove the developed concept falsification estimates can be done [Pop89]. Each failed falsification attempt increases the maturity and the reliability of the concept.

3. SOFTWARE SUPPORT AND REALISATION OF INDUSTRIAL BUSINESS PROCESSES

Different types of software systems that support industrial business processes can be distinguished. One criterion for their classification is their scope. Software can be used on the one hand for micro management, e.g. the operation of production machinery. CNC software [Alti00] is often used for this purpose. On the other hand there is software for the macro management of the production workflow and additional business processes, which support for example the human resource management or the financial accounting. This software manages the control and the data flow of the whole business process, while micro management software is used for one step of the process.

The information technology is a vital element during the complete production life cycle beginning with the design, the fabrication, the sale and further development. An example for a framework which connects all technical and economic information systems of an industrial plant is the Y-CIM model [Sche97]. This second type of software, such as Enterprise Resource Planning (ERP) Systems [Vakh05] [Call00], is directly affected by changes of the business processes. This paper focuses therefore on the latter type of systems.

4. MODEL DRIVEN ARCHITECTURE

The idea of MDA [OMG01], [MSUW04] is the translation of information models via different steps into finally executable code. According to the definition of MDA the process of creating software starts with information models on computation independent level (CIM) and transforms them into models on a platform independent level (PIM). These models on PIM level are enriched and then transformed into platform specific models (PSM) which after the last transformation result in executable source code [FeLo03], [OMG01]. By a separation of concerns through creating CIMs and PIMs before PSMs you reach a kind of interdependency from platforms, languages and systems. The transformation starts on a highly abstract level and gets more concrete with each step down. ERP systems which support manufacturing processes are a very good example how to use MDA. Domain experts can be much more included in the software development process to bridge the gap between real requirements and the understanding of them by a software engineer.

5. MODELLING OF INDUSTRIAL BUSINESS PROCESSES ON COMPUTER INDEPENDENT LEVEL

Inside a manufacturing company a lot of process descriptions can exist, for example for manufacturing processes, workflow and logistic processes and supporting ones, such as personal administration processes. They are designed and understood by technical engineers or business economists and form the CIM perspective.

Contemporary MDA approaches attach more importance to the PIM level which is a fairly information technology oriented perspective despite its level of abstraction [Fra03]. This means that the starting point of the transformation process is mostly not the conceptual level which directly contains the user's requirements.

To bridge the gap between business and IT, semi-structured models such as Event Driven Process Chains (EPC) [KNS92] were created to have a common understanding of workflows and processes. These models and textual descriptions are used to generate more technical models which serve until now as top level for a MDA software project. But this creation of new models can lead to inconsistencies and produce unnecessary costs. For this reason CIM models should directly serve as the main starting point for a MDA software project. So a modelling language will be developed which can be used to model user requirements and which at the same time serves as a starting point for MDA software projects.

6. CONCEPTUAL MODELLING LANGUAGE FOR MDA-SUPPORT OF BUSINESS PROCESSES

A special language is needed to integrate domain experts which are involved in an industrial business process and their knowledge into the software development. It has to be a trade off between the "non-IT-oriented" people who are the target users of a new system and the people who implement it. So, there are two main requirements:

1. The language has to be as simple and commonly understandable as necessary and
2. simultaneously as concrete as possible with the intention to automatically create programs.

In order to create such a common language different established languages and notations were explored. For example the Business Modelling Notation (BPM), the Business Process Execution Language (BPEL) and the Event driven Process Chain (EPC) have been analysed. It turned out that each has its advantages and disadvantages. EPCs are a multi-purpose standard for a high level design of application systems or organisational structures, but they are not focused on transformation into an IT system. BPEL is a machine readable, textual format without an easy-going way to sketch a process in a graphical way. BPMN on the other hand is a graphical notation for describing business processes with a weak semantic and no strong formal definition, but, based on our research, it offers the best starting point for creating the new language.

So, the BPMN meta model was used as a basis and enriched by different items, partly gathered from other languages as well as newly created. For example we introduced the concept of business rules, but it showed that, on conceptual design level, we only need decision rules and constraint rules [ScWe05].

Furthermore we added three views, namely a process view, a data view and an organizational view. The most extensively represented one is the process view, which integrates the other views. It consists of eight parts each of which describes a particular

element of the meta model. *Structuring objects* are the top-level class the model contains. The *control flow* section introduces lane elements, which are connected to each other by flow objects. The c*onnections* section has two further types of connections between objects in a model. The *annotated elements* part of the meta model shows model objects that are used to enrich activity objects with relevant information. The *activity* section tells which elements are representing actions in a model. The *events* section describes different types of events which describe what kind of triggers could be used in a model. *Gateways* explain how decisions of different types could be integrated into a VIDE CIM model. The e*numerations* section is the last section and it gives an overview of the complex types used in three different classes. Data view and organizational view introduce interfaces to two further business process analysis scopes. Figure 1 shows the graphical meta model of the proposed CIM language.

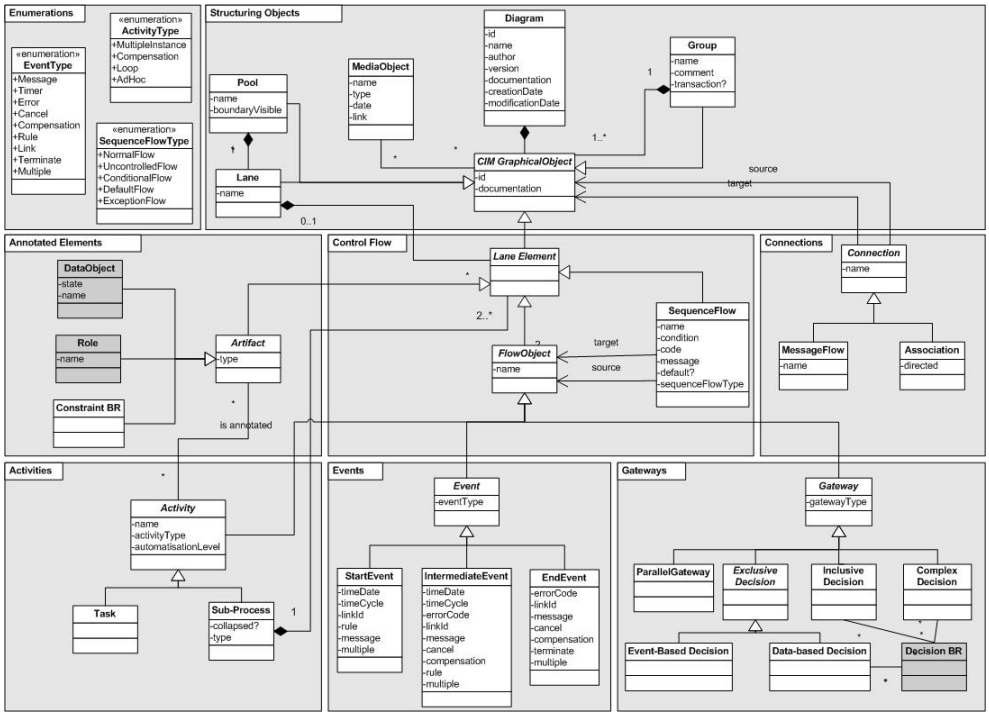

Figure 1: CIM meta model

A completely new item is the media object. It represents unstructured data that can be attached to every element in the diagram. Media objects could be hand-written texts, recorded audio data of interviews or videos enriching the background knowledge of the model element they are annotated to. So, an analyst or programmer has always the possibility to reconsider the origin of a software requirement.

7. CONCLUSION AND OUTLOOK

A possible way to create software systems to support flexible business processes in industrial enterprises is the MDA approach. Currently software systems are designed without appropriate consideration of user requirements. Therefore domain users and their knowledge should directly be involved in the software design process. So, models on the

CIM level should be used as the starting point for Model Driven Architecture approaches. This can lead to a model transformation process that starts on conceptual level and leads to generated models on PIM and PSM level.

But actually suitable conceptual modelling languages that are seamlessly integrated into a MDA approach are still missing. Hence the authors proposed a conceptual modelling language which is based on and still compliant to BPMN. This proposed language was defined by an implementable UML meta model.

Further research in the area of MDA approaches starting on CIM level is needed in the model transformation from CIM to PIM level. Additionally a practical evaluation of the presented concepts should be done. But this will only be possible if an adequate software tool support is available, which constitutes another research area.

REFERENCES

[Alti00] Altintas, Y.: Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and Cnc Design: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design. Cambridge, 2000.

[Call00] Callaway, E.: ERP-The Next Generation: ERP Is Web Enabled for E-Business: ERP Is Web Enabled for E-Business. 2000.

[FeLo03] Fettke, P.; Loos, P.: Model Driven Architecture (MDA). In: Wirtschaftsinformatik, Bd. 45, 2003, Nr. 5, pp. 555-559.

[Fra03] Frankel, D.: Model Driven Architecture. Applying MDA to Enterprise Computing, Wiley & Sons, 2003.

[Fra05] Frankel, D.: Toward a Business Process Platform. In: MDA Journal, July 2005, pp. 1-7, 2005.

[GKK99] Giaglis, G. M.; Klein, S.; O"Keefe, R. M.: Disintermediation, Reintermediation, or Cybermediation? The Future of Intermediaries in Electronic Marketplaces, In Proceedings of the 12th International Bled Electronic Commerce Conference, 1999, pp. 389-407.

[HMPR04] Hevner, A. R.; March, S.T.; Park, J.; Ram, S.: Design Science in Information Systems Research. In MIS Quarterly, Volume 28, Number 1, 2004.

[Kelp97] Klepper, S.: Industry Life Cycles. In: Industrial and Corporate Change, Vol,6 number 1, 1997.

[KNS92] G. Keller, M. Nüttgens, A.-W. Scheer: Semantische Prozeßmodellierung auf der Grundlage Ereignisgesteuerter Prozessketten (EPK). In A.-W. Scheer (Hrsg.): Arbeitsberichte des Instituts für Wirtschaftsinformatik, Heft Nr. 89, Saarbrücken, 1992.

[MSUW04] Stephen J. Mellor, Kendall Scott, Axel Uhl, Dirk Weise: MDA Distilled: Principles of Model-Driven Architecture, Addison Wesley, 2004.

[Mush99] Muschter, S.: IS-gestütztes Prozessmanagement. Wiesbaden, 1999.

[Nike07] Nike Inc.: NikeID. http://nikeid.nike.com/nikeid/index.jhtml?ref=emealanding&sitesrc=emealanding. visited 30-04-2007.

[OMG01] Object Management Group: Model Driven Architecture (MDA) http://www.omg.org/docs/ormsc/01-07-01.pdf, 2001.

[OMG04] Object Management Group, Inc. (OMG): UML 2.0 Superstructure Specification., http://www.omg.org/docs/ptc/04-10-02.pdf, 2004.

[OMG06] OMG: Business Process Modelling Notation Specification. http://www.bpmn.org/Documents/OMG%20Final%20Adopted%20BPMN%201-0%20Spec%2006-02-01.pdf, 2006.

[Pop89] Popper, K.R.: Logik der Forschung. 9th enhanced edition, Tübingen, 1989.

[Port01] Porter, M. E.: Strategy and the Internet. In: Harvard Business Review, March 2001 p. 2-21.

[Port85] Porter, M. E.: Competitive Advantage. New York, Free Press, 1985.

[Sche97] Scheer, A.-W.: Business Process Engineering: Reference Models for Industrial Enterprises. 2nd ed., Berlin, 2002.

[ScWe05] Scheer, A.-W.; Werth, D.: Geschäftsprozessmanagement und Geschäftsregeln. In A.-W. Scheer (Hrsg.): Arbeitsberichte des Instituts für Wirtschaftsinformatik, Heft Nr. 183, Saarbrücken, 2005.

[Vakh05] Vakharia, G.: ERP Strategy. 2005.