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Toward Process Modeling in Creative Domains

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ABSTRACT

Process modeling has emerged as a widely accepted approach in order to reduce organizational complexity in organizations. Process models are used for different purposes, including process analysis and redesign, risk management, and the implementation of software systems. However, the majority of existent approaches is restricted to processes that are well-structured and predictable. Highly creative environments, such as the film industry or R&D departments, however, are characterized by high levels of flexibility. As existent approaches do not provide ample means to model such processes, this paper discusses the capabilities that a conceptual process modeling grammar for processes in creative environments must provide. Furthermore, we suggest an approach to process analysis that aims at the identification and specification of creativity in business processes. The study belongs to the design science paradigm; the discussion is grounded in a theory that explains the nature of processes that rely on creativity.

Keywords

Business Process Management, Modeling Language, Creativity, Creativity-intensive Process, Design Science

INTRODUCTION

Business Process Management (BPM) is a holistic approach that comprises a multitude of tools for the analysis and design of business processes (Harmon, 2007). Business processes have been defined as a series of tasks that are carried out in order to collectively realize organizational objectives (Hammer, 1990; van der Aalst and van Hee, 2002). Business process models are formal or semi-formal, mostly graphical documentations of a process's sequence of activities, generated products, required resources and information, involved organizational units and personnel, pursued goals as well as dependencies between these elements (Lindsay, Downs and Lunn, 2003).

Particularly in industries that are characterized by processes that feature a high level of predictability, structure, and repetitiveness, business process models have been successfully used for various purposes; examples range from process analysis and redesign to the implementation of software systems (Dalal, 2004). However, in order to make the benefits of business process management available to those industries which are characterized by creativity-intensive processes (Seidel, 2009; Seidel, Rosemann and Becker, 2008b), there is need to design process modeling grammars that provide means to handle the processes' complexity and flexibility. Whereas parts of processes in creative environments may be well-structured and thus amenable to a specification in a precise flow-chart manner, other parts may be not. Processes that rely on creativity usually do not have a predefined process structure and produce outcomes that are hard to predict. Consequently, the rigid means of process description provided by existing process grammars do not provide ample means to model creativity-intensive processes.

The present study explores process modeling in the creative domain from a business perspective. For this purpose we discuss the concept of pockets of creativity (Seidel, Müller-Wienbergen, Rosemann and Becker, 2008a; Seidel and Rosemann, 2008) as sections within business processes that are characterized by high levels of uncertainty with regard to process structure, outcome, and required resources. We further introduce an approach to identify and describe pockets of creativity within an organization's overall process landscape. In doing so, we extend an existing modeling grammar with novel modeling constructs. The discussion of this design-oriented approach is based on a theoretical model of creativity-intensive processes.

The paper is structured as follows. First, we expose the research approach underlying this design study. We then introduce the theoretical underpinnings that inform the design process. This is followed by a concise description of the object of this research (a method for modeling creativity-intensive processes). The application of the method is demonstrated by modeling a real-world creativity-intensive process. Finally, our research is related to existing literature and the paper concludes with a discussion of limitations and an outlook to our future research agenda.

RESEARCH APPROACH

The present study aims to explore for, and develop, a novel approach to modeling business processes in highly creative domains. Examples include organizations from the film industry, visual effects (VFX) production, and the production of computer games. The design of purposeful IT artifacts has been referred to as design science research (Hevner, March, Park and Ram, 2004; March and Smith, 1995). It has been asserted that design science research can complement behavioral science research. Behavioral science research in the IS discipline generates and tests theories which explain and predict phenomena that are related to IT artifacts; design science research creates and evaluates artifacts that are needed to solve identified problems (Hevner et al., 2004).

The design of the conceptual modeling language that is proposed in the present study is grounded in a theory of creativity-intensive processes (Seidel, 2009; Seidel et al., 2008b). The theory explains the "confluence of people, organizations, and technology" (Hevner et al., 2004) in those processes that are characterized by creativity. It thus provides an in-depth understanding of how creativity impacts on business processes and their management. The theory asserts that creativity-intensive processes are characterized by high levels of *uncertainty with regard to process structure*, *outcome*, and *required resources*. Process managers pursue what can be referred to as *operational* and *creative process performance* while simultaneously mitigating *operational* and *creative risk*. The theory further states that creativity-intensive business processes are highly iterative and characterized by various levels of structure.

The method we are proposing comprises detailed procedures of how to analyze creativity-intensive processes as well as a modeling grammar tailored to the process of creativity identification and description. The modeling language is developed using a meta-model-based approach (Rossi, Ramesh, Lyytinen and Tolvanen, 2004). The syntax is specified in a meta model that defines the modeling grammar. Figure 1 depicts the relationship between theory and design artifacts underlying this research.

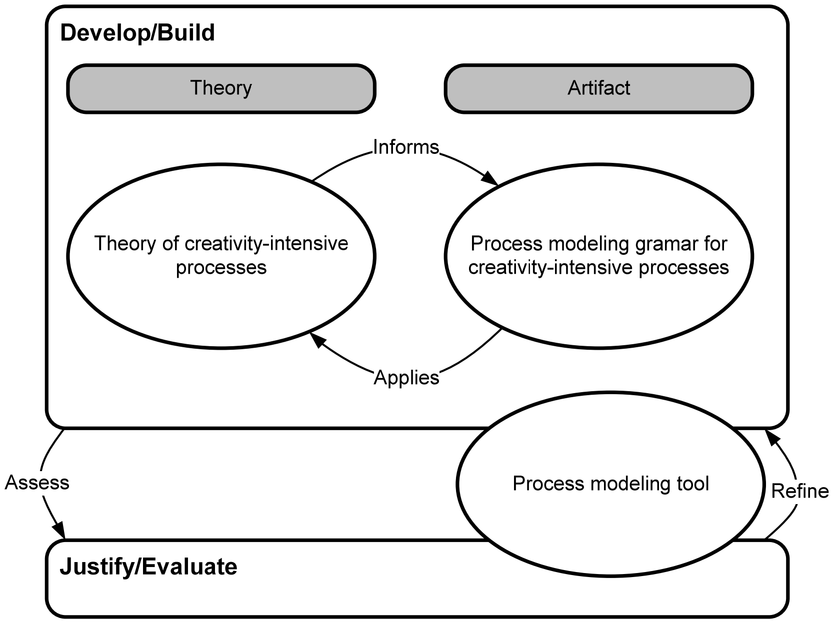

Figure 1. Research Framework

It is imperative to verify the usefulness of a designed artifact by thorough evaluation (Hevner et al., 2004). In this paper we demonstrate the applicability of the nascent approach to analyzing and modeling creativity-intensive processes by modeling a real world scenario from the visual effects industries. It is further planned to utilize the method in multiple case studies within the domain of interest. For this purpose we will implement our approach into a process modeling tool, which is meant to support the future evaluation studies. Recker (2008b) provides feasible measures that are ample to explain continuance in process modeling method use. Following his findings, the perceived usefulness of a modeling language constitutes a reliable evidence for continued use.

THEORETICAL GROUNDING: CREATIVITY-INTENSIVE PROCESSES AND POCKETS OF CREATIVITY

Creativity-intensive processes comprise both sub-processes that inherently depend on creativity and sub-processes that are well-structured and do not rely on creative acting (Seidel, 2009). The latter ones produce defined outcomes and are well-understood regarding the discrete process steps (or tasks) that have to be accomplished. The process sections that imply creative acting have been referred to as *pockets of creativity* (Seidel et al., 2008a; Seidel and Rosemann, 2008). Pockets of creativity do not inevitably exist as an atomic element but may by itself be further broken down into pockets of creativity and well-structured process sections.

Pockets of creativity can be characterized by a distinct set of features (Seidel, 2009). Firstly, acting creatively means to create something novel that is not entirely specified until the process is completed. This feature of pockets of creativity can be referred to as *uncertainty with regard to outcome*. Secondly, the actual process structure is not entirely known in advance. Due to product requirements that evolve in the course of a creativity-intensive process and individual approaches of solving a creative problem, a pocket of creativity's internals are unknown when a process starts. The set of required actions, the number of possible iterations, as well as the temporal sequence of actions are entirely or partly unknown until the process ends. Pockets of creativity are thus characterized by *uncertainty with regard to process structure*. Thirdly, uncertainty related to outcome and process structure cause *uncertainty with regard to required resources*. Different creative actors may utilize different materials or apply different instruments for creating a creative product. Moreover, a varying number of process step iterations cause a varying consumption of resources.

A creative organization's creative capabilities are intimately linked to its capacity to compete. Consequently, we argue that any attempt to model processes in creative environments must consider information that is related to pockets of creativity. We further argue that the distinct nature of pockets of creativity requires a separation from well-structured business processes. Performance measurement, for example, will focus on different measures if creativity is involved; i.e. creative performance may be assessed as opposed to conventional performance. While the former one refers to creativity measures such as originality, the latter one primarily focuses on measures related to efficiency. Other relevant issues include resource allocation in pockets of creativity. Although the required resources are not precisely known in advance, it has been asserted that pockets of creativity are sufficiently equipped. A shortage of resources may prevent creativity because creative people will invest their creativity in accessing the required resources (Amabile, 1998).

We thus argue that the specification of pockets of creativity can be beneficial for their management. While pockets of creativity are characterized by uncertainty, at the same time they are restricted by certain constraints regarding outcome, process structure, and resources. Creative products have to be purposeful (Firestien, 1993), i.e. they serve a specific objective. As a consequence they often will obey defined constraints. Moreover, a pocket of creativity can be detailed by explicating both the required resources that are known in advance, as well as constraints related to human resources, time, budget, and equipment. Process steps that might or will be part of a process, as well as dependencies between different process fragments, may be exposed. Consequently, some attributes characterizing a pocket of creativity can be defined in advance; some evolve while the process is executed and thus impose further exigencies on process management.

Grounded in the above discussion we introduce three types of constraints that describe what elements of a pocket of creativity are known in advance: *product constraints*, *process constraints*, and *resource constraints*. These constraints specify required and available resources, known features of the output, and process steps and dependencies between these. Those aspects that may not be specified in advance but evolve while the creative product takes shape can also be pinpointed. They may become subject to monitoring in order to secure that they evolve in accordance with the process goals. It is expected that the explication of the characteristics of a pocket of creativity empowers process designers to allocate resources as well as identify potential strategies in order to support pockets of creativity and to better plan for precedent and subsequent process steps. Process manager become aware of the uncertain aspects that must be monitored in order to keep control of their processes.

MODELLING CREATIVITY-INTENSIVE PROCESSES

Hierarchy-Driven Process Analysis

In order to analyze and describe creativity-intensive processes we propose the separation of well-structured process parts from those that rely on creativity (pockets of creativity). Process sections that have well-defined outputs, required resources, and underlying process structure are amenable to traditional process modeling techniques. Pockets of creativity, however, must not become straight-jacketed by imposing a rigid structure on activities that inherently rely on flexibility, uncertainty, and indefiniteness. We propose to detail pockets of creativity; i.e. to explicate known constraints and attempted goals. Applying these separate means of process specification allows for independently addressing operational performance in terms of minimal resource consumption and lead time as well as creative performance concerning the creation of novel and purposeful products. The ultimate goal is to enhance operational performance without impeding creative performance.

For the identification and separation of pockets of creativity we propose a hierarchical, iterative, top-down approach that starts from a highly aggregated view on an organization's process landscape. Similar approaches have been suggested in 'classical' process modeling where an organization's value chain is subdivided into sub-processes on up to seven "levels of analysis" (Harmon, 2007, p. 81). We suggest to successively breaking down an organization's processes into structured, well-defined process sections and sections that contain creativity that match the notion of a pocket of creativity. The starting point of our process analysis procedure is a creativity-intensive process. A creativity-intensive process can, at the highest level of abstraction, be represented by a single pocket of creativity. The pocket is then broken down into a set of distinct process chunks. For every chunk a process modeler decides whether it is a pocket of creativity or a well-defined process section. In order to identify creativity within business processes the process modeler has to search for its symptoms (uncertainty with regard to outcome, structure, and require resources). These characteristics guide the identification process. If the process analyst is not able to precisely name a process chunk's output, the required resources, actions that have to be carried out in order to generate the desired outcome, as well as the precise order of these actions, the chunk is another pocket of creativity. The identified pockets of creativity provide the starting point for the next iteration cycle. The termination condition that indicates when to stop the process of further detailing the process hierarchy may be chosen in dependence on the individual purpose of modeling. In order to retain a comprehensive process tree, the iteration may proceed until none of the identified pockets of creativity may be further subdivided (similarly Harmon (2007) proposes to break an organization's value chain down to atomic activities). Having identified the hierarchy of creative and non-creative process chunks, the pockets of creativity can be further specified in terms of their constraints as described above. Pockets of creativity on a higher level are often characterized by the accumulation of the constraints held by the elements they comprise. Table 1 encapsulates the entire procedure of process analysis.

#	Step	Description
1	Initial setup	A creativity-intensive process constitutes the initial pocket of creativity thus serving as a starting point for the subsequent process analysis.
2	Pocket break down	The initial pocket of creativity is broken down into disjoint process chunks.
3	Process chunk assessment	Every process chunk is judged whether it constitutes a (sub-)pocket of creativity or a well-structured process section.
4	Termination check	The termination condition has to be checked for all (sub-)pockets of creativity identified in step 3. For every (sub-)pocket that is assessed to require further break down, the process is rerun starting from step 2.
5	Pocket specification	The pocket of creativity is described by means of product constraints, process constraints, and resource constraints.

Table 1. Process Analysis Procedure

The described procedure results in a hierarchy of pockets of creativity on different levels of specificity. The approach aims at identifying and specifying creativity within business processes; thus, the detailed specification of well-structured process chunks is not part of the procedure. However, process chunks that are labeled as non-creative are approachable by traditional process modeling techniques and may also be broken down along a hierarchy of increasing detail.

The iterative top-down approach introduced in this section features a number of advantages. It allows to capture and specify a phenomenon that otherwise is hard to catch. Trying to model creative processes bottom up is cumbersome; starting at the most specific level of something that may hardly be specified in detail is a daunting exercise. The approach of nested pockets of creativity aims at isolating creativity in an iterative manner. Moreover, a top-down approach of process modeling facilitates flexible decision making at the appropriate level of detail. The most detailed process models are generated last. Thus, the process designer may determine the level of detail in the course of the modeling exercise. Likewise, the divide-and-conquer technique underlying the procedure features the efficient identification of pockets of creativity. Process sections that do not contain any creativity are sorted out as soon as possible and on the most aggregated level. This feature is especially beneficial if a modeling exercise primarily focuses on pinpointing creativity.

Introducing Pockets of Creativity to Process Modeling with BPMN

In order to evaluate the theoretical concept of pockets of creativity (PoC) in real-life process modeling scenarios, we propose to design a process modeling grammar. The grammar will be required to provide language constructs for the concept of pockets of creativity and its properties. It further has to provide means of hierarchically structuring processes and sub-processes. This may be achieved (a) by developing a novel modeling language from scratch, or (b) by adapting an existing notation. The adaptation of existing modeling languages features several benefits in contrast to a development from scratch:

- Avoidance of redundant development effort ("yet another process language") by reusing language constructs that are not novel to the particular method
- Easy introduction for experienced modelers learning the new language constructs and their application
- Opportunity to easily implement the new language constructs into existing software tools
- Compatibility of legacy models to the new modeling method (to a certain extent)

However, using an existing and established modeling framework also bears some risks that need to be addressed. To leverage the benefits stated above, the original modeling language has to be extended without significantly altering the syntax and semantics of existing language constructs. The underlying paradigm of the base language must thus be compatible to all novel constructs of the target language. A role-oriented process modeling language, for example, might not be applicable if a detailed sequencing of activities is to be described (Lin, Yang and Pai, 2002).

In the present study the Business Process Modeling Notation (BPMN) has been chosen as a base language. BPMN is a widely accepted multi-purpose process modeling grammar that is incorporated in numerous commercial and open source software tools (Recker, 2008a). Its specification is freely available and comprises detailed meta-models describing the language constructs and their properties. This allows for a meta-model-based method engineering approach (Rossi et al., 2004) in order to enhance the language. The BPMN meta-model is expressed by means of the OMG Meta Objects Facility (MOF). MOF is an object-oriented framework for describing meta-objects (i.e. language constructs in the context of conceptual modeling). The application of this framework allows for the modification of BPMN by deriving the necessary language construct classes by means of specialization.

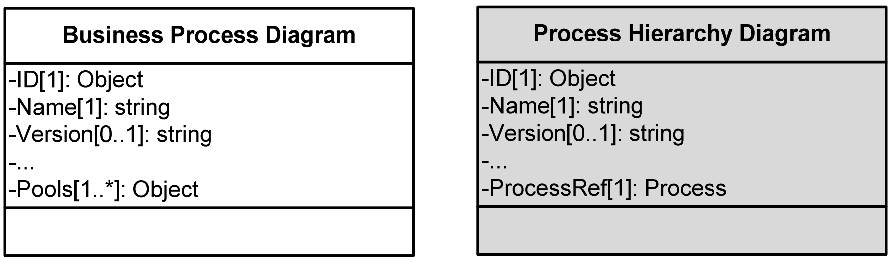

Figure 2. Meta Model Extension for Process Hierarchy Diagrams

In order to provide means for modeling the hierarchical analysis concept introduced above, we introduce a new diagram type: the *Process Hierarchy Diagram* (PHD, cf. Figure 2). A PHD arranges sub-processes (PoCs as well as structured sub-processes) of a creativity-intensive business process horizontally, thus displaying a rough sequential order. Vertically the sub-processes are further refined with increasing level of detail. In comparison to the *Business Process Diagram*, the PHD does not require a pool as an organizational unit to be modeled. In the BPD this model element provides the logical link between the model elements and their governing process. The PHD directly references the process that represents the top element of the hierarchy. The advantage of this approach is that no mandatory statement about the organizational structure must be made at this point of analysis.

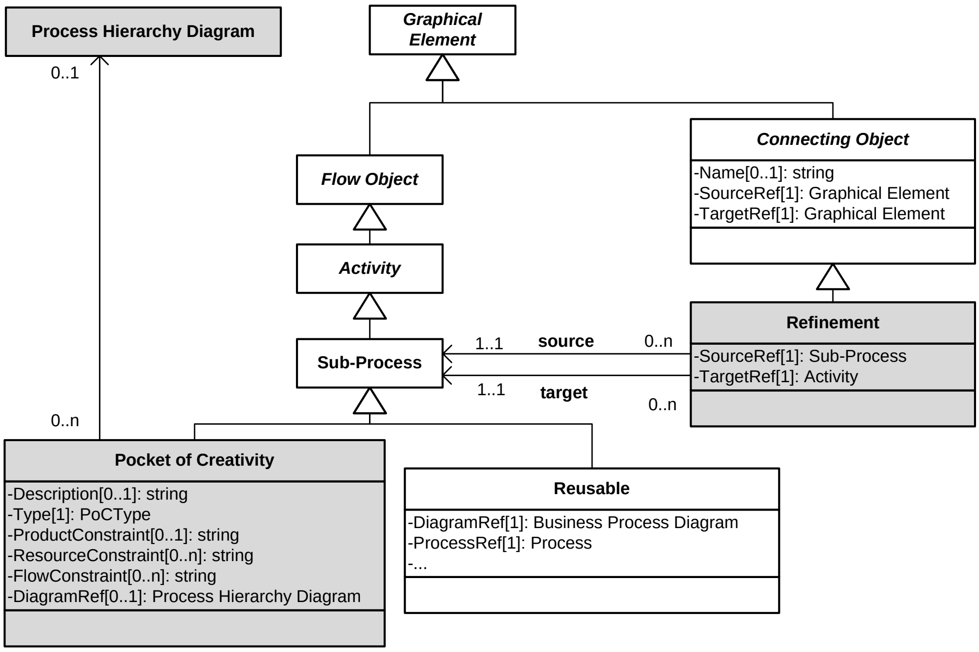

Figure 3. Meta Model Extension for Pockets of Creativity

The key concept of our method is the `Pocket of Creativity` (Figure 3). From the perspective of BPMN the PoC is a specialized sub-process. Alike the sub-process of BPMN, a pocket of creativity may reference a diagram that further details its inner structure. The diagram to be associated with the respective PoC, however, must be of the type PHD; this enables modelers to both build a process hierarchy in a dedicated diagram and divide the hierarchy into manageable parts in multiple associated models. The `Refinement` is the only edge type in the PHD and connects sub-processes with their subordinate parts.

A pocket of creativity can be further detailed by specifying its constraining properties by the means of free-text strings. These constraints are not meant for automatic analysis. Thus, a stronger formalization is not necessary at this point of analysis. Free text specifications provide modelers with a high degree of flexibility.

The concrete syntax (visualization) of the language concepts will be introduced in the following section alongside a modeling example from the domain visual effects production (VFX).

MODELING EXAMPLE – A VISUAL EFFECTS PRODUCTION PROCESS

In order to evaluate the modeling method we attempted to model processes from visual effects production. Processes in this domain are characterized by high levels of creativity and comprise of both well-structured and creative tasks.

The process analyzed is concerned with the construction and animation of digital characters. These are visual artifacts that are created by VFX artists using specialized software tools. The material can later be integrated into footage that has been recorded on an actual film production set. In Figure 4, the creativity-intensive process of *Digital Character Animation* has been modeled as the root node of a PHD. This top-level pocket of creativity has been subsequently refined, revealing both well-structured parts (modeled as regular BPMN-sub-processes) as well as creativity-intensive process chunks (modeled as PoCs). The PoC “Modeling” was further refined in the diagram, while all other PoCs are described in separate PHDs. This is indicated through the small icon in the bottom-right corner. The PoC “Base Mesh” is a leaf node in the diagram and is therefore not further specified in terms of process structure. However, product and resource constraints have been instantiated to provide further details on the individual creative task.

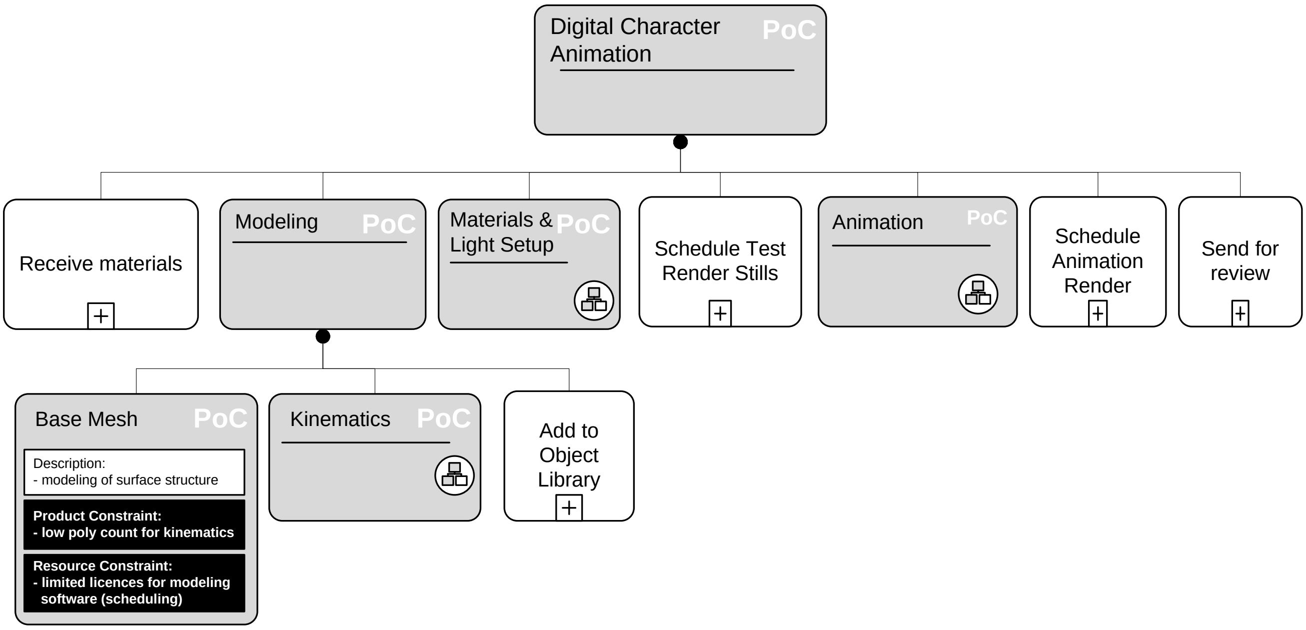

Figure 4. Process Hierarchy Diagram of Digital Character Animation

Figure 5 shows how the introduced language concepts are integrated into the BPMN modeling environment. Here, the PoC "Modeling" is integrated to a Business Process Diagram specifying the process structure. In this visualization the PoC bears some similarities to the BPMN concept of the "Ad Hoc Sub-process". However, ad hoc processes merely comprise collections of unordered but defined tasks. The sequence and number of iterations of these tasks is not determined until process run time. The PoC language construct resembles this flexibility within the BPD and adds the capability of accommodating complex sub-processes, both well-structured and of PoC type.

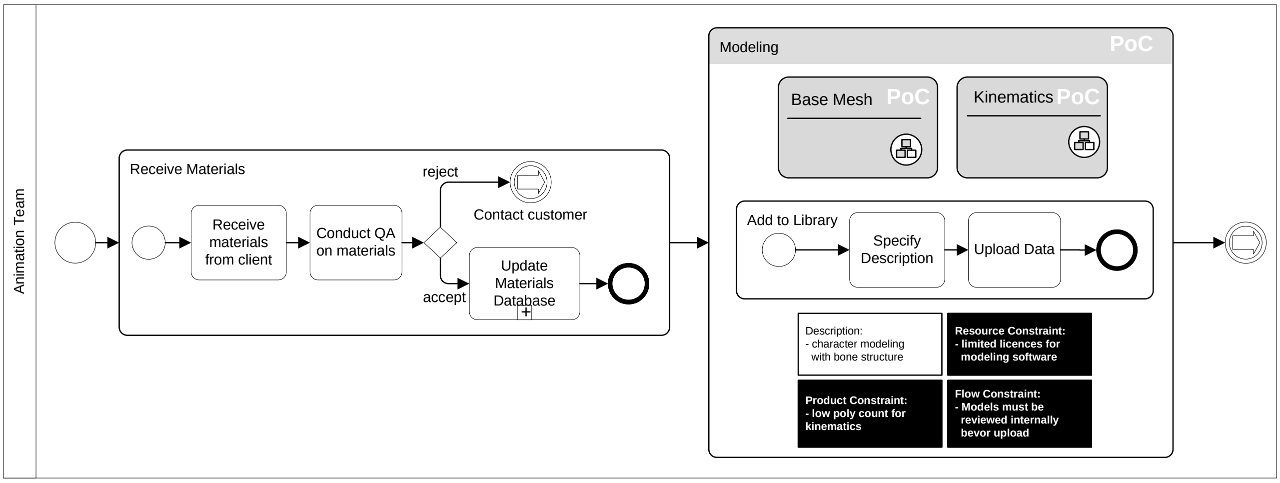

Figure 5. Visualization of Pockets of Creativity in Business Process Diagrams

When we applied our method to a first use case in a creative company we observed that a hierarchy-based perspective on this specific type of business processes can help to assess well-structured and creative tasks much faster. Using the standard BPMN notation in this context, the modeler is impelled to represent complex creative sub-processes as single atomic activities, since no structural information can be expressed for these process parts. The introduced PoC language construct implies a considerably higher emphasis on these process parts that constitute the creation of value for creative teams and organizations. The annotated constraint properties provide for additional transparency throughout the process.

RELATED WORK

Business process modeling is driven by various objectives. The utilization of visual models for describing organizations' business processes along with reengineering efforts has some tradition (e.g. Curtis, Kellner and Over, 1992). The modeling languages used for this type of description, however, typically originate from formal domains such as software engineering, simulation, and workflow management (Giaglis, 2001).

Research on process modeling in the field of workflow systems takes in a rather technical focus. Fellow scholars from this area focus on implementation and automation of business processes through workflow systems. Even though creativity is not amenable to automation, research in the field of workflows systems has revealed a related phenomenon: Recent years have seen a number of studies concerned with flexibility within workflows. Approaches such as *workflow evolution* (Casati, Ceri, Pernici and Pozzi, 1998), *exception handling* (Russell, van der Aalst and ter Hofstede, 2006), *declarative workflow techniques* (van der Aalst and Pesic, 2006), *case handling* (van der Aalst, Weske and Grunbauer, 2005), *pockets of flexibility* (Sadiq, Orlowskaa and Sadiq, 2005), and *ad-hoc workflows* (Han and Shim, 2000) advance different aspects and shades of flexibility within business processes.

Sadiq et al. (2005) introduce the concept of *pockets of flexibility*, which facilitates the specification of loosely defined process sections within highly structured workflow models. These sections comprise a set of workflow fragments and constraints that restrict the control flows that are allowed between the fragments. Right before execution of the workflow, however, there has to be an explicit workflow model that describes process coordination. The so-called *case handling paradigm* seeks to overcome the limitations of rigidity that is inherent to workflow systems. Van der Aalst et al. (2005) propose to follow a data-centric approach rather than merely considering process-flow. The selection of activities that have to be executed is based on conditions related to data objects. Moreover, additional authorization types allow people who are involved in the process to decide whether an activity has to be skipped or redone. These concepts aid the injection of latitude into processes that implicitly get leashed in the course of process execution. Nevertheless, these grammars focus on technical issues of process implementation into workflow systems rather than outlining processes for a human audience. Thus, they do not provide means for effectively describing flexibility in processes from a business perspective.

The ARIS framework (Scheer, 2000) comprises a model type that allows for a hierarchical decomposition of business processes similar to the approach presented in this research. The Function Decomposition Diagram (FDD) projects a process hierarchy onto a tree of functions (activities). FDDs are commonly used as means of navigation to access process models stored in an extensive model repository. As "functions" are the only model elements in these diagrams, their applicability for the purpose of analyzing creativity-intensive processes is limited.

CONCLUSION

This paper presented a novel approach to analyzing and modeling so-called creativity-intensive processes. The design of the approach has been informed by a theory of creativity-intensive processes which explains how creativity impacts business processes and their management (Seidel, 2009). The design science approach we followed thus exemplifies the relationship between IS theories and the design of purposeful IT artifacts. It is further hoped that the proposed approach can be used to assess and evaluate the underlying theory.

This study has some limitations. Most notably, the proposed approach has only been applied to a number of processes from visual effects production. It is planned to further evaluate it by conducting multiple case studies and use feasible measures to evaluate conceptual modeling grammars; according measures have been proposed by (Recker, 2008b), for example.

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