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MODELLING AND SUPPORTING PROCESSES IN CREATIVE ENVIRONMENTS

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Abstract

Processes in the screen business are characterised by their agile nature. First, the industry is constantly changing and recent technologies such as High Definition Television, digital production and new distribution channels are having deep impact on the industry's value chain and processes. Second, processes contain tasks that are highly creative and involve different types of knowledge workers such as producers, animation artists or compositors. With regard to the highly agile nature of the processes in this industry and due to the fact that these processes are characterised by multiple levels of structure and creativity we have developed a framework for flexible process support based on case study findings and a literature review. The construction of the framework has particularly been informed by empirical generalizations on what we refer to as Creativity Intensive Processes. The framework classifies existing approaches to process modelling and support based on different criteria and therefore aims to support the introduction of IT support in creative environments. In this paper we introduce case study findings along with the framework. The application of the framework is a first step to its evaluation since it is used to retrospectively analyse evidence from case studies and literature review.

Keywords: Business Process Management, Case Study, Creativity, Creativity Intensive Process, Screen Business, Workflow Management

1 INTRODUCTION

The screen business, as part of the creative industries, comprises all creative and business related aspects and processes of film, television and new media content, from concept to production and finally distribution. Recent technologies such as High Definition Television (HDTV), digital production and new distribution channels (e.g. iPods and PSPs) are having a deep impact on the screen business and its value chains (Gross & Ward, 2004). In order to stay competitive the industry must apply contemporary business approaches, such as business process management.

Interviews with managers and teaching professionals from the screen business have shown that many companies are aware of the importance of process management but do not consciously deploy it (Seidel et al., 2006). A reason can be seen in the fact that there has not been an in-depth investigation on how creativity influences business processes and, thus, business process management. Parts of the screen business value chain can be regarded to as “creative processes” (Osborn, 1957). Other parts, such as typical back office processes are well-structured and not creative at all. This leads to the question of how to model and support processes in a creative environment such as the screen business. Consequently, within exploratory case studies with screen business organisations we have been investigating the nature of what we refer to as *Creativity Intensive Processes* (as defined in section 3).

Based on the case study findings and based on a comprehensive literature review, in this paper we introduce a framework for flexible process support. As a first evaluation step we have applied this framework to classify and model processes from the screen business.

2 RESEARCH METHOD AND CASE STUDIES

Case studies have been chosen as a research method since this research covers a new topic area and an intimate connection with empirical data is sought (Eisenhardt, 1989; Yin, 2003). The sourcing strategy involved unstructured and semi-structured interviews with creative workers and teaching professionals as well as process analysis, document analysis and a literature review. Based on these findings, a framework for flexible process support has been developed.

Table 1 gives an overview of two case studies that we have been conducting. One case study is in cooperation with the *Australian Film, Television and Radio School* (AFTRS), one with *Rising Sun Pictures*. The AFTRS is our main partner in this project and has expertise in all stages of the screen business value chain. Rising Sun Pictures has been a partner because of their expertise and size in visual effects production. The selection of the interview partners has been guided by their process knowledge.

Organisation	**Approx. Number of Employees**	**Main Areas**	**Interview Partners**
Rising Sun Pictures	Approx. 120	Post Production: Visual Effects Production	CEO, CTO, Head of 3D, Technical Directors, Compositors, Lighter, Coordinator
AFTRS	40 employees, 100 full-time postgraduate students, 5000 students attending short courses	Teaching	Director, Head of Editing, Producer, Post Production Supervisor

Table 1: Case Study Companies

Among other findings, these exploratory case studies led to the following empirical generalizations (Handfield & Melnyk, 1998):

(1) Processes in the screen business are characterised by flexibility. This can be reasoned by various factors, such as:

- Requirements to the creative product are often not sufficiently specified which leads to difficult to predict processes.
- Processes are also influenced by the intervention and knowledge of the customer. Consequently, processes that involve different customers often look different.

(2) Processes in the screen business cover various levels of structure. A process that contains creative tasks[1] can contain pure technical tasks (e.g. transfer from tape to tape), too.

(3) Creative tasks within screen business processes can be supported by knowledge management. This includes documentation of procedures as well as previous creative work that can serve as input.

(4) Creative tasks within screen business processes are communication-intensive and, thus, can be supported by group communication systems.

3 FOUNDATION AND RELATED WORK

A business process consists of a number of tasks or activities that need to be carried out in order to collectively realise an organisational objective or policy goal, and a set of conditions that determines the order of the tasks (v.d.Aalst & van Hee, 2002). We define a *creative task* based on a framework introduced by Rhodes who tried to unify the many different definitions of creativity. The framework is based on the assessment of 56 definitions and clusters these around four aspects: the *creative product*, *the creative process*, *the creative person* and the *creative environment* (Brown, 1989). Consequently, we define a creative task (which corresponds to the creative process in Rhodes' framework) as a task of a business process that involves creative persons that work on (or produce) a creative product. The *creative product* corresponds to the business object in a business process that is characterized by novelty. The task is carried out in a creative environment that can be described as its context including internal and external factors. Those processes that include creative tasks we refer to as *Creativity Intensive Processes*. Creativity Intensive Processes are a subset of Business Processes.

To support modern business processes, the best perspective may be "an approach towards interoperation of a mix of business improvement tools, and to allow workflow techniques to be used in harmony with ad-hoc collaboration tools, databases, decision support and so on" (Tagg, 2003). Consequently, we investigate established approaches to business process support. Tagg identifies a fundamental spectrum of business processes with fully structured processes at the one extreme and processes without any structure at all at the other (Tagg, 2003). The following overview of different approaches is roughly guided by this spectrum. Therefore, we start by introducing concepts supporting highly structured processes and then move forward to approaches supporting less structured processes.

Workflow

At the one extreme there are production workflow systems (Tagg, 2003). These systems aim to support fully structured processes; consequently, all possible pathways must be explicitly specified in the business process model (v.d.Aalst et al., 2005; Oberweis, 2006). Such systems are adept at modelling conventional business workflows, but are by their nature relatively rigid, and typically fail to allow for unexpected or developmental change to business practices and processes. In some work environments, and for some kinds of activities, rigid representations of work play a fundamental role by giving order to tasks and assisting in getting the work completed correctly (for example medical and banking environments). But even in such highly structured environments, it is difficult (if not impossible) to successfully capture all work activities, and in particular all of the task sequences

[1] Creative tasks are defined in the next section.

possible, in a workflow model, at least not without producing some very complex models. In addition to the complexities involved in statically representing a business process in a computationally executable way, it is the case that, for any given activity, the process for successfully completing the activity is constantly evolving because of changes in laws, market requirements, technologies, business opportunities, techniques and so on.

Workflow Evolution

Workflow evolution (or *adaptive workflow*) refers to extending the otherwise static workflow processes described above so that, when change occurs, the process model can be modified or augmented in some way, rather than being required to construct a completely new model. It addresses the problem that in a fast-changing environment existing workflows often have to be changed (Casati et al., 1996). Evolution takes place on two levels. First, the workflow description (or process model) has to be changed, referred to as *static workflow evolution*, and has associated issues regarding what kinds of changes are allowed and whether the changes maintain support for the organisational objective. Second, any currently running instances have to be managed when the workflow description has been changed, referred to as *dynamic change*, which has its own issues, such as should the instance be aborted, restarted using the new model, allowed to continue (so that there are several co-existing versions of the same business process), and associated problems of migration, synchronisation and version control (Rinderle et al., 2004; v.d.Aalst, 2001). So workflow evolution provides support for *occasional* changes to the business process model, and assumes the model is basically correct but incremental or ad-hoc changes may be accommodated. However, it has been shown that deviations from the process model occur during almost every executed instance of a process (Hwang et al., 1999), particularly if the work being modelled is relatively unstructured or 'ad-hoc'. Thus, if an event occurs that impacts on the execution of a process instance that is not explicitly catered for in the process model, then certain strategies need to be undertaken to 'handle' this previously unforeseen event. The typical approach in production workflows is that the occurrence of an unexpected deviation requires either suspension of execution while the deviation is handled manually, or an entire process abort. However, since most processes are long and complex, neither intervention nor process termination are satisfactory solutions (Hagen & Alonso, 2000).

Malone et al. point out that conventional workflow systems can support only those processes that can be formalised in sufficient detail (Malone et al., 1999). For more creative work environments to be successfully supported, focus must shift from building systems that execute processes to systems that *assist people* to carry out processes.

In (Twidale & Marty, 2000), Twidale and Marty use a detailed case study of a (non-computer-based) system employed to process the relocation of a large museum and its contents. They use their observations to support the notion that collaborative systems are better suited to the business process environment they are attempting to emulate if the focus is more on error recovery than error prevention. That is, in any work process, it may be more productive to accept the fact that exceptions to any plan will occur in practice, and to implement support mechanisms which allow for those exceptional behaviours to be incorporated into the model, rather than to develop a closed system that tries to anticipate all possible exceptions, then fails to accommodate others that (inevitably) occur. This notion supports the idea of evolutionary workflow support systems, which over time and through experience tune themselves to the business process they are supporting.

Exception Handling

Suchman finds that work is not strictly governed by plans, but rather by the possibilities and limitations of the situation at hand (Suchman, 1987). In those more creatively focussed work environments, formal representations may provide merely a contingency around which ad hoc tasks can be formulated (Bardram, 1997). Deviations from the plan should be considered as natural and valuable parts of the work activity, which provide the opportunity for learning and thus engender natural evolution of the plan. Thus for creative environments, rather than explicitly define the complete process model statically, it may be more appropriate to provide a *guide* to the objective of the process that can accommodate various tasks and orderings based on the context and progress of the individual case instance.

Casati et al. point out that a workflow designer often has to "explicitly deal with exceptional situations" (Casati *et al.*, 1999). Traditionally, exceptions are events that by definition occur rarely. But exceptions in business process instances have a wider meaning than commonly understood by the term. Rather than being considered errors, they are simply events that were unaccounted for in the original process model.

Russell et al. present a framework for the classification of exception-handling in process-aware information systems based on patterns (Russel et al., 2004). They point out that modelling all possible paths might be useful for well-behaved processes but in processes where many exceptions may occur, this may lead to very complex models where the actual business process is camouflaged by exception handling branches. Alternately, systems that provide support for exception-handling allow exceptions to occur during the execution of a process instance, then provide mechanisms called *exception-handlers* (external to, but linked to, the "parent" business process) to handle the exception and allow the process instance to continue unhindered. These handlers may be defined graphically, or as rules, or as a combination of the two. Thus a distinction between static workflow systems and exception handling systems is that in the former, all business rules, conditions and exception handling branches must be explicitly defined in the business process model itself, whereas for the latter the exception handling parts of the process are separated from the main business process. It is important to note that, typically, handlers can only be specified for exceptions that are expected (because the definition of exception-handlers must be completed before the instance is executed), although some recent developments in this field also provide the ability to capture and handle *unexpected* exceptions at runtime (for example, the *WorkletService* of the *YAWL* system

Declarative Approach

van der Aalst and Pesic point out that the majority of languages used to described and define business process models are of a procedural nature which limits their effectiveness in very flexible environments, and introduce a *declarative* approach to process modelling (v.d.Aalst & Pesic, 2006). Their *DecSerFlow* graphical language avoids many of the assumptions, constraints, conditions and rules that must be explicitly specified in procedural languages to perform flexible activities, the inclusion of which typically lead to an over-specification of the process. Relations between tasks (for example, that task *A* must follow task *B* at some time during process execution) can be defined as hard constraints (which are enforced) and soft constraints (which may be violated) using the very concise and extendible modeling language.

Case Handling

A different approach to the problem of rigidity in workflow systems is provided by van der Aalst et al., who argue that there is a lack of flexibility and, therefore, a lack of usability in contemporary workflow systems (v.d.Aalst et al., 2005). The case handling paradigm seeks to overcome the limitations of rigidity inherent in workflow systems by using a data-driven approach. This is reasoned by the fact that control flow routing (or the predefined ordering of tasks) is the only mechanism that drives cases. They consequently identify four major problems caused by the workflow approach (straight-jacketing of work into activities, routing is used for both work distribution and authorisation, the context is moved to the background due to focusing on control flow, push-oriented perspective). They position production workflow, case handling, ad-hoc workflow and groupware systems in a two-dimensional framework where structure makes up the one axis and data-driven vs. process-driven the other (v.d.Aalst et al., 2005). Case handling addresses the fact that most workflow systems do not meld with the way work is carried out in most non-manufacturing environments (v.d.Aalst & Berens, 2001). Case handling attacks this in two ways: each participant is provided with a broader view of the entire process (thus avoiding *Context Tunnelling*, where participants have knowledge only of their own tasks), and purports better support for exceptions (Reijers et al., 2002). While the goals of case handling systems and workflow systems are similar, the properties of case handling differ in three characteristics (from (Reijers et al., 2002)): *Focus on the case* (rather than presenting very specific work items related to a task), the *process is data-driven* (rather than process-driven) and *implicit modelling* (rather than specifying any routing between tasks).

Approaches for supporting unstructured processes

Groupware is mentioned by van der Aalst et al. as a means to support unstructured and data-driven processes (v.d.Aalst et al., 2005). Groupware, also called CSCW (computer supported cooperative work), is a collective name for those systems that enable groups to cooperate, and the relationships between group members can be quite loose. Groupware products and workflow systems often operate in combination – the main difference between them is that groupware focuses on cooperation between people, while for workflow systems the focus is on supporting business processes (v.d.Aalst & van Hee, 2002).

An interesting hybrid approach is called *XFolders*, a light-weight, document based workflow system that uses the metaphor of the inter-office memo circulation envelope to pass tasks from person to person in a work group following some loosely defined routes, until such time that the case is completed. Xfolders provides flexibility by allowing: the dynamic addition of new users, new documents and new document repositories during a process instance; any person to take the decision to modify the process flow; and disconnected operations which allow for more flexibility for mobile users (Castellani & Pacull, 2002).

4 FRAMEWORK FOR FLEXIBLE PROCESS SUPPORT

4.1 Classification Criteria

Based on the above work and on our case study findings, we introduce a framework for flexible process support in creative environments. The framework positions different approaches for process support as well as modelling techniques according to the following criteria.

Level of process structure

With this criterion we subsume structural aspects of workflows, that is, those aspects dealing with the control flow structure. Oberweis points out that a general distinction between schema flexibility and instance flexibility can be made (Oberweis, 2006): dynamic instance adaptation deals with flexibility at the instance level (Tagg, 2003) whereas workflow evolution (Casati et al., 1996) deals with flexibility both at the schema and instance levels. Tagg highlights that regarding dynamic instance adaptation there is not only need for catering for exceptions but also “the forecasting of what can be expected downstream”. van der Aalst et al. identify “straight-jacketing of work in to activities” and the focus on control flow as major problems related to flexibility in workflow systems. They further use the level of process structure to position groupware, case handling, production workflow and ad-hoc workflow in a two-dimensional framework (v.d.Aalst & Berens, 2001). The need for this dimension has been supported by case study finding (2).

Data Perspective

To position production workflow, case handling, ad-hoc workflow and groupware, van der Aalst et al use the values “data-driven” vs. “process-driven” as the second dimension of classification criteria. The data perspective may contain both attributes and values pertaining to actual case work, as well as data pertaining to the enactment of the process (case and workitem statuses, flags, control aspects and so on). Thus this perspective defines: how data in its various forms is used within a business process; the range of information that a workflow enactment engine captures; and the interaction of data elements between the workflow and the environment (Russel et al., 2005a). The need for this dimension has particularly been supported by case study finding (2). Less structured processes are rather data-driven than process-driven.

Resource Perspective

A resource is an entity that is capable of carrying out a task in a business process (Russel et al., 2005b), and can be classified as either:

- a human, typically a member of the organisation (operating the business process) and occupying a particular organizational role; or
- non-human, that is, a resource that does not correspond to an actual person, for example plant and equipment or a computer based application.

The level of resource autonomy refers to the extent to which resources are explicitly defined within the process model and coupled to particular tasks. Typically, static process models are very explicit in defining which resources must be used to carry out each task, while, at the other end of the scale, groupware products allow resources to be defined for a task on-the-fly at execution time. Particularly processes that contain creative tasks as defined above are often hard to predict which includes the resources that are required during process execution (case study finding (1)).

Creativity Perspective

Based on case study findings we define "creativity intensity" as *the latitude that creative persons have within a process both to use resources and to change the creative product.* Based on this we introduce the creativity perspective as a new criterion of a business process. As the case studies have shown, creativity leads to high demand for flexibility (1) and to less structured tasks (2).

The case study findings have further led to the conclusion that knowledge and communication are important factors within creative tasks as defined above (case study findings (3) and (4)). Therefore, according techniques, methods and tools can be applied that support creativity. Kristensson and Norlander for example refer to creativity as "a unique and complex human capability that, on the group level, is tightly interwoven with communication" (Kristensson & Norlander, 2003). Guilford highlights the "role of information" and the "role of previous experience" (Guilford, 1967 p 312 ff.) which corresponds to the case study finding that concepts like knowledge management (Nonaka, 1991) should also be considered. This relationship between knowledge creativity is also highlighted in (Christiaans & Venselaar, 2005; Weisberg, 1999).

4.2 Framework

Based on the classification criteria identified in section 4.1, in the following, we introduce a framework considering different levels of flexibility that are required in a creative environment.

	Static Workflow	**Dynamic Workflow / Exception Handling**	**Declarative Approach**	**Case Handling**	**Knowledge-intensive application**
Level of process structure	High level	Structure but with evolution and exception-handling	Low level with process rules	Low level with data rules	No structure
Process vs data-driven	Fully process driven	Process driven but with some data use when evaluating rules and monitoring exceptions	Process-driven	Data driven but with a 'preferred' process flow	Fully data driven
Level of resource autonomy	Explicitly specified	Explicitly specified at design time; may be supplemented, modified or withdrawn at runtime via exception-handling routines	Not excplicitly addressed	Loosely defined, can be re-defined at runtime	Undefined at design time, resources independently request items
Creativity intensity	Not explicitly addressed	Not explicitly addressed but supports some	Not Explicitly	Not explicitly addressed but	Support different aspects of

		flexibility	addressed but supports less structured processes	supports less structured processes	creative tasks

Table 2: Dimensions of flexibility

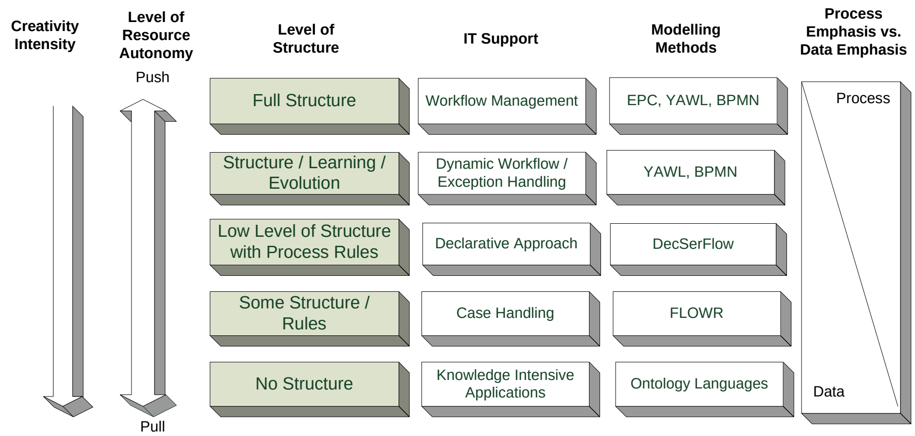


Figure 1: Simplified 2-dimensional illustration of Framework for Flexible Process Support

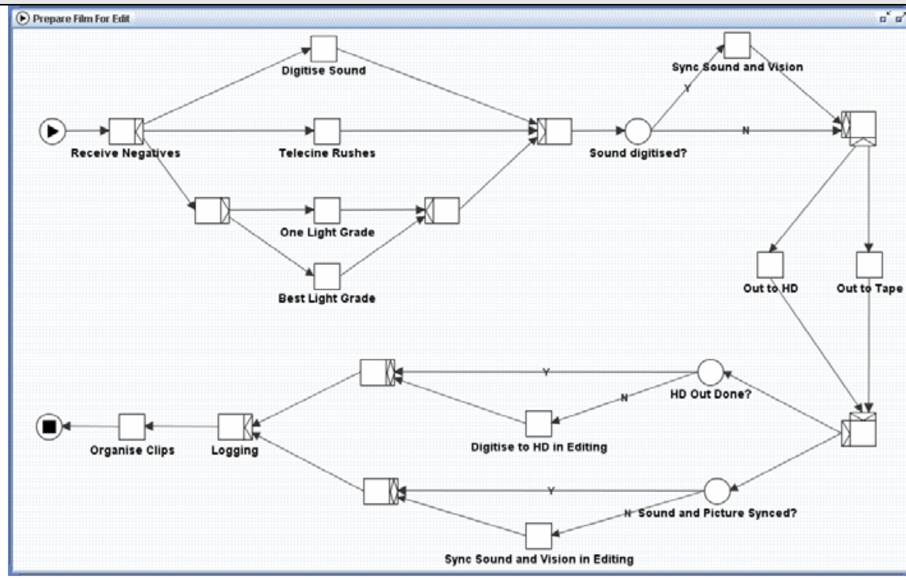
Table 2 leads to a simplified 2-dimensional illustration: Figure 1 gives an overview of the different levels of structure, shows how processes at a given level can be supported by Information Technology (IT) and lists some modelling techniques that are available. Whereas workflow systems provide the knowledge worker with the information he needs (a push oriented perspective), in unstructured situations the user has to seek the information required by himself (a pull oriented perspective). The latter can be supported by groupware systems and knowledge management systems, for example. Processes with some structure or rules can be supported by Exception Handling, Case Handling or the declarative approach. Figure 1 furthermore points out the emphasis on processes versus data. Where there is full structure, the process is the driving force, whereas unstructured process sections focus on data. Workflow systems can be modelled using modelling languages like EPC (Scheer, 1999), YAWL (v.d.Aalst & ter Hofstede, 2005) or BPMN (BPMI.org, 2006). Some of these languages (YAWL, BPMN) provide means to model exceptions as well and therefore can be used for modelling exception handling. The DecSerFlow language is used to define processes declaratively (v.d.Aalst & Pesic, 2006). Case Handling processes can be defined using FLOWer, for example (PallasAthena, 2000). To model the IT support for purely unstructured tasks we suggest the use of ontology languages such as the Web Ontology Language (OWL) (W3C.org, 2006).

5 APPLICATION OF FRAMEWORK

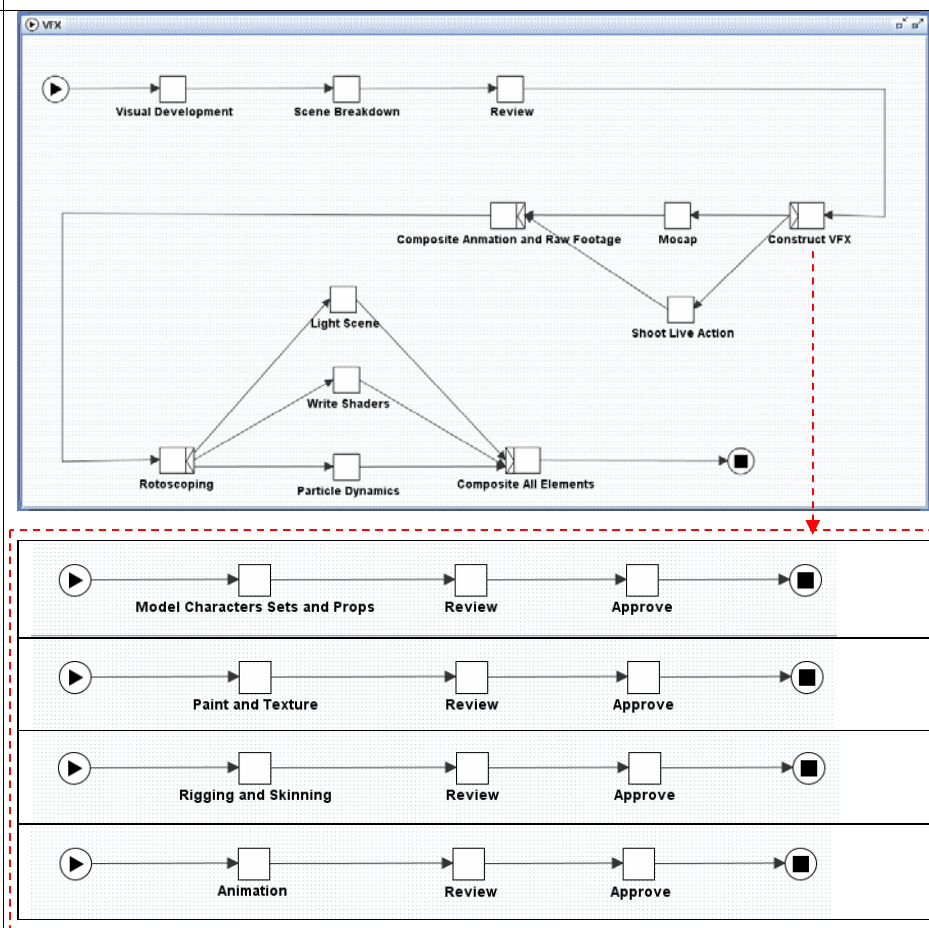
The application of the framework is a first evaluation step since it is retrospectively used to analyse evidence from case studies and literature. Table 3 lists some processes that have differing levels of structure. The first process model (Prepare Film for Edit) has been constructed within the case study with AFTRS. The second process model (Visual Effects Production) is based on current literature on Visual Effects Production and the third example is based on the AFTRS case study again.

<table>
<tr><th>Process</th><th>Model</th></tr>
<tr><td>Prepare Film for Edit

Full Structure, some options that can be catered for by configurability

An introduction to the YAWL notation can be found in (v.d.Aalst & ter Hofstede, 2005).</td><td>
</td></tr>
<tr><td>Visual Effects Production

Structure, many exceptions can occur

An introduction to the YAWL notation can be found in (v.d.Aalst & ter Hofstede, 2005).</td><td>
</td></tr>
</table>

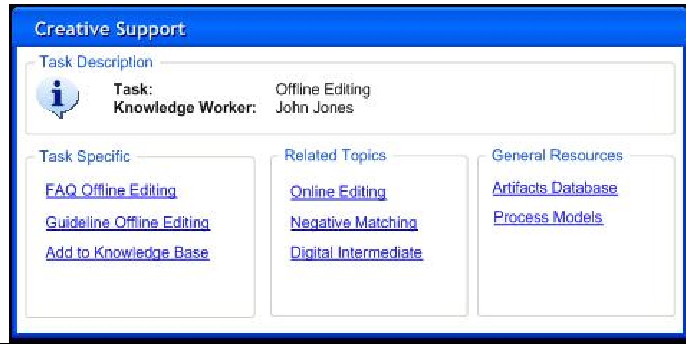
Offline Editing No structure, support through knowledge management and groupware	

Table 3: Exemplary process models

Some processes such as Prepare Film for Edit have a predetermined structure. Visual Effects Production is characterised by many approval steps and possible re-dos. Modelling every possible exception would lead to an unmanageable process model (v.d.Aalst *et al.*, 2005). Consequently, Exception Handling systems (Russel et al., 2004) have been identified as possibly more appropriate means to support knowledge workers. Offline editing is a highly creative task that could be supported by knowledge management systems and groupware to foster communication, but is inherently unstructured, relying more on the editor's sense of aesthetics and imagination.

The *Prepare Film for Edit* process model is an example of a static model. It can be seen that even though this process is relatively simple, there are points in the process where decisions or choices must be made on which branch of the model to execute, based on the conditions of the particular executing instance. That is, any flexibility must be incorporated into the process control flow as explicit conditional branches, so that control flow decisions are mixed with business process logic.

The *Visual Effects Production* process model is an example of a flexible model. Here only the actual business process is modelled. The conditions and associated branches have been defined, not in the control flow, but in an associated rule set, which automatically makes decisions for each case instance, based on its context, and executes the required worklet accordingly (Adams et al., 2006). The task *Construct VFX* utilises the rule set, with its set of associated worklets, to carry out all the necessary work in constructing the visual effect. The rule set for the *Construct VFX* task manages the ordered execution of the worklets, which must be completed in the above order, but with the added complexity that, if the work carried out by any worklet is disapproved, execution may return to *any* of the previous worklets. That is, a disapproval of a later worklet may also result in the disapproval of a previously approved worklet. When all four worklets have been approved, the parent process continues. The Approve task in each worklet works in conjunction with the rule set to determine whether to proceed or re-invoke a previous worklet, and if so, which previous worklet to re-invoke. To model a process such as this statically would require all of that conditional decision making and branching to be explicitly modelled in the process model, which would result in an unnecessarily complicated model when flow logic and business logic are intertwined.

Offline Editing has been identified as highly creative and we do not aim to create an explicit process model. This task can be supported by knowledge management (Nonaka, 1991). Here, we show what an entry point for navigation that is offered to the knowledge worker carrying out the task could look like.

6 CONCLUSION AND OUTLOOK

With this paper we contribute to this field of IS research by introducing a framework for flexible process support based on findings we have made within exploratory case studies and a literature review. At this stage we have identified characteristics of what we call Creativity Intensive Processes.

Based on this we have identified what modelling languages and IT support is available to support processes based on their level of process structure, resource autonomy, creativity intensity and based on whether they are data- or process-driven. We have applied the framework to identify and model different processes from the screen business with different levels of structure and creativity intensity.

This research has the following limitations: First, it is based on a limited number of case studies with organizations from a particular industry. Further research is needed to evaluate the applicability of the framework in other contexts. Particularly, we aim to investigate whether and how our findings can be generalised and transferred to other application areas such as automotive industries, banking or insurance. Creativity and different levels of flexibility can be found in many industries. Although we think that the screen business is a good starting point for this investigation since creativity in this industry is exposed as the key competitive factor. The empirical generalizations that this study is based on will serve as the basis for formulating propositions on the way to develop a theory on Creativity Intensive Processes. Second, we have not targeted the question of whether there should be one method and software to support processes with all levels of structure. Consequently, we will investigate how the creative and highly agile nature of the processes can be considered in extended process modelling techniques.

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