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# Migrating from Process Automation to Process Management Support: a Holistic Approach to Software Engineering applied to Media Production

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**Abstract**— This paper presents the on-going research performed in order to migrate from process automation to process management support in the context of media production and more specifically 3D cinematographic immersive and interactive production. The endeavour has been addressed on the basis of a holistic approach to software engineering applied to media production modelling to ensure design correctness, completeness and effectiveness. The focus of the designed application is on information and metadata management throughout the process in a similar fashion to that achieved in Decision Support Systems (DSS) to facilitate well-grounded business decisions. The paper sets out the aims and objectives and the methodology deployed. The proposed solution is then described in some detail including the workflow to be supported and the experimental scenario as planned. The paper concludes with some preliminary conclusions and sets out the planned future work.

**Index Terms**— workflow, process management, software engineering, media production

## I. INTRODUCTION

In the media industry the production process has always been rather complex and has often required the adoption of reference models and standards to ensure the desired level of quality; for example in the publishing domain ‘The Chicago Manual of Style’ or the ‘Xerox Publishing Standards: A Manual of Style and Design’, or the ‘Web Style Guide, 3rd Edition’.

The appearance of other media such as: cinema, TV, CD, web, etc. has further increased such complexity as well as the number of needed reference standards. An interesting case is a range of manuals known collectively as the Rainbow Books: Red Book (CD Digital Audio), Yellow Book (CD-ROM and CD-ROM XA), Orange Book (CD-R and CD-RW), White Book (Video CD), Blue Book (Enhanced CD, CD+G and CD-Plus), Beige Book (Photo CD), Green Book (CD-i standard), Purple Book (DDCD), Scarlet Book (Super Audio CD), etc. so, although the technical processes have always been modelled and specified, such effort has rarely been applied to the creative process.

In the film and TV industry a number of standards have been developed and applied to the production, projection/broadcasting, storage and distribution of content. The Internet has brought new formats and scenarios (from IPTV to iDTV, etc) well beyond the availability of cable and satellite distribution. In such a complex scenario the usage of workflow is often limited to the automation of tedious or error-prone processes such as the content annotation [15] or the adaptation for delivery to a different device than that originally expected [4][6][8][9].

With the trend towards higher yet affordable computation power and progress in Artificial Intelligence (AI), the number of applications devoted to content processing automation (even in relation to creative aspects such as storytelling, etc) that exploit workflow technology has been constantly growing. Nevertheless, at least as far as content creativity is concerned, the optimisation of the trade-off between efficiency and effectiveness to satisfy a given standard is still an unresolved problem; not least because in the media industry, the result quality and success greatly depends on the “human factor” and its ability to create content having some “artistic value”.

Despite the number of interesting experiments, mostly carried out by “creative directors” and scientists, it is widely accepted that a computer cannot replace a human in respect of creativity [29][13][16][17][18]. In most such cases at the core of the solution there is some sort of an expert-based reasoning system that enables the simulation of some aspects of “human” creativity. In some of the simplest cases a simple workflow management engine has been adopted and extended or enriched to achieve tasks that usually require a certain degree of creativity [4][6][8][9].

In general the perception of decision makers and creative people in the media industry is that technology can only support some specific aspects of the overall workflow within well-defined stages and segments of the overall value-chain provided seamlessly integrated with existing legacy systems and *modus operandi* of actors as routinised within other stages and segments of the value-chain are deemed by sceptics to be impossible to automate or support through DSS. However this work

has set out to demonstrate that certain workflow and decision support when properly matched to the application domain so as to seamlessly harmonise with and thus support the existing creative processes not only can support, but even increases the possibilities offered in terms of process management and decision support.

## II. SCOPE AND OBJECTIVES

In the context of the 2020 3D Media project (dealing with 3D Media Production), as an example of a challenging task we can describe the definition, design, deployment and validation of a collaborative, semantically-enabled workflow system aimed at providing decision support for the production, post-production and distribution in the film industry.

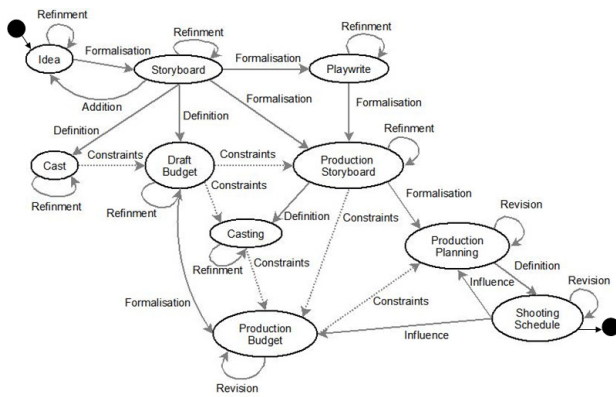


Figure 1. The Film production process from the idea to the shooting

Actually there is a variety of “metadata” that accompanies the output of each stage of the process and not all of it is relevant to all stages that the production will undertake. In Figure 1 there is a simplified graph representing the production of a movie from its initial idea up to the filming process. As is apparent, there are a number of stages with several kinds of transitions and relationships including, but not limited to, constraints. Additionally this representation does not provide any detail on the respective roles and responsibility spaces of the various types of “actor” performing, authorising or monitoring a specific action.

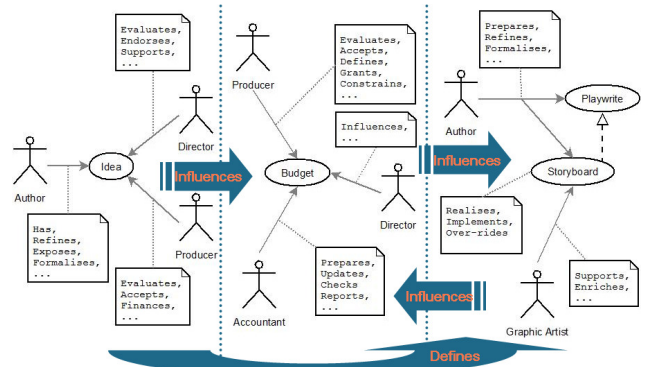


Figure 2. Actors, roles, actions and relations in the initial stages of the Film production process from the idea to the script-writing and storyboarding.

At the same time if we analyse the types and respective

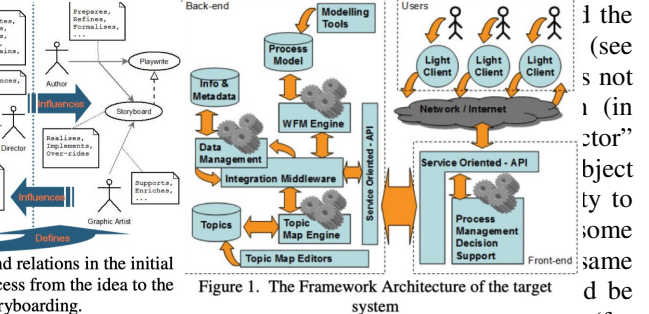


Figure 1. The Framework Architecture of the target system

Figure 1. The Film production process from the idea to the shooting

this lies both the novelty of the proposed approach that aims to encompass the whole process from process automation to process management support, keeping track of all the information which is often lost during the process (from the original sketch of the idea to its formalisation in a draft storyboard, through to the full implementation of the script and the storyboard). While it is a fact that media production is moving from the analogue to the digital era; from time-to-time the scanning of the analogue source into digital format is still needed when the original source is not digital and much accompanying information (script, storyboard, etc.) is still in the analogue format thus making data loss more of a threat than a remote possibility.

It has to be taken into account that in the present context characterised by hectic timing and high level of pressure, the loss of even a single item of information in certain passages of the (post-)production may lead to subsequent problems in the management of the generated asset or cause useless repeat-work and additional costs.

represented by different “actors” in the process (for example Mel Gibson is the producer, director and writer of *Apocalypse*; director, and leading actor in *Brave Heart*). This is why another layer of information is needed to fully contextualise all steps and aspects of the process and situate it in its proper relationship; such an additional layer has also to take into account the semantics of the given domain in order to properly resolve and disambiguate input received so as to provide the relevant, appropriate and consistent response. The deployment of Topic Map technology additionally enables arbitrary conditional Points-of-Inspection (PoI), [6] to be set such as these will be legacy-workflow-agnostic and as such facilitate coordinative monitoring and progression of work in the context of collaborative multi-factory production and distribution.

## III. METHODOLOGY

To achieve the proposed aim and objectives it is necessary to ground the analysis on the knowledge of

state-of-practice and state-of-the art in the related domains as well as market and technology trends and entity, process, and actor lifecycles analysis [7]. This will lead to the identification of the reference models and methods to be used in the definition of the framework to be implemented and the related supportive tools. A subsequent phase will comprise a set of interviews with key-stakeholders in the expected application domain to further refine and restrict the set of reference methods and supportive tools (mostly in respect to the usage-contexts to be supported) to a minimum number yet retaining the maximum flexibility.

Once this initial phase is completed and the framework architecture is defined, associated specifications will be drawn up using formal descriptions and standardised methods and guidelines (including but not limited to UML and MIL). During this phase a number of relevant key-stakeholders will be periodically contacted to review the progress and helped to keep all the activities in focus.

Specifications will be initially drafted and then kept constantly updated during development, as we intend within an evolutionary system design and development methodology implemented as a spiral rapidly iterative prototype-and-evaluate process. This will make it possible to quickly finalise the development of a first prototype to be used in the experimental phase to be subsequently refined and finalised in due course. Also the experimental phase will be structured in cycles as it is expected that usage will lead to a revision and refinement of what is achieved following comments, remarks, suggestions from involved stakeholders as well as functional / logic bug-spotting.

Results of the process will then be analysed against those expected and collected evaluation metrics (as defined in the initial phase) will be analysed both in terms of absolute value and trends exposed during the overall process. Accordingly after several iterations, the resulting system is expected to meet the user-specified needs to an acceptable level thus allowing some significant level of take-up by the practitioners in the sectorial value-chain.

#### IV. THE PROPOSED SOLUTION

##### A. A high-level architecture view

To overcome the challenges involved in designing, developing and deploying a collaborative workflow support in the 3D film production domain, the authors have started by modelling the underlying semantics. The target system framework architecture (see Figure 1) has been derived taking into account the results of the Domain Knowledge analysis, together with observations made through interviews with practitioners, results of the research into state-of-the-art for modelling and supporting the workflow logic in cinema and television production [32][33][24][25].

We have started the testing of two open-source workflow engines (namely YAWL, and, jBPM which is a dominant workflow systems as deployed in the sector) to measure their efficiency and suitability as a core

component of the back-end system. To ensure the richest possible semantic representation of the domain processes knowledge so as to help create more expressive semantic models of the domain and thereby save the above-mentioned lack of contextualisation of the domain processes and relationships it was decided to adopt Topic Maps (ISO/IEC 13250) as a semantic standard that would offer a high level of flexibility and richness of representation.

It is not intended nor expected to develop specific modelling tools or editors to be used to serve the back-end processes; although it is planned to develop a specific integration middleware that will interact with the workflow engine, the Topic Map engine and the data management component.

The arrows in Figure 1 represent the information and metadata flow in the system. Such a flow will be kept separate from the related management information flow. This will be one of the responsibilities of the integration layer and of the service-oriented API that will have to be deployed.

Given the specific aim of the system to provide process management support in a context characterised by a variety of actors and inter-connected systems (not all necessarily belonging to a unique entity) we envisage a front-end that will embed the business logic relying on the models and information provided by the integrated back-end. This component will also expose a specific service-oriented API both towards the back-end and the clients (that have to be realised as light clients and inter-connected with the system via networking).

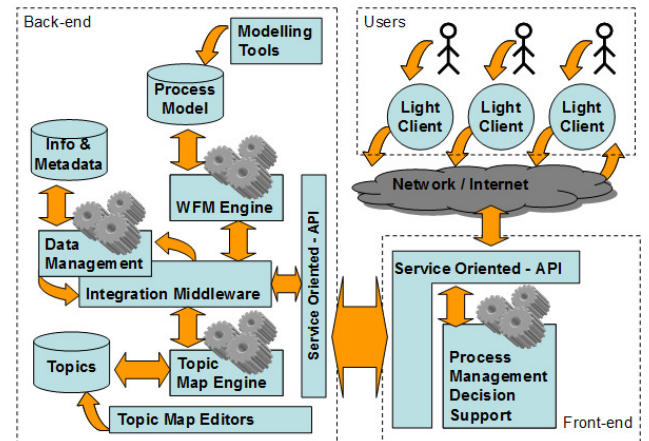


Figure 1. The Framework Architecture of the target system

Topics are anything yes but typically actors, objects, story elements, processes/tasks, goals, resources, subjects etc and all their scoping, associational, roles and responsibility relationships etc. Such an approach makes it possible to achieve a high level of re-usability while at the same time ensuring a high level of specialisation of models and data structures used for the monitoring and control of the system. In essence the system will exploit a set of hierarchical models and data structures. The logical workflow will be described using a (fully) connected graph approach in which conditions and

constraints can be applied both to nodes and arcs. For example the action that takes data from a specific node to another will be flagged as “internal” or “external” depending on the relationship existing between the actor performing it and the entity requesting it (i.e. if the actor belongs to the requesting entity then the action is “internal”, otherwise it is “external”). This is a significant distinction since in reality an external action implies a contract with a pre-requisite of an SLA; which has to be in place before the contract can be placed. Additional constraints such as these require the activation of specific sub-processes and may involve several actors spread over several decisional levels, having a number of relationships with other actors and actions that may even establish indirect consequences. An example of this could be if the person that has to take care of the contract / SLA is already busy sorting out other activities, this unexpected additional load, may cause a backlog and either result in a delayed completion of this request or in the delayed completion of other requests, or both, with consequences that may vary significantly depending on which action is delayed.

In some cases an action that is normally internal may have to be outsourced and performed externally for a number of possible reasons e.g. the unavailability, or overloadedness, of the required resources, the need for a higher level of quality than that achievable internally or as a consequence of a specific request of the producer or a major stakeholder. Also in this case even if the higher level stage in the process flow may not be changing in the next cycle (i.e. even if the next stage is still within the same process as the previous one), there may be changes in the lower level processes (at least for the node where an outsourced action is to be completed). In such a context, the workflow for the internal node(s) i.e. for the “internal” operation will have to be replaced “on-the-fly” with the one of the service-providers; additionally the flags of the arcs connecting the node will have to be toggled and additional information/metadata will have to be collected (including regular feedback from the service-provider).

All this should be accomplished without the need to re-model the system. This will be realised by the fact that the adopted model for the action has been designed so as to accommodate both cases and has flags that allow toggling of the usage-context from one case to the other, on-the-fly, thanks to the topic-map-based management support that allows the filtering/aggregation of information in a very effective and efficient manner irrespective of the object under examination. Table 4 below shows a typical analysis base for a digital media production workflow.

The Activity				The Roles involved	
Idea (1)	Storyboard drafting (2)			Author Writer Script editor Art director Director Producer Production accountant	
Cost estimation (3)				Producer Production accountant	
Go/No Go decision (4)				Producer	
Title design (5)	Storyboard finalising (5.1) Script drafting (5.2) Casting preparation (5.3)	Cost estimation refinement (7)	Negotiation, Acquisition, Distribution & sale IPRA® Contracts management (16)	Author Script editor Producer Director Casting director Art director	
Design & preparation (6)	Casting (6.1) Scripting (6.2) Lighting drafting (6.3) Shooting plan drafting (6.4) Effects drafting (6.5) Costumes drafting (6.6) Sound track drafting (6.7) Contracts finalising (6.8)			Costume designer Makeup designer Composer Audio Engineer Graphic designer Special effect designer Fight arranger Lighting cameramen Production assistant Location manager Art director Director Casting director Producer Production lawyer Production accountant	
Production (8)	Setting up scenes (8.1) Lighting management (8.2) Audio management (8.3) Shooting (8.4) Daily rushes (8.5) Storyboard revision (8.6) Shooting plan revision (8.7) Costing revision (8.8) Call list revision (8.9) Local effects and stunting management (8.10)	Cost control (12)			
Post Production (9)	Mounting (9.1) Sound editing (9.2) Special effects (9.3) Dubbing (9.4) Packaging (9.5)			Censorship approval (10)	
Marketing (11)				Marketing manager	
Distribution & rights selling (13)				Marketing manager Production accountant	

Figure 4. The analysed workflow.

It is worth re-iterating that in this system the object of the monitoring and management is exclusively the information and meta-data used and generated during the process. This implies that the system will have to be able to interact (essentially receive) data from various sources and has to be able to analyse and interpret them. Besides this, the system needs to be scalable so as to accommodate different loads over time depending on the number of productions monitored in parallel, the production stages monitored for each monitored production, the number of actors and models involved and the number of information/metadata sources as well as the size of the received data.

These requirements point to a Service-Oriented and Model-Driven Architecture (SOA-MDA) as the basis of the development of the target system; in which components are distributed and interact possibly using services well-established over TCP/IP so to allow a distributed environment regardless of the physical arrangement.

## B. The experimental scenario

Each shooting method has its own characteristics and could be used to produce a compelling user experience; 3D methods open new opportunities in this perspective. The validation and field verification of the target workflow management system will take place in the context of real small-scale 3D interactive productions.

It has been considered necessary to start from the analysis of the mechanisms that make a film successful and attractive in order to address all aspects of the (post-)production and distribution scenario for 3D production. These would be the criteria, as deployed, by practitioners such as film producers and their patrons, that are considered in determining a feasible scenario for a small-scale real 3D interactive production to be completed with the support of the developed system. In this respect it is



worth taking into account that to achieve a minute of movie time it may be necessary to shoot over a hundred minutes which in turn may have required several days of preparation and planning; thus even a small-scale production, if well-conceived, will involve the similar preparatory stages and resource types as needed for planning and producing a large movie.

In more detail it has been decided to exploit one of most relevant characteristics of 3D as the starting point for the identification of a suitable scenario. Undoubtedly one of the most striking characteristics of 3D production is the illusion it gives the viewer of being able to actually interact with the objects. At the same time in the well-established 2D production it is a common feature to create a wave of emotion that should hold the audience and retain their attention. Such an effect is built over time and seamlessly drawn into the delivery so as not to be perceived as natural. For example in Alfred Hitchcock's "Psycho", "Vertigo", "The Birds"; Mel Brooks's "High Anxiety"; Sergio Leone's "The Good, the Bad and the Ugly", Robert Zemeckis's "Back to the Future Part III", Blake Edwards's "The Party", and Fellini's "Amarcord", to stress an emotionally intense situation, pauses are used in the narration leading to a heightened perceived suspense in the audience.

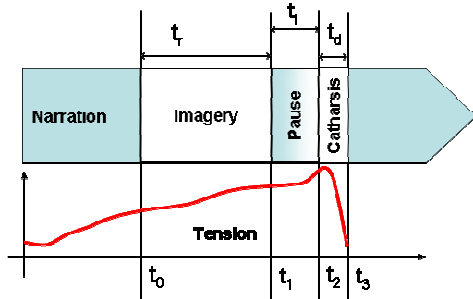


Figure 5. The tension curve within a narration sequence.

At a time ( $t_0$ ) a specific imagery process would be induced in the audience by the narration; this effect would rise over time ( $t_r$ ) thanks to the narration which then enters as a sort of pause (at  $t_1$ ) – essentially a period of time where the action is apparently frozen – for a number of seconds ( $t_i$ ), just before the catharsis takes place (at  $t_2$ ) and there is a tension drop-time ( $t_d$ ) which leads to a return to a normal level of tension (at  $t_3$ ) and to the start of a new narration cycle as depicted in Figure 5.

While this holds true in most cases and especially in action or thriller movies, in others the same approach has been used to achieve a different result. For example in Mel Brooks's "High Anxiety" the effects that in Alfred Hitchcock's "Psycho" and "Vertigo" are used to create pathos, have been exploited to trigger a comic effect in place of the original thriller one; as similar timing observations apply to various stages of a joke scene setting that may raise certain expectations or a sense of some threat and the final punch line that delivers the relief by way of a precisely timed surprise.

The analysis of some such passages brought to light the possibility of exploiting the above-mentioned communication strategy and filmic grammar component to achieve a certain degree of interactivity in the plot

evolution (even although this means having a multiple-plot storyboard and more complex production and post-production phases along with some specific way to get users' feedback / reaction / emotion detection).

In more detail it has been assumed that at ( $t_0$ ) a specific imagery process takes place in the audience's mind under the suggestion of the overall narration as per the one proposed by sequences  $K, K+1$  ( $t_r$ ) to be followed by a virtual pause staring at  $t_1$  and closing at  $t_2$ . During this period of time (where the action is apparently frozen for  $t_i$  just before the catharsis takes place) it will be possible to detect the audience mood (averaged probably) and decide which moment to introduce the climax and thus the related catharsis to be reached at  $t_3$  via the related set of sequences ( $K+2x$ ).

Figure 6 shows a partial sequence description from the storyboard being developed (introductory part) and the sequence structure.

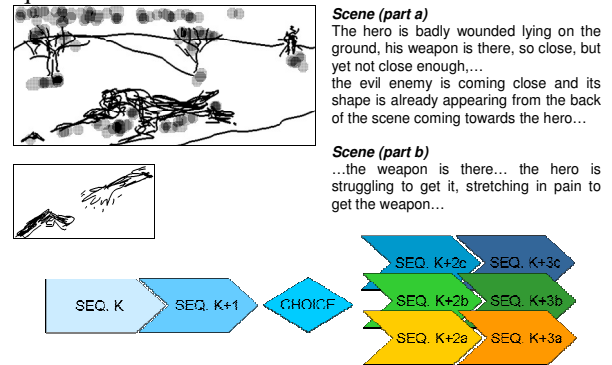


Figure 6. A partial sequence description from the storyboard being developed (introductory part) and the sequence structure.

## V. FUTURE WORK

The development is currently in the second analysis phase of the domain specific state-of-the-art as well as a literature survey performed in parallel to the Software Requirements Engineering activity based on the UI-REF framework [7] to classify, resolve and prioritise requirements. The analysis of the process, its layers, involved actors, actions, triggers and relations is also being performed to model the system appropriately and further refine the initial draft architecture. Once this second phase is complete a first implementation will be drafted exploiting either YAWL or jBPM and Topic Maps.

The workflow management system and the Topic Map management engine will be progressively integrated thanks to a purposely developed middleware that will also allow the connection to the data management system. Models for the various entities to be managed will be progressively edited, validated and stored, starting with the most relevant and enabling one then progressing towards the optional ones. In a similar fashion every model will be iteratively refined and adjusted in response to field verification that will take place in the context of real small-scale 3D interactive productions.

## VI. CONCLUSIONS

In the context of media production, as in many other industrial or business contexts, the term workflow is associated with the automation of tedious, repetitive, potentially error-prone activities. Thus the vast majority of products available on the market aim at the simplification and automation of certain processes in the value chain and provide solutions that are usually part of tools used during specific stages of the overall “production” chain. The followed approach is very often to embed the workflow management directly in the tool hiding it from the user.

There are very few examples of workflow management tools specifically devoted to the media or movie industry with the specific aim of facilitating the process management; one such example is YAWL4Film developed by the Business Process Management (BPM) Group at the Queensland University of Technology (QUT) based on YAWL which presently addresses the automated support to some of the most re-utilised activities of the “production” part of the chain in filming and media production etc.).

Thus the proposed system will enable a significant advance in the current state-of-the-art of process management support in the media production environment. The expected result will exploit a holistic approach to software and system engineering in the design and development of a system that will integrate a workflow management system with a Topic Map engine to provide the back-end for a process management decision support front-end implementing the needed business logic. The system will essentially act like a DSS but in the context of process rather than business management.

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