OptIn DBPM: An Information-centric Approach to Business Process Management

– *Positioning Paper* –

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Abstract. Traditional BPM systems are often limited in terms of flexibility and adaptability. These limitations are mainly caused by the dominant paradigm for process modeling underlying these systems, which is almost exclusively activity-centric. In this paper we present OptIn DBPM, a BPM tool which follows an alternative, more demand- and goal-driven approach. The conceptual design of DBPM is based on the perception that processes deliver certain information content, whose use enables a more natural representation and modeling of process flows when compared to purely activity-centered approaches. We describe basic concepts behind DBPM and illustrate its practical use by applying it to processes in an educational setting. Altogether DBPM creates new possibilities for process analysis, goal-driven automated process modeling, and flexible runtime process modeling and enactment.

1 Introduction

Traditional workflow and business process management (BPM) systems are characterized by well-known limitations in terms of flexibility and adaptability [1][2][3]. These limitations can be associated with the dominant paradigm for process modeling found in these systems, which is almost exclusively *activity-centric*. Complexity in understanding and executing process models often originates from the numerous relations which are specified between the process steps (i.e. activities), although they either do not reflect actual dependencies or only apply in specific context. Moreover, industry-strength process models tend to become large and complex, where the processes they aim to capture are much simpler, yet essentially dynamic by nature. In traditional modeling approaches this leads to the definition and modeling of numerous exceptions [1][4].

In this paper we present a commercial BPM tool based on a fundamentally different concept, creating new possibilities for (1) (what-if) process analysis, (2) goal-driven, automated process modeling (cmp. [9]) and (3) flexible run-time process modeling and enactment. This concept is based on the research presented in [1][2] and has been implemented since 2005 as OptIn DBPM (Dynamic Business Process Modeling). The concept behind DBPM is based on the perception of a process as ‘an evolution of information content’. This implies that the goal of a process is to deliver a certain information content, which facilitates a different and more natural representation of process flow than a purely activity-centered approach. It also implies that, at any time, the current state of a process is captured in the content of the information on which the process is acting. As such, it adds a new dimension to the traditional conception of the BPM life-cycle only distinguishing the succession of design-time and build-time phases. Instead, it opens opportunities for run-time configuration, as shown in Fig. 1.

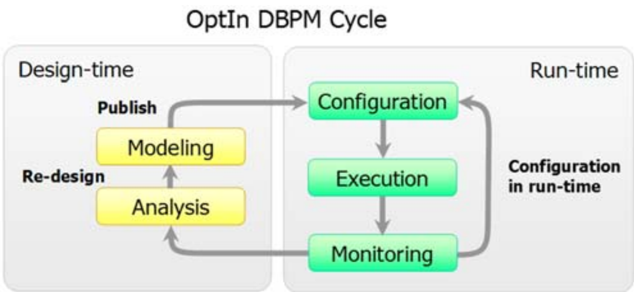

Fig. 1: OptIn DBPM life-cycle for BPM allowing for configuration at run-time.

As will be explained, the application of the concept requires the specification of the context in which a process occurs; this context is defined by the set of (independent) process activities (incl. sub-processes) that can be performed, and by a consistent semantic model that can be used in this context to describe information content.

Sections 2 and 3 summarize basic concepts and prerequisites of the DBPM methodology. To illustrate the use of DBPM in practice, Section 4 discusses its application in an educational setting. In Section 5 we discuss related work. The paper concludes with a summary and an outlook on future work in Section 6.

2 Basic Concept

Process Model Configuration: The DBPM methodology for configuring process models is characterized by its demand-driven foundations. Process models are composed from independent process activities that are applicable in certain process context. The process activities are defined as black-boxes that require a certain information input and result in information output, and that have characteristics concerning their execution (e.g. required resources and planning). The composition of process activities results in an interrelated process network, which is valid for the specific combination of a 'need for information' (goal) and a current process state ('current information content') for which it is generated. In the DBPM algorithm, this process network is generated by reasoning back from the process goal towards the current information content, positioning process activities that are able to contribute the evolution towards the process goal (similar to approaches found in the field of automated planning techniques [22]).

The next step in the methodology is the deduction of a (set of alternative) process model(s) from the process network, similar as in [20]. This is achieved by using optimization criteria. Depending on these criteria, it is possible to select e.g. the fastest or most cost effective path(s) in the network. The resulting process model(s) can subsequently be used for further analysis and presentation. Furthermore, they can be sent to an 'execution engine'. During the execution of a DBPM process model, the available options for run-time flexibility and adaptation can be utilized.

Application Scope: The demand-driven configuration of process models with DBPM applies for recurring processes as well as for individual cases. In healthcare applications, for example, the latter approach enables the configuration of patient-specific processes [6].

Besides these ‘design-time’ configuration scenarios, it is also possible to utilize DBPM in a 'navigation mode'. In this mode, the process model is treated much the same as a 'route' in a car-navigation system. At any time, an automated evaluation can determine if the process is still on course, or if course correction (i.e. re-configuration) is required. This approach enables incremental modeling and management of business processes during process execution, based on the actual process state and the process goal. This is particularly useful in highly dynamic and unpredictable environments such as, for example, design and engineering.

A third dimension in the application scope of DBPM is the level of flexibility. Beside the entirely demand-driven configuration of process networks, DBPM can be also used to specify so called black-boxes in static, predefined process models. This approach is described in more detail later on.

Process Execution and Run-time Aspects: Regarding process execution the traditional divide into run- and design-time fades away. DBPM enables the reconfiguration of a process model at any time during process execution. In this procedure the process model can be reconfigured using the actual 'current' process state as starting point. Depending on the capabilities of the used execution engine a process can be published and executed as a stream of individual steps or as dynamic (sub)processes. With DBPM it becomes possible to realize incremental updates of process models in almost any run-time environment. With the run-time support of DBPM, long-running, unpredictable or highly dynamic processes can be supported effectively. Furthermore, ad-hoc deviations from a process model can be supported without need to explicitly model the deviation. In analogy with the metaphor of the car navigation system, the optimal route will be automatically recalculated.

Process models and Black-boxes: DBPM is well suited for the realization of flexible and efficient management of dynamic (sub-)processes within a (more rigid) structure of processes. In addition, the configuration and execution of ad-hoc processes during the execution of an aggregated process is possible with DBPM. For applications such as these, a black-box concept is used (similar to the concept of 'late modeling' as described in [7]). In this concept a static process model is defined using common BPM tools. Within this process model, dynamic 'process sections' or sub-processes are denoted by black-boxes. These black-boxes will be detailed by DBPM during process execution, according to the actual circumstances at that time. As such, process management and support functionality can be implemented in a way that assures structure and predictability where necessary, and allows for flexibility and dynamics where desired. This enables a BPM solution to arrive at the best compromise in process efficiency and process effectiveness on the one hand, and process control and accountability on the other hand.

Semantic Integration: The method for information integration used for DBPM is based on the use of a semantic model that is valid for the entire context in which processes take place. In this model, all information types relevant for process management are present. A full integration of all information types in a business environment is possible, but often not required for effective process management.

With the use of a semantic model and translations for the relevant information systems, an integrated overview of relevant information is created. This overview can either be updated continuously or can be based on specific information requests. The actual storage of information remains in the local information systems. In this way, information that is separately managed in different information systems, is integrated into a coherent set of information, representing the current process context.

3 Support

Information integration: The use of DBPM changes the conventional approach of process modeling in several respects. Instead of a primarily top-down decomposition of a business process into process steps that exchange information, the application of DBPM treats the information exchange as the starting point. Applying DBPM implies the analysis of information that is exchanged within a process context. This process context is defined by the scope in which processes should be configured.

This analysis should result in an integral overview of information within a process context. As the information relevant for such an overview is hardly managed within a single system, integration of information from different sources is a necessity. With existing middleware, and under the denominator EAI (Enterprise Application Integration), information of different sorts can be brought together and represented as a single coherent set. With the advent of Web services as a means of unlocking information from backend systems, a start is made towards semantic abstraction of business information content. However, currently this semantic abstraction almost never leads to semantic integration. Instead, specific intra process mappings of information entities, without a reference to a broader semantic model, are still commonplace. Besides the high degree of redundancy, this approach causes adaptations and extensions of information systems to be complex and time consuming.

Semantic Modeling: Initially, semantic models can be based on analyses of the information exchange between actors in the current business processes that are executed in a process context. In the DBPM software module, the semantic model can be adapted easily, with consistent propagation through, for example, definitions of process activities. Moreover, information systems can be added and removed independently from each other, at any time. The semantic model (cf. Fig. 2) itself can be a rich one. Information types are denoted by a combination of a type and a domain, which allows for a wide range of possible representation and filtering. A semantic model can contain multiple status qualifiers per information entity, both qualitative and descriptive.

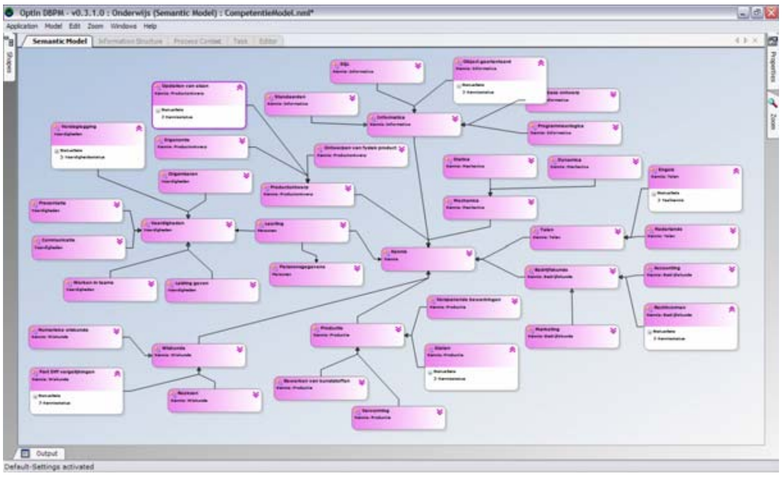

Fig. 2: Semantic model as a network structure of information types.

Positioning in BPM Solutions: Fig. 3 shows how DBPM and its semantic integration layer function as modules within the architecture of EAI / BPM platforms.

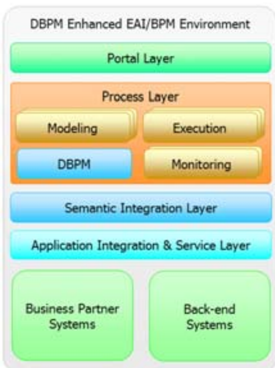

Fig. 3: DBPM and its semantic integration layer function.

The semantic integration layer enables the information-centric approach by abstracting the overview of relevant information at any point in time. DBPM is situated in the process layer and supports both the modeling of the process context (semantic model, individual activities) and process configuration. Depending on the concrete use case the process configuration module operates either in design- or run-time.

4 Application Example

To illustrate the use of DBPM in practice we discuss its application in an educational setting. Though not all features and advantages apply in this relatively straightforward setting, the impact of DBPM and parallels to other applications are easily perceived.

Following social, technological and economical developments, *Higher Education*, in general, is shifting from fixed curricula to demand-driven customized education. Flexibility and internationalization are some of the driving forces in this. For example, international accreditation by means of European Credits is forcing institutes in education to define and conform to industry-like semantics. In practice this means that for an institute's universe of discourse, a (networked) competence structure has to be defined, containing all meaningful skills and knowledge entities. The activities in the education processes are the education products, such as courses and modules, which are usually stored in the educational product catalog of education institutes. In order to assure coherence between the products in the catalog, and the competencies that will be assessed, each individual 'product' in the catalog has to be interrelated with the competence structure. Once this education context is set up the ingredients for composing Personal Education Plans (PEP's) are ready (cf. Fig. 4).

PEP's are student-specific paths (i.e. process models) through an education system. For each individual student, a path is composed based on the competencies the student has at the time of application and the profile of competencies he or she wishes to leave the school with. Based on the individual preferences for study load, study locations, etc. a customized plan has to be composed for each student. Normally, this task of configuration is assigned to a special counselor who must have an up-to-date overview of the education catalog at any time, and needs to be able to weigh alternative paths in order to arrive at optimized ones. Typically, a certain amount of time per student per year is available. However, with increasing flexibility and (international) cooperation of educational institutions, this counseling task becomes more and more complex. Obviously, there are two likely outcomes to this situation. Either the counselor constrains himself to a small set of options, thus departing from the true demand- driven and customized approach, or he will likely be swamped with the analysis and comparison of paths, alternatives etc.

The challenge, as it manifests itself in this context, is the support of the process modeling process. It is clear that resorting to explicit modeling of all current and future PEP alternatives is impractical. The dynamics of possible starting points and ever changing goals and education catalogs rule out this course.

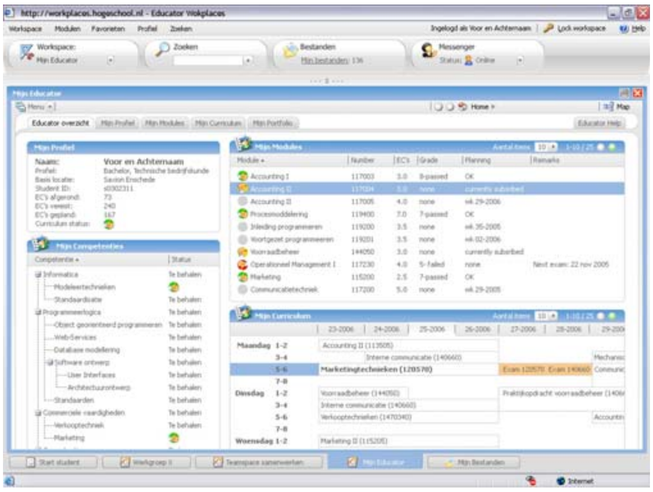

Fig. 4: Student portal in which the personal education plan is displayed.

DBPM provides a solution as a ‘gps-navigation’ style application. At the click of a button it can present individualized paths between current and desired competence profiles. This is achieved while allowing for a range of optimization settings and explicit “do or do not” choices (e.g., in terms of modules that a student specifically wants to do or not). PEPs can be monitored and updated at any point in time, based on accredited competencies and an up-to-date learning goal.

As stated, a PEP is a process in which the starting point and goal are unique for each individual student. Especially in large institutions the number of available education products in the education catalog can be enormous. As the contents of this catalog evolve continuously, it becomes very challenging to compose customized and personalized learning plans.

The educator application of the DBPM concept presents a student counselor with a modeling and navigation tool that overcomes this complexity. In the educating context, the ‘current position’ of the student is repeatedly monitored. This position is formulated in terms of the competencies that a student has acquired at a certain point in time. These student competencies are a subset of the aforementioned competence model as it is used in an institution. The education goals are also expressed in terms of a profile of competencies. Furthermore, all products in the education catalog are expressed in terms of competencies from the competence model. For each entity (e.g. a course) or module the required skills and knowledge, as well as the targeted skills and knowledge to be gained, are defined. In this manner entities in this catalog can be defined, altered, or deleted independent of other entities; i.e., no explicit precedence relations between these products (process activities) have to be defined.

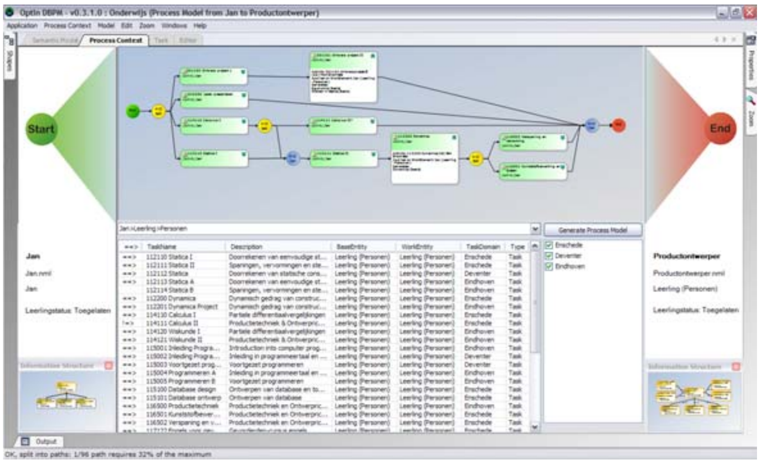

Fig. 5. Overview of the process model (top) as a result of the goal (right), the current information content (left) and available process activities (bottom, middle).

5 Related work

DBPM extends the design-time as well as the run-time parts of the BPM cycle, both of which are reviewed here for related work.

With respect to the design of a business process the tight relation between its *goal* (or function) on the one hand and its optimal *structure and content* on the other hand has been stressed before (e.g. [8][9]) . In [12], which is closely related to the work on MIT's process handbook [13], a goal hierarchy is proposed as a means to (1) verify whether an existing process design meets the goals at the overall process level, (2) to identify non-functional sub-processes, and (3) to search for alternative sub-processes within a repository of documented models. In [10], a formal framework based on *situation calculus* is presented, which takes goals – among other entities – as a starting point for matching processing requirements with the capabilities of the available roles in an organization. Similar in spirit is an informal, more business oriented approach as presented in [11]. Although these approaches share the focus on goals as starting point for process design with DBPM, none of them contains sufficient guidance to determine a process representation that is near-ready for enactment. In particular, they do not detail how the exact routing constructs within a desirable business process should be determined.

More similar to DBPM in scope and depth is the method of Product-Based Workflow Design (PBWD) [20]. The latter's focus is on the *product* that is being delivered by a business process. Obviously, the delivery of a product can be considered as a primary goal of executing a business process. The inspiration for PBWD comes from manufacturing, where a Bill-of-Material can be used to derive the production process of the product in question [14]. Comparable to the role of the semantic model of DBPM, in PBWD a product/data model is used to drive the design of the business process. Where PBWD seems more mature with respect to laying out the overall methodology to be followed in actual process design projects [14][18][19], DBPM distinguishes itself by more sophisticated tool support and a close integration with the enactment phase of the BPM lifecycle.

For flexible process enactment at run-time different paradigms have emerged recently (e.g., [16][23][24][25]). Adaptive process management systems (see [17]), for instance, enable (dynamic) process changes at different levels. Systems like ADEPT [3][5][16], WASA [25] and METEOR [23] support ad-hoc changes of single process instances (and might therefore be a well-suited enactment service for DBPM) as well as process schema changes and their propagation to a collection of running process instances. In both cases, underlying correctness constraints of the processes are preserved and efficient implementations are offered. As opposed to DBPM, the focus is more on the provision of a generic infrastructure for realizing adaptive processes. However, in principle, these systems could serve as runtime platform for DBPM. Other flexible execution paradigms include case handling [24] and planning [22].

6 Summary and Outlook

In this paper we have described the basic concepts behind the OptIn DBPM tool and illustrated its practical use by applying it to processes in an educational setting. DBPM is based on research results of the authors [1][2] and constitutes a good example of how innovative research results can be transferred to a commercial product. DBPM extends the traditional activity-centered view on BPM software by enabling demand- and goal-driven process modeling and evolution. Applying this metaphor, process modeling changes from a primarily top-down approach of process decomposition towards an approach of process configuration. Key advantages are the demand-driven reuse of process activities, the automated configuration of process models, process navigation in highly dynamic and complex environments, the support of case-based and run-time process modeling, and the bidirectional optimization between process planning and process modeling. Future activities will include improved support for product-based workflow design (cf. Sect. 5) and the use of adaptive process management technology like ADEPT as underlying enactment service.

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