TOWARDS INTEGRATING PERSPECTIVES AND ABSTRACTION LEVELS IN BUSINESS PROCESS MODELING

Ivan Markovic and Florian Hasibether
SAP Research CEC Karlsruhe, Vincenz-Priessnitz-Str. 1, 76131 Karlsruhe

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Abstract: In process-driven organizations, process models are the basis on which their supporting process-aware information systems are built. In this paper, we propose an approach for integrating perspectives and abstraction levels in business process modeling. First, we propose six process perspectives to adequately organize information about a business process. Second, we present the abstraction levels in process modeling and discuss metamodel projections on each of the levels. Third, we provide a comparison of our approach to other efforts in the field. With our approach, we make a step towards reducing the complexity of process modeling.

1 INTRODUCTION

In the 1990s, the vision of a process enterprise was introduced (Hammer and Champy, 1993) to achieve a holistic view on an enterprise, with business processes as the main instrument for organizing the operations of an enterprise (Weske, 2007). Benefits of investing in business process techniques were demonstrated in efficiency, increased transparency, productivity, cost reduction, quality, faster results, standardization, and, above all, in the encouragement of innovation, leading to competitive advantage and client satisfaction (Chang, 2005).

Process orientation considered IT as a key enabler and thus followed with the introduction of process-aware information systems (PAIS) (Dumas et al., 2005) as means to support the knowledge workers in performing business processes. PAIS are driven by explicit process models, which enable a better understanding of business processes, facilitate communication between business analysts and IT experts and serve as a basis for the management and execution of business processes.

Several issues contributed to the fact that the design of process models is still a complex task. First, a broad knowledge must be taken into account when designing a process model. This knowledge is scattered in various business documents, presentations and the heads of business people, making it difficult to access and reuse. Second, process modeling approaches do not adequately support process perspectives (e.g. motivational, resource, functional, etc.). One of the ways to reduce modeling complexity is to provide separate process modeling perspectives which allow the modeler to model only the desired aspect of the process. Similar approaches can be found in software design (Nuseibeh et al., 1994). This way of organizing and modeling of process information is more intuitive, easier to understand, analyze and later navigate the process landscape based on defined perspectives. Third, there is no support for "abstraction levels" - enabling different stakeholders to have their view on a process model by filtering out irrelevant information depending on their role. For example, an executive might want to see how does the process relate to enterprise goals and strategies, what are its key performance indicators (KPI) and how well is it performing. He would not be interested in detailed process flow, information systems supporting the process, business objects manipulated by the process, etc. Similarly, a line of business manager might be primarily interested in how a particular process contributes to a broader business scenario, who is responsible for it and who is involved. Existing modeling tools for different stakeholders are often not based on a holistic, unified metamodel which brings many problems with respect to information integration, redundancies, traceability and communication between different abstraction levels.

On the other hand, Semantic Web (SW) technologies (Hepp et al., 2005) have shown potential in integrating the knowledge coming from various sources by means of ontologies (Uschold and Gruninger, 1996). In addition, SW provides concepts and tools

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for automated inference on the represented knowledge, which enables the provision of additional services based on existing process knowledge.

In order to address the listed issues, we present an approach for integrating perspectives (Section 2) and abstraction levels (Section 3) in process modeling, supported by ontologies. We compare our approach to other efforts in the area in Section 4 and summarize our contributions in Section 5.

2 PROCESS PERSPECTIVES

Following (Curtis et al., 1992; Weske, 2007), we define six key perspectives to adequately organize information about a business process. We visualize them in figure 1, motivated by the "orthographic projection" paradigm used in mechanical and civil engineering to create detailed drawings of physical objects. The main idea is to enable the process modeler to easily manage and navigate the various perspectives in process design. In the following, we shortly describe each of them.

Functional perspective provides a functional breakdown of activities that an enterprise performs. Starting from high-level business functions (value chain), the coarse-grained functions are broken down into finer-grained functional units by means of functional decomposition. Functional decomposition has proven to be an important concept for capturing and managing complexity (Weske, 2007).

Motivational perspective is inspired by the recent OMG specification, the Business Motivation Model (BMM) (OMG, 2008). The notion of motivation is important for business processes because an enterprise should be able to say why it executes a particular process. This perspective is divided in two segments: intentional and directional.

The intentional segment captures the enterprise aspirations - the things it wishes to achieve, i.e. goals. Every business process exists for the purpose of achieving some goal, which should be made explicit. When formulating a process goal it is useful to already think about quantifiable results. The way to do this is to define appropriate KPIs along e.g. the dimensions time, cost or quality that measure the process.

The directional segment describes the things that the enterprise will employ to achieve its goals, i.e. strategies, business policies and rules. A strategy shapes the way in reaching a goal, i.e. it channels efforts towards a goal. Business policies and rules control, guide and shape strategies. With respect to processes, it is important to know how a particular business process fits into the overall strategy (plan) and

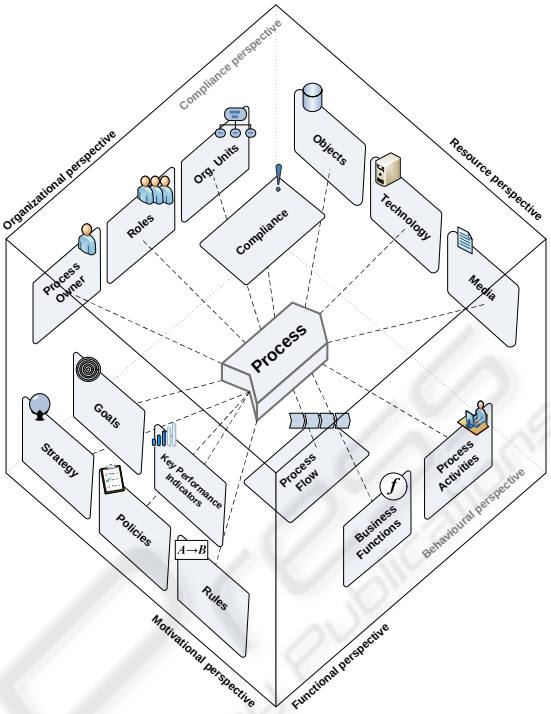

Figure 1: Process perspectives.

what policies and rules guide (affect) its execution.

Organizational perspective represents by whom (roles and organizational units) activities are performed. We depict it in figure 1 by a grouping under the label of stakeholders, encompassing organizational units, roles and process owners. It is important to stress that processes run across one or more organizational units within a functional or divisional hierarchy. A role is defined as task and responsibility bundle which is clearly distinguished from the person that is performing the role. It can be held by different persons and one person can hold several roles. Talking about roles and processes allows to easily talk about the tasks that should belong together or should be separated from a process perspective before mapping them to the organizational structure. The process owner as an accountable manager for the process end-to-end execution can be seen as a special role.

Resource perspective describes applications and resources that should be spent when carrying out certain process activities (e.g. objects, IT systems, or resources needed in order to accomplish the activity) or that may be results of certain activities. As processes essentially are transformations that manipulate objects (e.g. create, change or delete) it is relevant to capture information on these and the states they take on during transformation. Technology acts as an enabler for certain steps in the process. In a tight con-

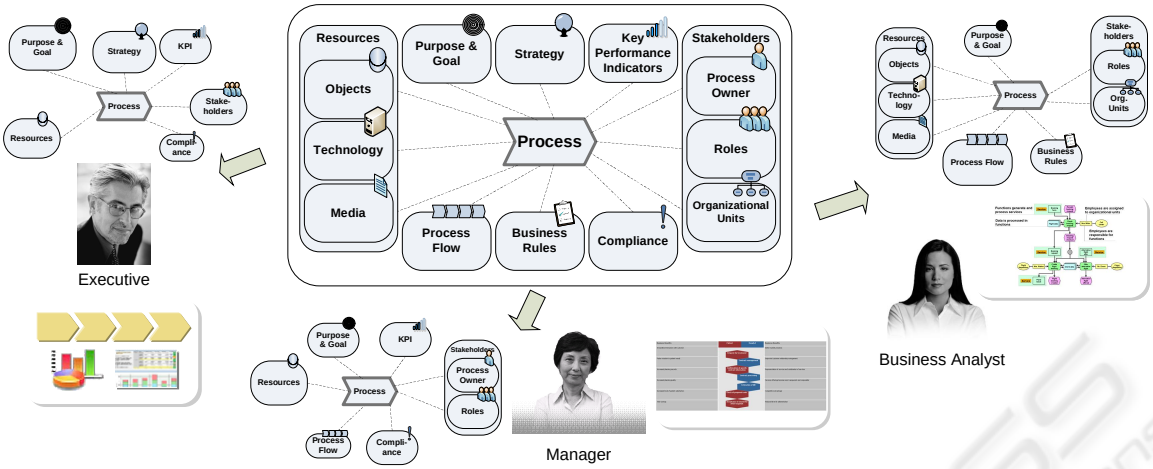

Figure 2: Projections of the metamodel.

nection to objects and data are the media used in a process.

Compliance perspective represents compliance requirements within process models. Compliance is of high importance to nowadays businesses. Compliance regulations especially impact processes as specific tasks in processes are required in order to fulfill regulatory requirements. Thus, in process design it is important to capture and incorporate these tasks.

Behavioral perspective captures process control flow. It represents the logical ordering of process activities and their causal interrelationships. This perspective could be seen as the core of a process representation and acts as a connection point (Weske, 2007) for the other perspectives.

The authors have presented a process-oriented enterprise ontology framework which formally captures all of the aforementioned perspectives (Markovic et al., 2009; Markovic and Kowalkiewicz, 2008). Using the specified relations between the perspectives, the process modeler can navigate through different aspects of a process representation and the process space of an enterprise. Queries such as "What resources are used by process *a*?", "What is the goal of process *b*?", "Which processes does the org. unit *c* participate in?", "What processes are currently performed in business function *d*?", can be answered using this ontology framework (Markovic, 2008).

3 ABSTRACTION LEVELS IN PROCESS MODELING

In this section we discuss abstraction levels in more detail and motivate why they are important in the context of process modeling.

Executive (Strategic) Level. Here the enterprise goals and the general strategic direction are set. Key performance indicators are determined for measuring the progress in achieving goals. Business policies are defined in order to govern the enterprise courses of action. Typical artifacts on this level may include goal specifications, strategy documents and policy guidelines (cf. fig. 2, left). Artifacts on this level of abstraction provide the motivation ("why") for the processes within the organization, which are defined on further levels. The modeling techniques are rather informal or ad-hoc (flip chart techniques or mind maps).

Line of Business manager Level. Based on the artifacts produced at the executive level, line of business managers need to provide quick and intuitive overview of the business processes of an organization. The aim is to depict processes from a high-level perspective with a focus on understanding key points of the process. These high-level processes are called business scenarios and each of them represents a set of logically related processes performed to achieve defined and measurable business goals. Models such as Value Added Chain Diagrams (Porter, 1985) and SAP Business Scenarios[1] are used for this purpose.

Business Analyst Level. Unlike the other two perspectives, the business analyst faces a variety of purposes in modeling. This includes business process documentation, process improvement, system requirements specification, etc. Process models created at this level detail each of the business scenarios specified and serve as a starting point for the underlying information system implementation (cf. fig.

[1]SAP Business Scenarios are delivered with the SAP Solution Composer, a modeling tool provided by SAP. http://www.sap.com/solutions/businessmaps/composer/index.epx

2, right). There are numerous modeling techniques (EPC (Keller et al., 1992), BPMN[2], UML Activity Diagrams) used in this space.

A major problem today is that the artifacts produced on each of the abstraction levels are not interconnected and integrated. This causes problems in communication, inconsistencies, redundancies, traceability between the levels and results in a significant amount of manual work. We argue that the aforementioned process-oriented enterprise ontology framework can serve as a common metamodel for all abstraction levels, as shown in fig. 2. Using metamodel projection, abstraction level-specific models can be derived (cf. fig. 2).

We can think of the process-centric knowledge depicted in fig. 2 (center) as being present on each level of abstraction in smaller or greater detail. Parts of this knowledge tend to grow stronger as we move down the abstraction levels, e.g. process flow. Of course, high level knowledge such as strategic goals and core strategy plans do not vanish as we reach a level of higher detail. They get refined and superimposed by a more concrete view. Strategic goals grow to measurable and timed operational goals, strategic directions to detailed plans, etc. For example, the executive abstraction level would encompass strongly concepts related to the motivational perspective (goals, strategy, KPIs, etc.), while it would not be interested in detailed process flow, information systems supporting the process or business objects (cf. fig. 2, left). The metamodel can be reduced (configured) to the executive level-specific needs and a new model is generated by metamodel projection.

Using this approach we are also able to derive abstraction-level specific models for the line of business manager and business analyst levels. By having a unified metamodel, the artifacts created in particular abstraction levels can be more easily traced and navigated.

4 FEATURE COMPARISON WITH COMMON METHODS

Sections 2 and 3 motivated different viewpoints that business process modeling is concerned with. In this section we build upon these descriptions and define criteria for a comparison with common modeling methodologies, both from academia and industry.

[2] http://www.bpmn.org

4.1 Criteria for Comparison

First, we are interested in which part of the process-knowledge (cf. fig. 1) is covered by the various approaches. We refer to this criterion as *(1) process perspectives*. Section 3 introduced the notion of different *(2) levels of abstraction* bound to typical roles in process engineering. Therefore, we secondly investigate what viewpoints a methodology supports. Thirdly we deal with what kind of models are produced, i.e. *(3) modeling business knowledge*. The last two criteria discuss the abilities of a methodology to work with the captured knowledge. Under *(4) querying/reuse* we ask for what possibilities exist to retrieve the modeled information, while *(5) analysis/inference* asks for: What can be deduced and is not explicitly modeled? How could weaknesses be detected?

To date there is no predominant modeling approach for neither enterprise modeling, nor business process modeling. To give a brief survey on the abilities of today's modeling techniques we selected the following, illustrating the broad spectrum of enterprise modeling: ARIS (Scheer, 1988), BMM (OMG, 2008), i* (Yu, 1995), TOVE (Fox, 1992).

4.2 Comparative Description

i* framework **–** The i* framework originates from "early requirements" research and is used to understand organizational processes, in terms of strategic relationships and goals in order to elicitate the rationale for software requirements. Since i* is based on intentionality, the concept of an *actor*, i.e. any active entity, is central. The core work for i* (Yu, 1995) proposes two types of diagrams, capturing the strategic dependency relationships among actors (SD model) and the strategic rationale model for expressing the rationale behind dependencies (SR model). Using SD and SR models, i* provides two levels of granularity: The former focusing on the relation between actors, using dependency links and actor aggregations. The latter connects hard goals to tasks and softgoals (non-functional goals) to contributing entities, thereby capturing the agent's intentions and abilities.

i* has been extended by a number of research efforts[3]. A formal description for i* has been proposed, using temporal logic and model checking for analysis (Fuxman et al., 2004). The approach can detect self-contradictory specifications, over- and under-specification using a graphical modeling tool[4] with a model checker interface. To check the satisfiability of

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

[4] http://www.dit.unitn.it/~ft

i*-like goal models, label propagation techniques and a SAT solvers are applied (Sebastiani et al., 2004).

The i* framework captures mainly information for the motivational perspective (cf. fig. 1). Although the concept of goal and softgoals is rather detailed, there is no concept of strategy or functional decomposition. Resources and tasks stay on an abstract level. Since the notion of actors is fairly general it provides no specific means for modeling organizational structures. Although tasks are important elements of SR modeling, there is no sequential connection between them. The absence of policies/rules and performance indicators underline, that enterprise modeling is not the main goal of the i* approach. A number of tools are provided by the i* community[5][6]. However, none of those is capable of querying parts of the model.

BMM – The Business Motivation Model is an OMG standard accepted in 2006 (OMG, 2008). While i* stems from software requirements research, BMM has its roots in the business rules community. Central to BMM is the distinction between means, ends, directives, assessments and influencers.The *ends* state, what the business wants to accomplish, not how. *Means* are concerned with how the business intends to accomplish its stated ends. Rules and policies that constrain and/or govern the available means are called *directives*. *Influencers* capture, who or what from within or outside the company influences its activities. *Assessments* judge the impact of influencers and provide impetus for directives. Each of these categories are further refined, with *vision* as a high level statement of a state to reach made operative by some *mission*. A *desired result* is either a goal (strategic) or an objective (quantified and therefore operational). *Strategies* are more general while *tactics* are more specific courses of action. Within directives, *business policies* are the basis for *business rules*. OMG sees BMM as a blueprint for business planning which is neutral in respect to methodology. It is not a complete business model, nor is it intended to be one, but should be supplemented by other standards such as BPMN and UML and thus deals mainly with the motivational perspective given in fig. 1.

Xactium[7] had BizModeler as the first prototypic tool supporting BMM. It allowed for drawing of Motivation Models from different perspectives using a subset of the modeling elements in each of them. The tool provided basic modeling aids regarding valid linkage of elements. Large models could be searched via string matching. Like BizModeler, KnowGravity's KnowEnterprise[8] mainly focuses on implementing the specifications in terms of model visualization. Due to the lack of formality there are limited means for analysis or inference on BMM models so far.

ARIS – The "ARchitecture of Integrated Information Systems" is a mature, industry-adopted method for business modeling. To deal with complexity, the so called ARIS house describes different views on processes: *Organization view:* Who (e.g. organizations, departments, roles) is involved in the process? *Function view:* Which functions are carried out? *Data view:* Which objects represented by data are manipulated? *Output/Input view:* Which products or services are produced or consumed? *Control view:* How do the views mentioned before interoperate in a process? (Exeler and Wilms, 2003)

The functional view deals with hierarchical decompositions of business functions. A connection between the former and goal decomposition diagrams is given in (Scheer, 1999). The organizational view operates on organization charts. Data objects can be modeled using Entity-Relationship-Diagrams. Product models, either as a decomposition of different types of product or as parts decomposition are suggested in (Scheer, 1999) for the Output view. Event-driven process chains (EPC) link the other views together within the control flow. The initial notation (Keller et al., 1992) was later updated to extended EPCs by adding elements for *roles*, *objectives*, *technical terms*, *organizational units*, and others. ARIS adopts Value Chain Diagrams (Porter, 1985) as a means of modeling high level processes. Although VCD capture functions which directly create corporate output, neither them, nor the an EPC flow model with additional goals elements do capture the entire motivational perspective (cf. fig. 1). The toolset gradually evolved to several platforms for various modeling tasks. It was recently completed by an strategy approach making use of cause-and-effect diagrams and KPIs. The designer tool can filter modeling elements of a selected model type and provides capabilities to generate reports from the process perspective. Since all modeled elements are stored in a relational database it allows for querying model elements and their related objects (Davis and Brabänder, 2007).

TOVE – Parallel to the early days of BPM in the area of information systems, organizational modeling was approached from knowledge management communities. One of the earliest efforts aiming at the development of an organizational ontology is the TOVE initiative (Fox, 1992). It aims at creation of a shared representation of the enterprise, definition of semantics, development of a set of axioms in order to pro-

[5] http://www.cs.toronto.edu/km/ome/

[6] http://www.cs.toronto.edu/km/openome/

[7] http://www.xactium.com

[8] http://www.knowgravity.com

vide automatic deduction capabilities and finally definition of symbols depicting defined concepts. The ontology underwent a large evolution and the current versions are focused on multidimensional enterprise modeling, and was converted into a set of tightly connected sub-ontologies (Fox and Gruninger, 1998) describing many aspects and different aims. Although the approach knows the concept of roles within the enterprise model, it does not provide different levels of abstraction for its usage. The model of the enterprise created in this approach, namely Common Sense Model of Enterprise, distinguishes three levels: a reference model with typical business functions (finances, sales, ...), i.e. the functional perspective, a generic model (concepts such as time, causality,...), and a concept model (e.g. role, property, structure), covering the organizational perspective. The behavioral perspective is formally described using the situation calculus. Although rich axiomatization is given, the lack of a contemporary ontology language the proposed concepts are expressed in, is a drawback. Tool support is another weak point.

5 CONCLUSIONS & OUTLOOK

In this paper, we proposed an approach for integrating process perspectives and abstraction levels in business process modeling. We defined the perspectives necessary to capture and organize information about a process. Further, we presented different abstraction levels in process modeling. We use a process-oriented enterprise ontology framework to formally represent all process perspectives and enable abstraction level-specific process modeling views by means of metamodel projection. Lastly, we provide a comparison of our approach to influential work in the field. By enabling the possibility to create abstraction level- and perspective-specific views, we reduce the complexity of process model design. In addition, using the formal process representation we can perform querying and automated inference on business process models.

We are currently working on tool-supported generation of a perspective and abstraction level-specific modeling editor using the process-oriented enterprise ontology framework.

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