Institute of Architecture of Application Systems

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Abstract. Film making is in many aspects a very complex business represented by highly non-trivial business processes in which multiple organizational units are involved. Whereas in regular manufacturing and paper factories like insurance companies there is an increasing adoption of information technology (IT) and especially business process management (BPM) technology, there is little adoption of information technology solutions in managing the collaborative aspects of film making. In this article, we elaborate on the process dimension and, in particular, we focus on processes of costume management in film making. We describe the key roles related to costume management in the film business which are used as swim lanes in the BPMN rendering of the process models. A draft of the major document structures currently used in costume management in film making is presented. We discuss candidate artifacts and tasks which are most feasible for support through information technology. The process models presented here are based on experiences collected in several medium-sized German film making projects, and therefore reflect a culture-specific way of work which is not necessarily the same as in films made in Hollywood productions.

Keywords: Film Making, Costume Design, Business Process Management.

1 Introduction

In order to lay the foundation for further research on process automation in film making, we need to be aware of the business processes that are carried out. In film making, we can distinguish between the development phase, the pre-production phase, the production phase, and the post-production phase [12]. Each of these phases has a large variety of participating roles. For example, in the production phase there are departments associated with the director, producer, camera, hair and make-up, grip, light, sound, special effects, catering, and the wardrobe. These departments can be further refined into sub-departments and corresponding roles. The wardrobe department, on which we focus in this work, can be split into the costume designer, costume designer assistants, and dressers.

A film's value is made up of three major influencing factors: Star value, production value, and story value [6]. These factors have a significant influence on the cost of a film. From an economic point of view, there is a strong need to reduce the cost of film making in order to achieve the most possible production value with the lowest possible production costs. In manufacturing industry, paper factories, and service companies, there is an increasing adoption of business process management (BPM) technology in order to make the performance of business operation more efficient. However, there is little adoption of such advanced solutions in the film business. There is a broad palette of advanced tool support for each specialist domain like 3D animation [15], sound effects [16], cutting [19] etc., but there is no integrated solution that joins, synchronizes and manages the work performed in the different departments and their collaboration in a BPM manner.

In Hollywood productions, the average film costs are about $60 million, plus another $20 million for marketing costs [17]. The typical setup of films in medium-sized German productions is significantly smaller, having average film costs between €2 million and €5 million, representing almost "no budget" in terms of Hollywood productions [18]. However, we argue that despite this monetary difference there is a large potential in cost saving in any "film making culture", achievable through more process automation, and process optimization or reengineering in the corresponding collaborative work.

As an initial contribution towards providing advanced information technology support in this field, we elaborate on process automation of costume design and costume usage to create an awareness of the business processes and their interrelations in terms of choreographies. We combined our experience in medium-sized German productions with our experience in application architecture and process design and improvement. As a result of this collaboration, we present in this article the business processes of one department mainly working in the pre-production and production phase, namely the wardrobe department. As we show in the following sections, the processes in this department are not trivial, revealing the overall complexity of providing efficient IT support in film making in general.

The rest of this article is structured as follows: In Section 2 we introduce the key roles involved in costume management. In Section 3 we present the business processes describing the process dimension of costume management. Section 4 focuses on the data dimension. Therein, the different document structures are described from a domain-specific point of view. Section 5 describes work related to IT support for costume management as well as initial approaches on applying business process technology in this field. In Section 6, we conclude the article in discussing how different aspects could be supported through advanced IT solutions.

2 Roles of Costume Management

Nowadays, film making is in many aspects a very complex business process in which multiple organizational units are involved. Figure 1 shows the major roles included in film making to illustrate the complexity. As depicted in this figure, the roles are organized in specialized departments. In the figure, each department is represented by the name of the department, the head of the department, and the subordinate roles. For example, the producer is the head of the production department, which is formed by the production manager, the production coordinator etc. Depending on the size and the complexity of the production, the number of departments being involved and the number of people the department is composed of can vary.

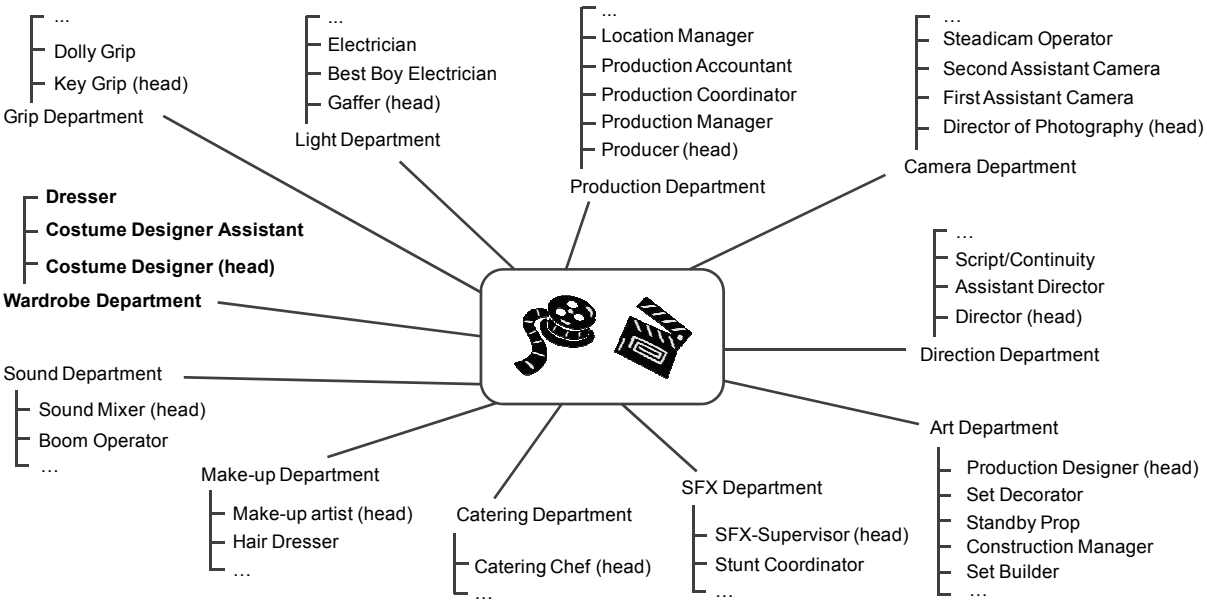

Fig. 1. Roles in film making in the production phase (excerpt). Roles related to the wardrobe are highlighted in bold type.

On top of the film production hierarchy stands the producer as head of the production department. The producer is the person who has the money to turn a specific idea into a film. Next to the producer, who is in charge of the fiscal decisions, is the director as head of the direction department. He is responsible for most of the creative decisions, e.g. the overall visual style of the film, the actors' performances and the choice of costumes the leading lady should wear in a specific scene.

While the producer and the director need to keep track of the production as a whole, the other departments are dedicated to small individual fields of film making. They are, for example, responsible for the camera, the props, the decorations, the light, the sound, the make-up, or the costumes. As shown in Figure 1, each of these departments is organized under a head of department. There is the director of photography for the camera department, the gaffer for the light department, or the costume designer for the wardrobe department. During several meetings with all departments, every little detail of a film has to be discussed to avoid, for instance, one dress in the same color as the wallpaper, or big microphones which have to be hidden under a small see-through silk dress. Every department is divided into smaller individual responsibilities, such as first assistant camera, who is responsible for pulling the focus, or second assistant camera, who acts as the film-loader and the clapper. With respect to the costume design and usage that is performed in the wardrobe department, we can distinguish three key roles which we describe in the following.

The *Costume Designer* has the duty to make sure that the right clothes are delivered to the right people at the right time, which means organizing the clothes in the pre-production phase, working the clothes to camera in the production phase, and returning the clothes at the wrap in post-production [8]. This role comprises a creative and an organizing aspect. The creative aspect mainly drives the development of the costumes to be used in a film. The film script provides the costume designer with guidance information like facts related to the historical setting of the film or the characteristics of the roles in the film. The organizing aspect is performing budget calculations, personnel planning of the costume department, as well as costume lending, buying, and ordering their manufacturing etc.

The *Costume Designer Assistants* take over some responsibilities to alleviate the costume designer's workload like performing investigation tasks for detailed analysis of historical costumes, costume stereotypes, and applicable color concepts. In supporting the costume designer, the assistants help organizing the department as well as assist in lending, buying, and ordering the costumes. Furthermore, they assist in fitting the actors and dressing the extras (which means "Komparsen" in German film terminology) at the set. While the costume designer basically works set-independent, the dressers mainly stay at the set. The costume designer assistants have the task to join these two up by bringing the costumes and the information needed to one and another.

The *Dressers* are responsible for the costumes at the set. They prepare the costumes for usage, dress the actors before a shoot, undress the actors when the shoot is done, and coordinate costume cleaning, repairing, changing, and aging. Aging means giving character to a piece of costume by making a new garment look worn and real by bleaching, over-dyeing, and getting them dirty and torn. For keeping track of the costumes, the dressers are working on a document called "set book" which contains practical wearing details of the costumes in action.

The skills discussed above reflect the main duties of the roles and may differ to a certain degree according to the persons involved or the film production. For example, an eccentric director will have thorough impact on costumes, and a committed costume designer might do adaptations of costumes and quality assurance directly at the set. Since there is nearly no defined job training for these assignments, most of the people working on costumes join the wardrobe department from areas of work related to fashion like fashion designers, tailors, cutters, or dressmakers. Most careers in the wardrobe department start with becoming a dresser, in order to learn the basic work with the costumes and the actors at the set. When being selected by a costume designer to become a costume designer assistant, one learns all the tasks a costume designer has to know. However, since every film is unique in its requirements and conditions, all three roles need to adapt their skills constantly.

Besides, there are also cultural differences in the distinction of these roles – the roles and processes presented in this article are based on job experience in German film making and therefore reflect a culture-specific way of dealing with the tasks of film making. For example, the wardrobe department in large Hollywood productions is differently structured containing a few more roles like a costume supervisor to organize the department and a key set dresser, who has to organize the various other dressers.

3 Processes of Costume Management

The processes for a complete film production are exceedingly complex, ranging from the phases of development, pre-production, production, and post-production. As an initial step to tackle the complexity of film making through information technology, we investigated the processes of costume management and their relations to other departments. The business processes of costume management are mostly carried out by the costume designer, assistants, and the dressers. We modeled several processes and sub-processes to increase modularity and to ease understanding. The way of process design is based on our best-practice in the field of BPM, practical modeling experiences from practice, and literature study. All processes have been modeled using the Business Process Model and Notation standard (BPMN) [1]. Currently, most of the tasks are performed manually with little aid of advanced IT solutions. Further, current software products and solutions to support the wardrobe department in particular and the coordination of the work across the different departments in general do not make use of advanced technology available in today's enterprises, such as business process technology. Where applicable we indicate the usage of software tools by showing icons for user tasks. For example, budget planning is often made with a stand-alone application for project planning, but there are no unified exchange formats and no well-defined processes to allow a seamless coordination and management of the overall choreography of all process participants involved in costume management.

3.1 Processes Overview

The processes for costume management start at the production department initiating the work of the wardrobe department, consisting of the costume designer, assistants, and dressers. After negotiations with the production department, the costume designer starts drafting the different costumes to be used in the film. Refinements to these drafts are made considering budget restrictions (see Section 3.2, costume planning). The details of the planning of costumes have been captured in a sub-process (see Section 3.3, costume management). After the costumes are ready for shooting, the dressers can prepare their usage (see Section 3.4, dressing preparation). The daily management process describes the dressers' day-to-day work (see Section 3.5). The actual process of using each costume on the set has been modeled as a sub-process (discussed in Section 3.6). The process of cleaning the costumes (see Section 3.7) is invoked in this sub-process.

The processes are modeled on a high level of abstraction – for many tasks several refinements could be made, although they are not explicitly marked as collapsed sub-processes. For example, the task "Create Budget Plan" in the costume planning process usually consists of several decisions to be made and sub-tasks to be performed. Furthermore, in between the coarse-grained tasks modeled in the processes, many fine-granular steps may need to be performed on a per case basis. For instance, when fitting a costume for an actor some ad-hoc changes in documents and the processes might be required. We considered this level of abstraction as adequate for supporting a basic comprehension of the domain. For the development of an IT solution, however, these subtleties have to be considered, too.

3.2 Costume Planning Process

The process depicted in Figure 2 describes the different tasks that need to be performed by the costume designer for the planning of the costumes of a film. The basic interactions of the process designer with other roles are described in the following. At first, the costume designer receives the script of the film by the producer. The script contains a prose description of the roles, the setting, the different scenes, and further details about the film which provide the costume designer with guidance on costume planning. The costume designer checks the script in order to assess if the film fits with his/ her professional interests, requirements, and capability.

When the script is accepted, the costume designer creates a script breakdown out of the script. The script breakdown reduces the script to the information that is needed for managing costumes. This includes for instance the time when the film is playing, the roles, doubles, damages to costumes etc. In addition, information is added that stems from interpretation of the script and creative work of the costume designer in developing the costume dimension of the film.

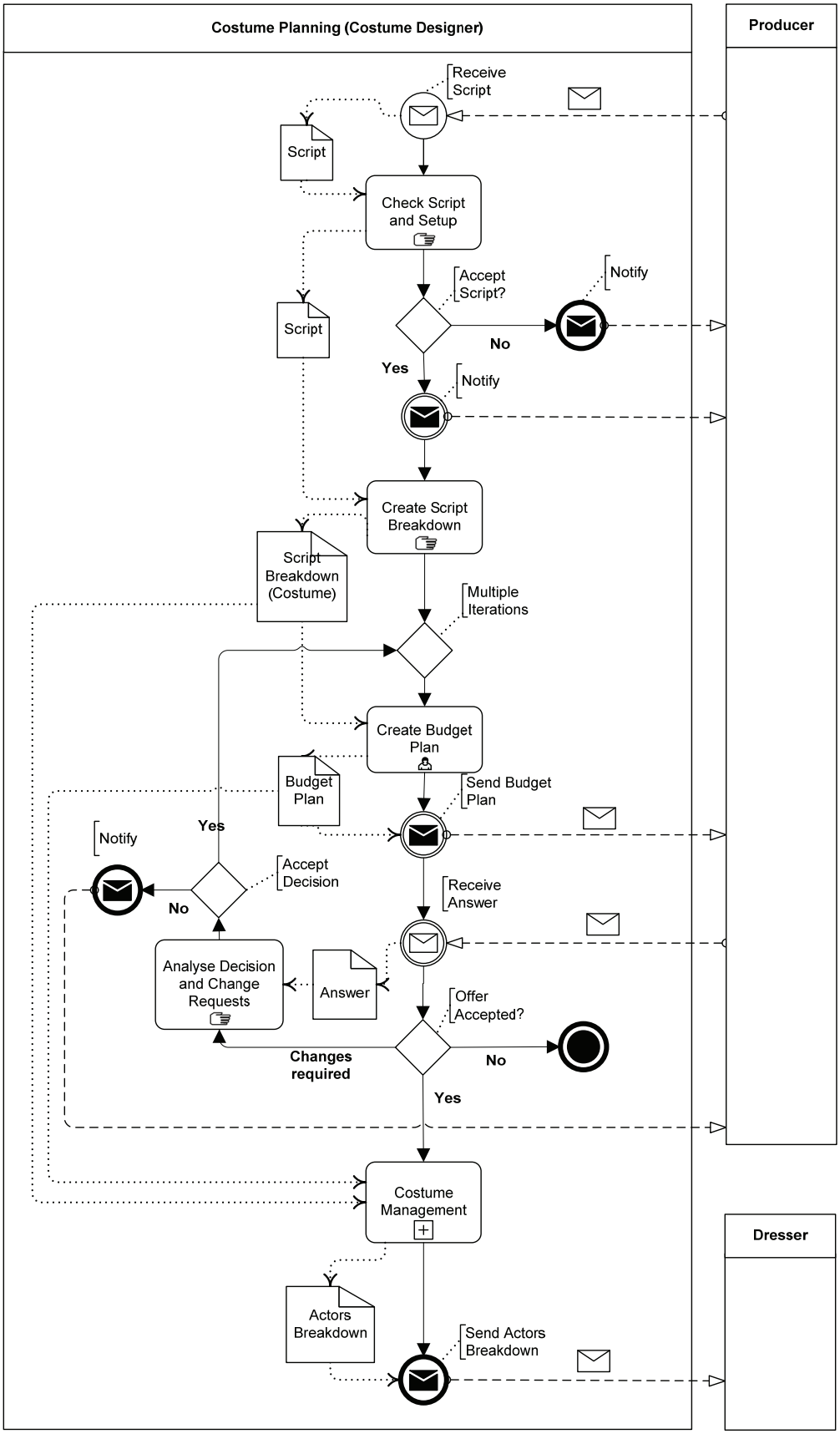

Fig. 2. Business process describing the different steps to be performed in costume planning.

The script breakdown is then used for budget planning providing a complete list of conceptual costume sketches and estimated prizes. The budget planning has to consider all the costumes needed for the shoot, the comfort clothing like warming jackets and crew requirements like sun hats, as well as some clothes for the extras. Further expenses include all the direct labor costs of the assistants, dressers, and depending on the size of the project, a truck person, an aging person, dyer, cutter, stitcher, a laundry person, or tailors. Department overhead costs include workroom set-ups, trucks, tents, all supplies like racks, hangers, safety pins, steamer, steam iron, and sewing machines. Research costs for books and copies etc. also apply here.

This budget plan is negotiated with the producer and possibly refined or changed multiple times according to the change requests by the producer (depicted in the process). It is being adapted during several meeting with the director and the heads of the other departments (mostly ad-hoc and thus not modeled in the process), e.g. when discussing the color concepts and the overall look of the film. The budget plan and the script breakdown are the major inputs for the costume management sub-process which is started after the negotiation with the producer. This sub-process produces the concrete costume concepts and organizes their procurement. The costume concepts as well as the real costumes are sent to the dresser who is responsible for the costume management at the set.

3.3 Costume Management Sub-Process

The process model shown in Figure 3 is the centerpiece of costume creation. Based on the budget plan, the script breakdown, and background knowledge the costume designer creates a costume breakdown. This document contains a list of all costumes to be used in the film. A costume is described in terms of a textual description, a visual sketch, its constituent parts, and first ideas how it should be worn. The respective task "Create Costume Breakdown" is marked as a manual, ad-hoc sub-process. The way this creative task is carried out strongly varies from one costume designer to another. Therefore, it is not modeled in greater detail here.

The costume breakdown resulting from this creative work is passed to the investigation task which refines the costume drafts according to historical information, concrete actors playing in the film, background information about the director etc. The assistants of the costume designer carry out many of the work-intensive parts of investigation. The refined costume breakdown serves as a list for the subsequent tasks which deal with ordering, buying, lending, or manufacturing the costumes. When a costume is available at hand, it needs to be fitted to a concrete actor. The assistants support the costume designer in organizing and performing the fitting of the costume. The director needs to approve the costume and provides further requirements or change requests after having seen the photos taken during the fittings. From this point on, the concepts of costumes have materialized and concrete costumes are being managed. The costumes breakdown is the document used by the costume designer. For the dresser, this format is translated into an actors breakdown, which changes from costume-orientation to actor-orientation.

Alongside the costume management tasks, the department of the costume designer itself needs to be organized. This includes hiring of the people needed for the department operation considering the complexity of the film production, production of costumes, and their adaptation and fitting. As a large film production may contain up to thousands of costumes, department organization and staff scheduling is a critical issue. The shooting schedule provided by the production department is an aid in planning in order to know which costume has to be ready for action at which certain time. Additionally, materials and machinery, rooms, and supplies need to be organized in a cost-efficient manner. These tasks can be further refined to sub-processes, as they all follow a particular order of processing. They are not described in more detail here. Currently, the department organization is mostly ad-hoc and manually performed.

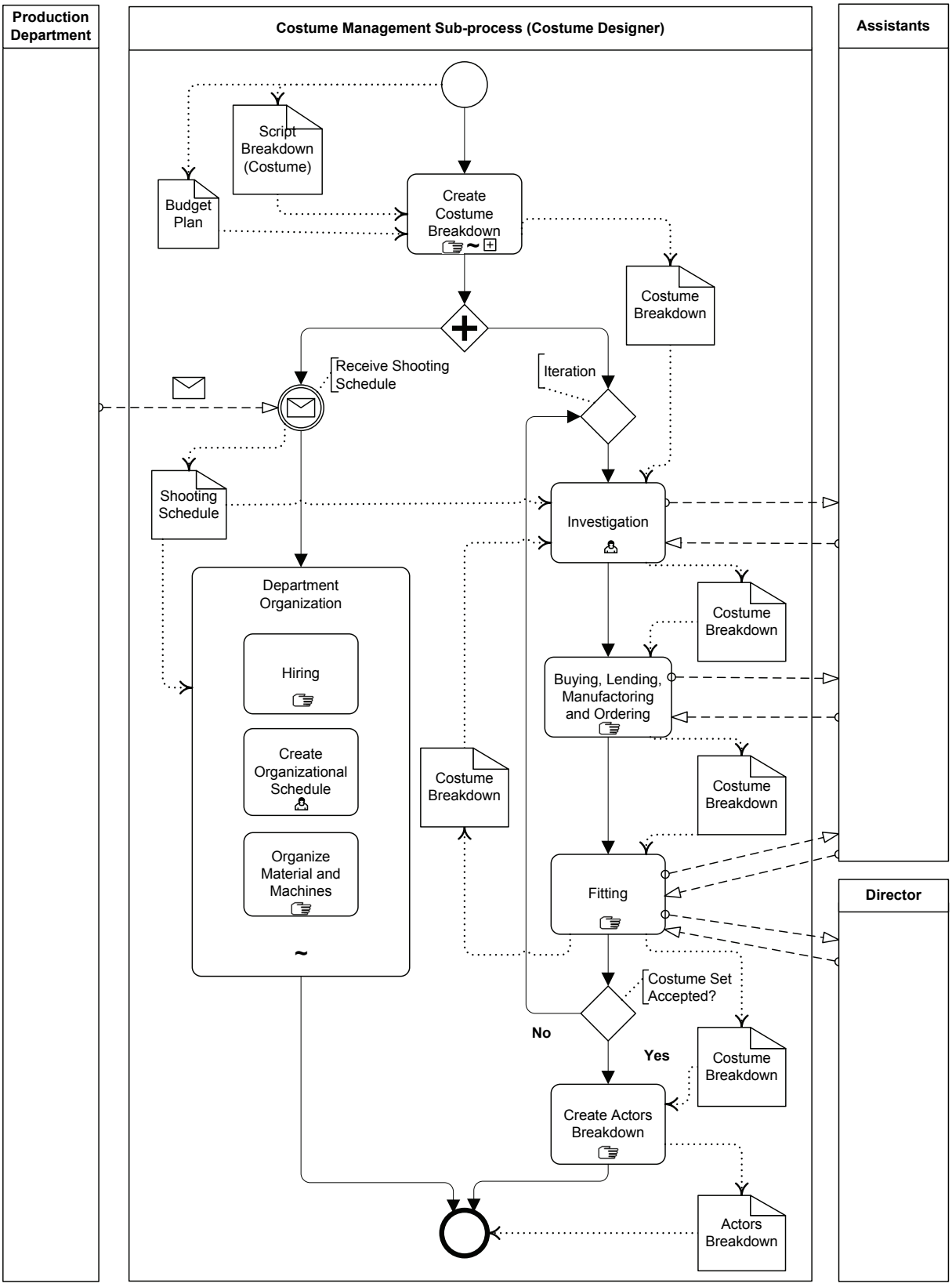

Fig. 3. Sub-process describing the management of costumes

3.4 Dressing Preparation Process

The dressers' work begins mostly a week before shootings start, while the costume designer has started already a few months beforehand, depending on the size and complexity of the film production. The dressing preparation process shown in Figure 4 shows the final phase of work in the pre-production phase. The dresser receives the script from the producer and creates an own script breakdown which contains the information relevant for dressing the actors like the time a watch must show (which is usually different from the real time of day), or if the actor gets wet or dirty. The actors breakdown is sent by the costume designer when ready, along with the concrete costumes for the film. These documents are used for the creation of a set book, which can be seen as a diary of costumes in which all information related to the costumes and wearing details is conserved. There is just one set book that all dressers are sharing, the set book is a real document and therefore meant as global variable across all the processes.

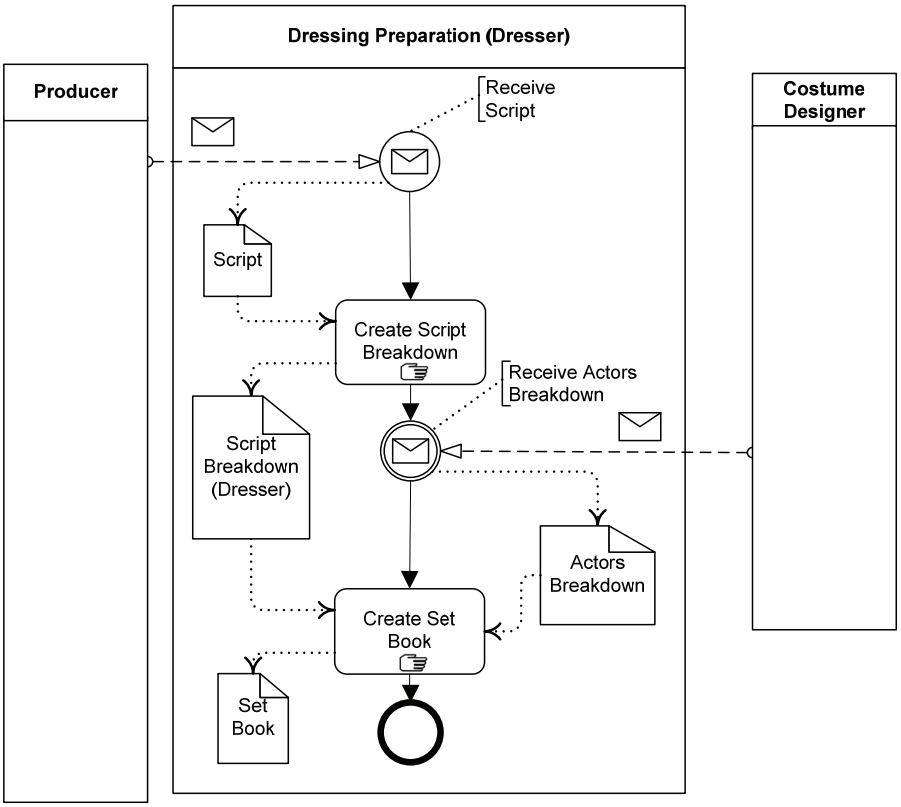

Fig. 4. Dressing Preparation Process.

3.5 Dressing Daily Management Process

On each day at the set, the dressers receive a daily call sheet by the production coordinator, see Figure 5. The production coordinator is responsible for coordinating the overall choreography of the different departments involved in film making in the production phase. The daily call sheet is an actor-oriented time schedule which is used for time planning of all departments. With respect to the dressers, the daily call sheet reveals information like when to prepare particular costumes, how much time is planned to dress or change the actor, and when to make which actor ready for action. At first, the dresser has to check the scheduling in the daily call sheet and report problems to the production coordinator for rescheduling. The daily call sheet and the set book are the main drivers of the daily work of the dresser at the set. We reflect the daily routine that has to be followed for each costume usage using a sub-process ("Costume Usage") with a "forEach" marker.

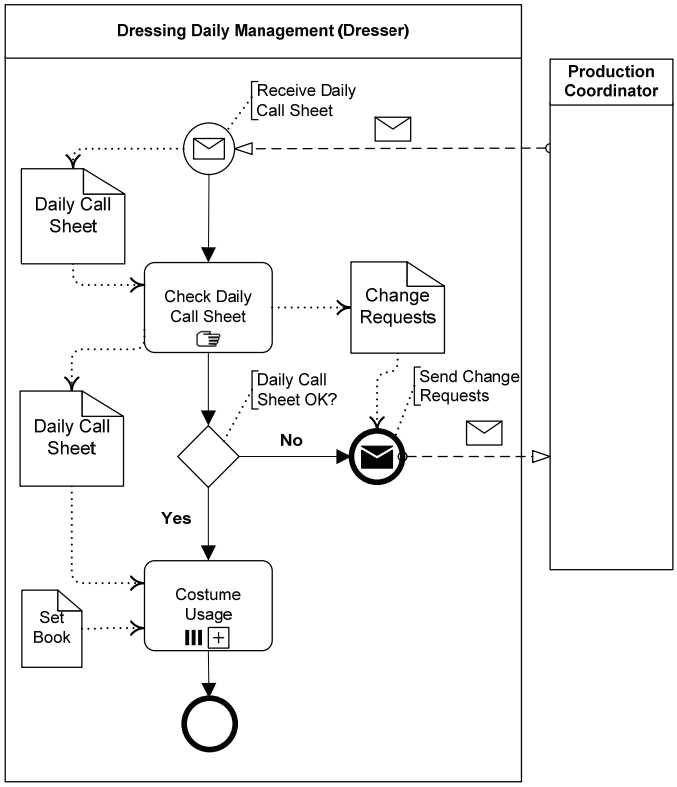

Fig. 5. Dressing Daily Management Process.

3.6 Costume Usage Process

The process depicted in Figure 6 is carried out for each costume usage in the film production. This means that for each actor, each day, and possibly each scene several tasks have to be performed. The process is beginning with fetching all the costumes needed that day from the costume storage room, checking if everything is alright with the costumes, and getting them organized in the dressing rooms. This means to lay everything out neatly in the right order like putting the tie around the collar, the cufflinks in the shirt, the belt in the pants, or the socks on top of the shoes so that the actor can quickly put them on and does not need think about it. In addition, corresponding support clothing for an actor needs to be prepared. For example, a dressed actor may need to be covered in a warm coat or provided with an umbrella, a hat, or gloves due to weather circumstances. All these clothes have to be prepared to be taken to the set. In the process, these steps are reflected as one collapsed, manual sub-process.

When the actor arrives at the set, he is being dressed – whereas it depends on the actor and the type of clothes he is supposed to wear, if he needs help or prefers privacy. After being dressed and taken to the shooting location, the director as well as the costume designer often check the first take of every costume and provide change requests. After the rehearsals and before every take starts, the dressers have to check again if the actors are ready for action. This means they have to make sure that the right buttons are closed, the collar is in the right position and nothing got dirty while waiting for action. The process continues when the actor is ready, which is usually defined by the daily call sheet. Working at the set is rather dynamic due to weather circumstances, the (un)availability of particular actors on short notice, or the daily mood of the director. Therefore, changes to this schedule may occur. These dynamics are not explicitly modeled in the process.

After the first take of a scene is shot, a picture of the actor is taken and put into the set book as connection photo. This is required because some scenes, which may appear within the final film directly one after another, are filmed in reality at completely different times. Thus, it can be assured that the actors – and costumes – still look the same. This also includes taking notes about wearing details of parts of the costumes. For example, a note might document that a sleeve is rolled up, the coat is worn opened or closed, or at which spots the clothes got wet.

When the location manager gives the signal that all takes of a scene have been completed the actor is being undressed or changed and the costume is being cleaned. The costume cleaning is modeled as another process, invoked after undressing the actor (kick-off and forget).

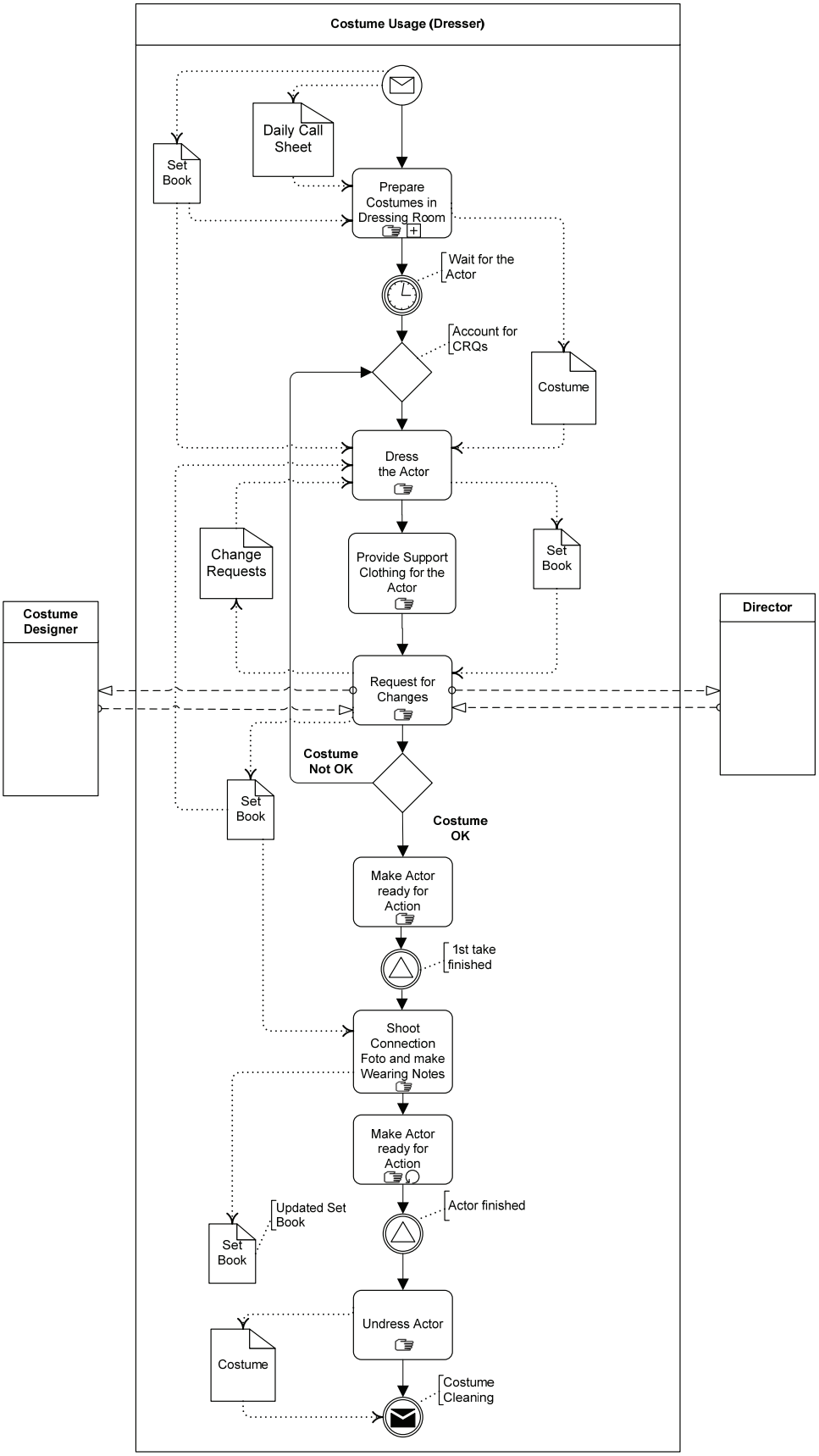

Fig. 6. Costume Usage Process.

3.7 Costume Cleaning Process

After the usage of a costume in action, the costume has to be cleaned and prepared for later usage on other days. The process model shown in Figure 7 illustrates the costume cleaning tasks to be performed. At first, the costume is checked for damage and dirt. Accordingly, the costume is cleaned and/ or repaired. The order in which cleaning and repairing is made depends on the particular costume and its state of aging. After cleaning, the costume is labeled with the name of the actor, the costume number, or the size. This label is pinned with a safety pin to the sleeve and sorted back to the other costumes, ready for further use in action.

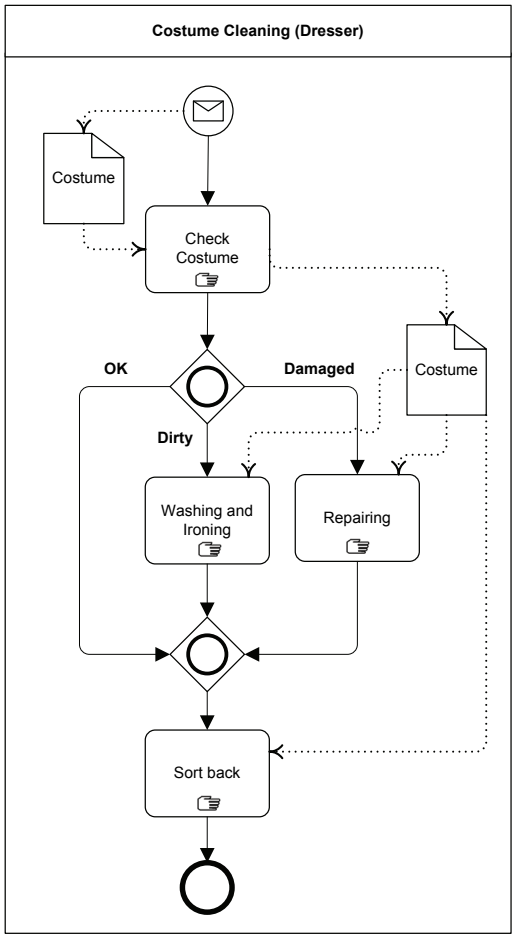

Fig. 7. Costume Cleaning Process.

4 Document Structures of Costume Management

The processes described in Section 3 have shown that many documents are created and exchanged in the course of a film production. Figure 8 depicts a document-centric and abstract view on the management of costumes, revealing the major documents and their relations. The main document of every film is the script, discussed in Section 4.1. In this section we also explain the graphical notation used to describe the document structures. The script is distributed to the different departments involved in the film, among them the wardrobe department. Starting from a script, various excerpts are created through the extraction of relevant information and extension through interpretation, background knowledge, and personal experience. The production coordinator creates a script breakdown for production (see Section 4.2), which is used to estimate details of the shootings. The result of this estimation is the shooting schedule (shown in Section 4.3). This schedule is taken as a basis to create a daily call sheet for each day (see Section 4.4), indicating the detailed planning which is a source of information for many other departments, including the wardrobe.

Regarding the wardrobe department, information related to costumes is extracted from the script. This information is documented in the script breakdown for costumes (see Section 4.5), containing a temporary planning of the costumes to be used in the film. Based on this draft, costs of costumes like manufacturing, lending, personnel costs etc. are estimated and described in a budget plan (Section 4.6). Then, the final set of costumes can be created, being described in the costume breakdown (Section 4.7). In contrast to the costume designer who is working in a more scene-oriented manner, the dressers work in a more actor-oriented manner. Thus, a new version of the costume breakdown needs to be created, containing almost the same information, but a different structure (see actors breakdown, Section 4.8). This document and a script breakdown containing notes relevant for the dressers (see Section 4.9) are then merged into one document, the set book. This document (see Section 4.10) is used for costume management by all dressers on the set.

The document structures we describe in this section reflect the as-is state we experienced in medium-sized German film productions. Currently, the exchange of information between the different roles is mainly paper-based, which results in many shortcomings. Information is often redundant, and distributed on different papers and copies thereof, circulating through the involved departments. This makes later changes in the script hard to manage and inconsistencies may occur. Furthermore, a lot of manual work is required to create the different documents. Advanced automation and support through information systems, e.g. through database-views on a shared information source, are little supported. The document structures we describe consist of properties which are simple, complex, or lists. For some of the simple properties, the data types could be clearly defined, e.g. enumeration, date, integer. For most of them, however, plain text applies.

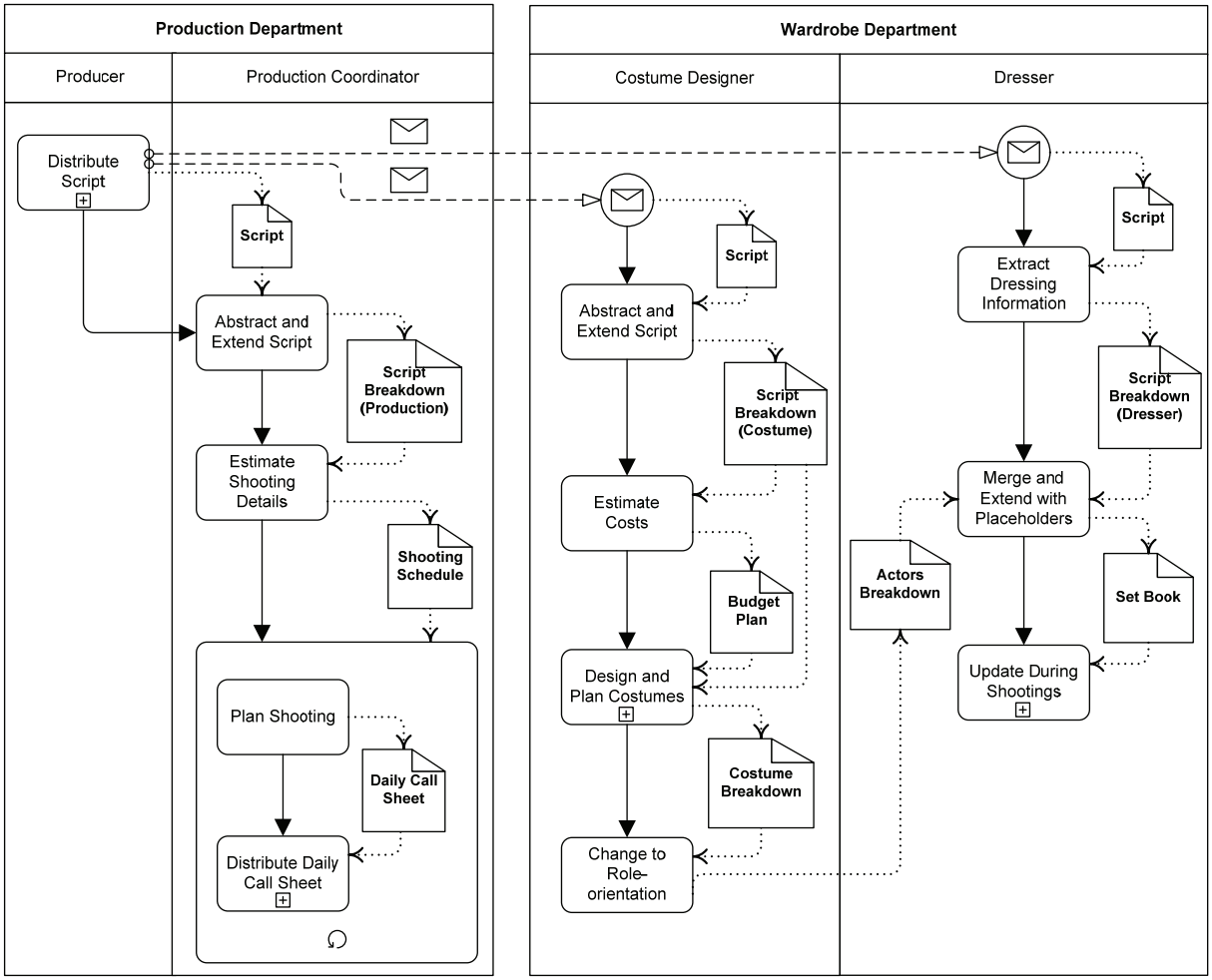

Fig. 8. Document-centric and abstract view on the management of costumes in films.

4.1 Script

The script, also called screenplay, narrates the story of the film and becomes the basis for all further documents. It contains information about gender, age and profession of the characters (main cast) and extras (background stereotypes) presented in the story. It also provides the costume department with first ideas how these characters or extras are supposed to look like. In addition to the information about the characters, the script gives first orientation about the period the story takes place (story time), how many days are shown (story day), or the locations supposed to appear in the film. Also, there is first technical information given like the type of connection between the scenes. To avoid mistakes during a non-chronological shoot it is important to know whether the connection between the scenes is a direct, indirect, or time jump one. After receiving the script, every department transforms the information required for the special duties of this department into their own script breakdowns.

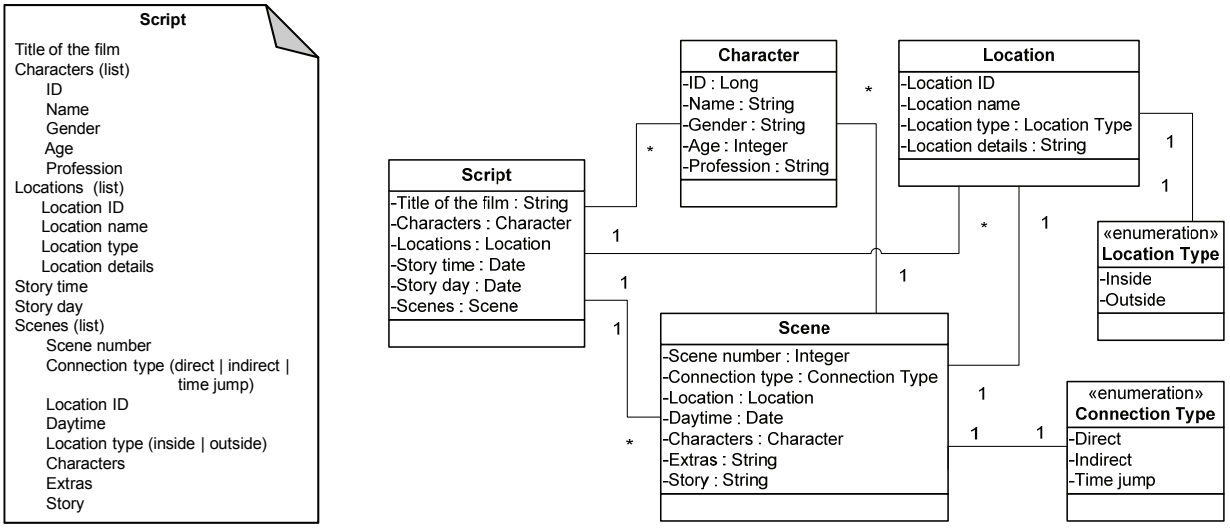

Fig. 9. Document structure of a script from a domain perspective (left) and from an IT perspective (right).

Figure 9 shows the document structure of the script from a domain perspective in a non-normative notation (left). The right side reveals the entities of the script from an IT perspective, described using UML (right). Due to limitations of space and to ease readability, in the rest of the section the document structures are only shown from the domain perspective. To obtain a UML diagram out of these document descriptions, the document structure can be transformed into a UML class diagram. Simple properties are translated to class attributes with corresponding data types, if known. For example, the Title of the film is represented as an attribute of type String, contained in the Script class. Simple type properties are translated to enumerations like the Location Type of a scene. Complex type properties like Character are translated into classes. Lists of complex type properties like the list of characters are reflected in 1..* relationships.

In order to indicate changes from one document to another, the respective properties that have been added to obtain that document are highlighted in bold type. For example, the script breakdown from the production department (see Section 4.2, Figure 10) contains the name of the producer, in contrast to the original script (see Figure 9) which does not include this property.

4.2 Script Breakdown (Production)

Despite of all the different formats of script breakdown they all have comparable sets of information. The script breakdowns of the production (see Figure 10) and the breakdown of the wardrobe department (described in Section 4.5) capture each scene in the script and isolate what is necessary about the scene, the location, and the characters. In order to abstract from non-relevant information every scene gets summarized in a scene synopsis which provides the reader with a brief interpretation of the story line.

The script breakdown of the production department contains all information relevant for making a realistic shooting schedule, such as a list of all scenes and characters or the assumed duration of the scenes in the total film (time of scene). The script breakdown of the wardrobe department, in contrast, tries to isolate the individual changes for each actor to discover the amounts and types of costumes needed.

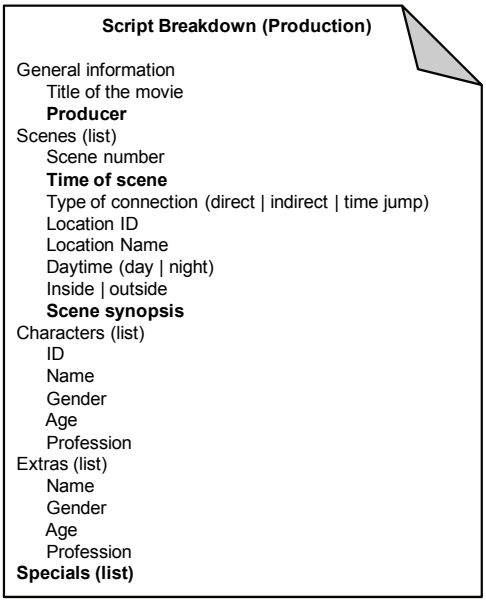

Fig. 10. Document structure of a script breakdown (production) from a domain perspective.

4.3 Shooting Schedule

Based on the script breakdown of the production department, the production coordinator who is responsible for most of the paperwork of a film production creates a shooting schedule. The shooting schedule (see Figure 11) provides the crew with a temporary plan answering the questions when, where and what will take place during the shoot.

The shooting schedule constitutes the base for organizing the pre-production and the production phase. Frequent adaptations of this schedule are required to account for particular conditions like weather circumstances, local laws, special restrictions in some countries, delays of delivery, or medical leave. Due to the shooting schedule everyone gets first information about the expected locations the shoot should take place, if there is a second unit planed (which means having two shooting areas at the same time), and which days are estimated for shooting or travelling. This general information contained in the shooting schedule becomes modified or confirmed in the daily call sheet.

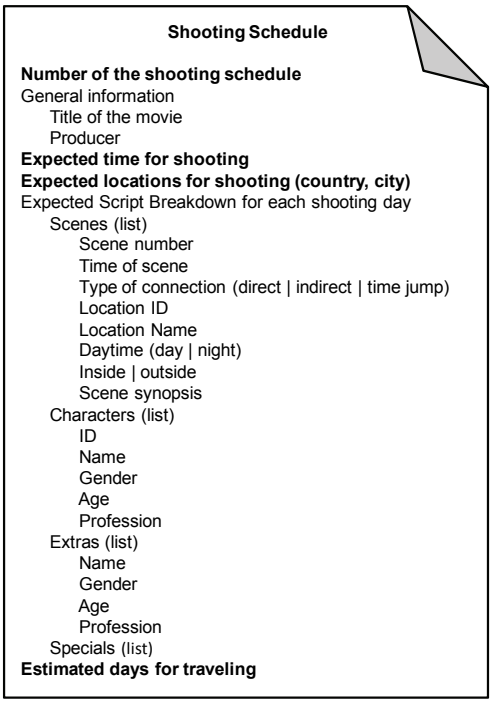

Fig. 11. Document structure of a shooting schedule from a domain perspective.

4.4 Daily Call Sheet

While the shooting schedule is an overall plan of the total production phase, the daily call sheet (see Figure 12) contains all information needed for one shooting day. Is serves as a to-do list for every person in the crew and organizes who has to be where and what is being filmed. The daily call sheet is not personalized, but gives the whole crew the same information to enable everyone to work together at the best. The mailing list on top of the daily call sheet shows all people being involved in the shoot of this day. The first section of the daily call sheet contains overall information of the production like addresses and telephone numbers, the location address, weather forecast (important for being properly dressed), or time of sunrise and sunset (important for the light situation). The next section provides the crew with a timetable. It announces at which time every department is expected to be at the set, when the rehearsal and the shoot is supposed to start and at which time lunch is planned. This is followed by the script breakdowns (production) information for the scenes planned that shooting day. A second timetable section is included for the actors in particular. The last two sections contain the location information like the parking circumstances for all departments (especially the trucks) and where to get power and water for the washing machines (electrical connection). Another timetable schedules the pick-up and delivery times for the drivers.

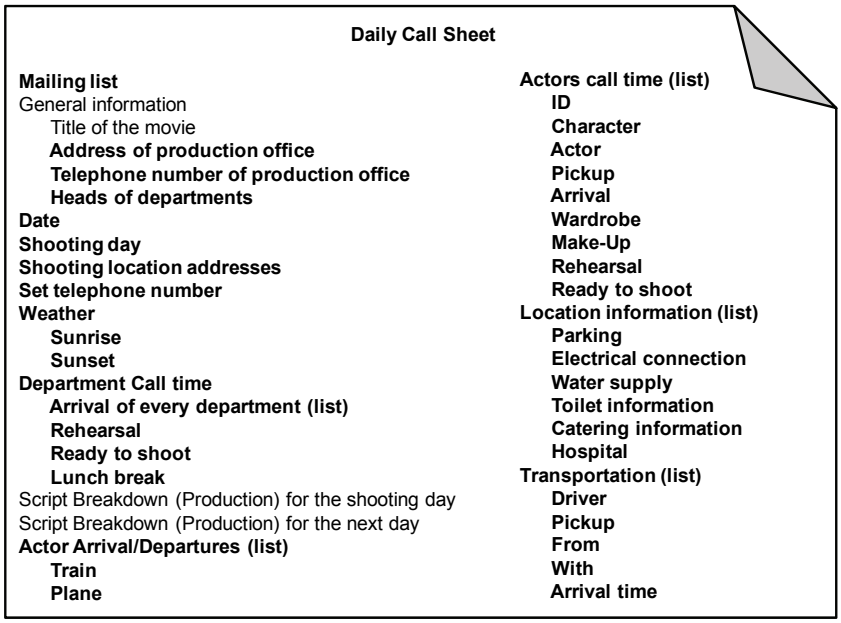

Fig. 12. Document structure of a daily call sheet from a domain perspective.

4.5 Script Breakdown (Costume)

While the shooting schedule and the daily call sheet are documents that affect the whole crew, the script breakdown of the wardrobe department (depicted in Figure 13) is specialized with focus on costume demands. The script breakdown isolates what is relevant about each scene like:

- The time of the day (Which time should the watches show on screen?)
- Dangerous actions (Is there a double necessary who needs a second set of costumes?)
- Changing conditions of the costumes (Does the costume gets wet, dirty, torn or burned? Is the costume required in different aging conditions? How many sets of this costume are needed?)

The costume designer and the costume designer assistant create the basic document for the wardrobe department. It is the foundation for the budget plan and the costume breakdown. While the costume designer and the costume designer assistants create the script breakdowns based on the script, they extend the given information with a first temporary description of the costumes. These fist ideas have to be verified and modified during the costume management process.

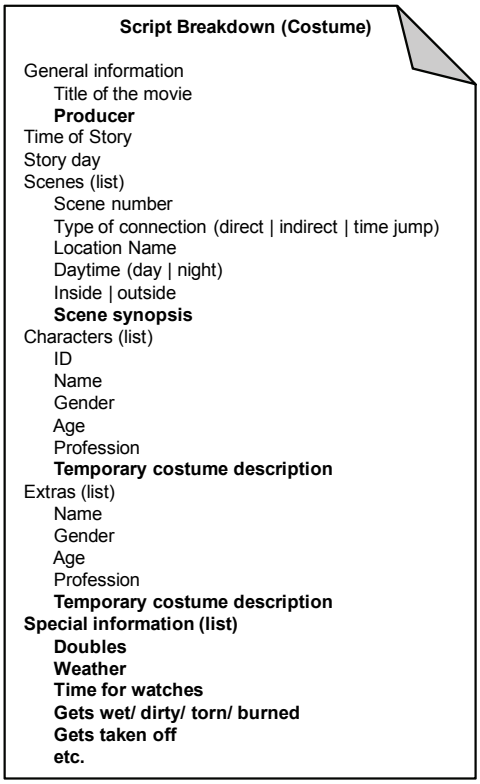

Fig. 13. Document structure of a script breakdown (costume) from a domain perspective.

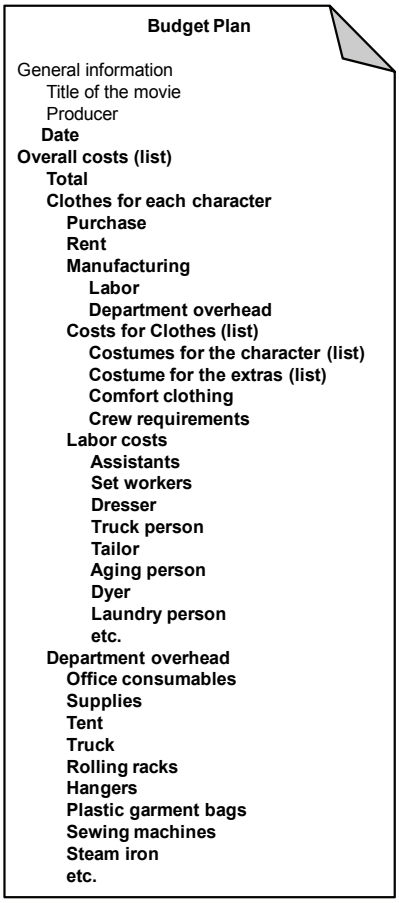

Fig. 14. Document structure of a budget plan from a domain perspective.

4.6 Budget Plan

The budget plan is made by the costume designer and contains all costs caused by the wardrobe department. This plan (see Figure 14) includes all the costs for the clothes, the labor, and the department supplies needed. In order to create this plan, the costume designer basically uses the script breakdown (costume) and the shooting schedule to answer questions like the following:

- How many people are needed to acquire the clothes?
- What has to be done with the clothes so that they look authentic?
- Is there a dyer or an aging person needed, who has the skills to give the clothes a new look by changing the color or making them look old and worn?
- What are the conditions at the location – are there any fitting rooms or is it necessary to order some tents to get the extras dressed?
- Are there some trucks or hangers required to transport the costumes to the locations?

Here the costume designer has to list every cost the costume department causes from the office paper up the underwear of the actors.

4.7 Costume Breakdown and Costume

The costume breakdown is an extended version of the script breakdown, which no longer contains the temporary costume descriptions of the script breakdowns, but a final list of costumes (see Figure 15). Since a costume is a complex combination of different constituents, each of them has to be described very precisely. The costume designer's task to create these complex combinations of trousers or skirts, t-shirt or blouse, a watch or other jewelry has a strong impact on the visual style of a film and on the characters' charisma [14]. Therefore it has to

be done thoughtfully. This includes not only the section of the constituent parts that make up the costume but also the way it is going to be worn. While a shirt that is worn buttoned up and combined with a tie looks more like the dress of a businessman, a shirt without a tie and a few buttons left open is rather linked to a man enjoying his spare time. Therefore, the costume designer has to extend the description of the constituents and their properties like type, color, or material with notes (wearing notes), photos, or sketches to define the specific ideas of how the costume is going to be used in the film. This information can then be passed to the dressers at the set.

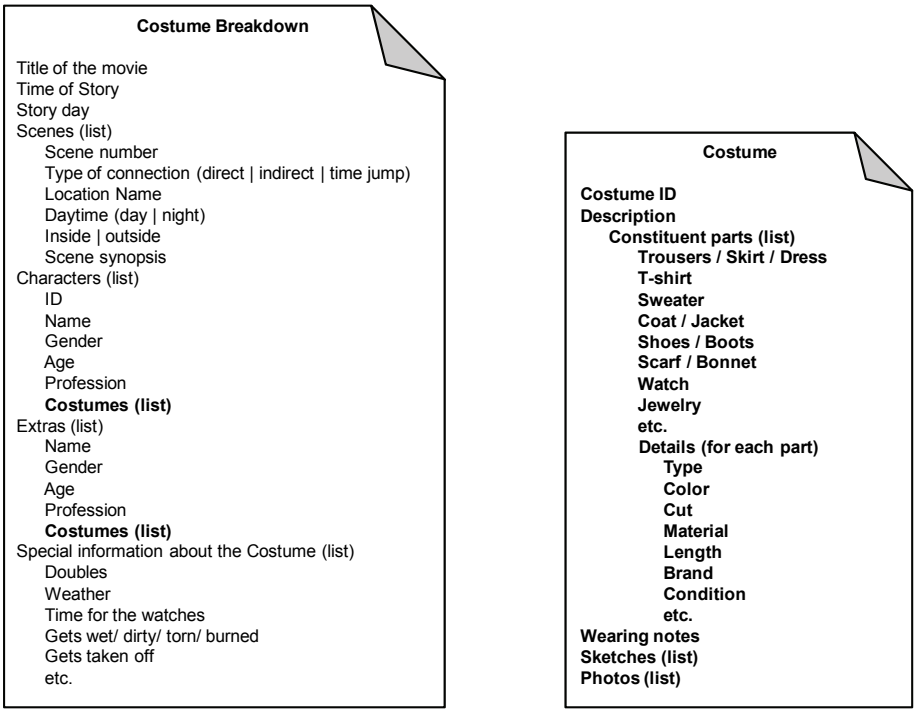

Fig. 15. Document structure of a costume breakdown (left) and costume (right) from a domain perspective.

4.8 Actors Breakdown

Before a set book can be created, the costume breakdown gets converted into the actors breakdown. The actors breakdown is no longer scene-oriented but provides an actor-oriented view. The only information that is added compared to the costume breakdown is the name of the actors playing the character in the film.

4.9 Script Breakdown (Dresser)

The script breakdowns created by the dressers are very much the same as the script breakdown (costume) the costume designer and the assistant create. The only difference is that they only isolate needed information without adding any creative costume designing. The script breakdowns made by the dressers function as the final check to avoid that important information about the costumes is neglected.

4.10 Set Book

The dressers create the set book out of the actors breakdown. This means that they make a new version (on paper) in which specific spaces are available to add the connection photo(s) and wearing notes while being at the set. The connection photos and wearing notes are essential to assure that the actors – and costumes – still look the same although they are filmed in reality at completely different times. The set book with all information about the composition, the look, and the wearing of the costumes has to be given to the production department after all the shootings have been finished. It may be required afterwards in case there are any later shoots necessary, following films to be produces, or lawyer requests to be answered.

5 Related Work

In this section, we discuss work related to business process automation in film making with particular focus on costume management. Firstly, we present software products currently used for managing the wardrobe department (Section 5.1). Then, we discuss different approaches coming from the BPM research community on supporting film making through business process technologies (Section 5.2). The section concludes with a presentation of recent contributions regarding the automated production of customized clothes (Section 5.3).

5.1 Software for Managing the Wardrobe Department

In order to increase the number of possible customers, the software vendors targeting the management of costumes do not limit their tools on film making in particular, but support costume management in general, also considering theatre and television productions. The available offerings mainly provide functionality for the documentation, inventory, and administration of costumes. Typically, costumes are treated as atomic units, disregarding the composition of the constituent parts. For example, ProFundus [5] is a modular inventory system for managing costumes, stage props, and other aspects of theatre, film, and television productions. With more focus on film making, actorsBreakdown [4] provides management software tailored for costume designers. It allows administering costumes, planning budget, and automatically creating role excerpts. CPlotPro [3] is an information system for running and budget planning of a wardrobe department. It provides report generation functionality suitable for printing, which is often required due to the lack of overall integration of the different systems and departments in the film business.

To the best of our knowledge, not all aspects of the work in the wardrobe department are currently covered by software. For instance, the investigation task for refining the costume drafts according to background information is typically based on time-, cost-, and resource-consuming analysis of tables and data sets in Microsoft Excel [23] and Microsoft Access [24]. Besides, there is no integrated, service-based marketplace for ordering, buying, lending, or manufacturing of costumes at present.

5.2 Business Process Technologies in Film Making

Several promising approaches have been proposed on leveraging business process technologies for more efficient work in the film business. Workflows, i.e. the technical implementations of business processes, are envisioned to enable efficient automation in the film business. In [2] Ouyang et al. discuss Yawl4Film, an information system based on the workflow language YAWL. The centerpiece of the system is a single workflow describing a film production process. The workflow, consisting of about 25 activities, describes the operative aspects of film making based on the daily call sheet. When a shooting day begins, a call sheet is generated and distributed to sound, camera, continuity, and assistant director. Information can be viewed and entered using a Web-based interface. Reporting functionality for printed call sheets is also covered. The system has been evaluated in two short film production, confirming significant time and cost saving compared to productions without workflow support. In [21], the challenges for deploying Yawl4Film in a high-budget film production setup are discussed. The main challenges discussed are (i) parallelism and collaboration of different shooting units scattered over different locations and (ii) increased demand on flexibility of the workflows for film production. Although the Yalw4Film process for film production coordination is rather simple, Yawl4Film clearly shows that business process technology applies well in the film business to increase efficiency.

In [12] Seidel et al. argue, that global competition forces the film business to combine their focus – creativity and flexibility – with sound business principles. As an initial step to bring process automation to the screen business, a business process reference model is proposed. The model is based on review of literature and case studies with a film and television school, a visual effects production company and a producer of TV commercials and animation films. The work shows an excerpt of the post-production process, indicating that all phases of a film production are inherently complex. Seidel et al. discovered that the film business is a very creative business and therefore rigid process models do no fit. As a consequence, in [13] the concept of “pockets of creativity” is proposed, indicating that the outcome of certain creative tasks is not known in advance. Some constraints may be imposed on these pockets to steer the creativity into the right direction. In fact, creativity is also a very important aspect in the management of costumes. Particular parts of costume-related processes may be structured and can be

performed always in the same way. However, multiple parts are rather dynamic, ad-hoc, and creative. For automation, these parts need to be treated differently. Pockets of creativity are one approach that may be applied for this.

Service-oriented Architecture (SOA) is one architectural style that has been proven as feasible in the automation of business processes in recent years. In [9], van der Weken et al. present a service-based infrastructure which implements several integration processes in a media production environment. The main use cases considered in this work are the transfer of media items between different departments, the automated validation of media formats, and human task management related to media items. In order to integrate the different departments involved in a film production, an infrastructure for secure transfer of large data is indeed volatile. The work presented in [9] can be seen as a source of experience for this aspect.

In summary, several approaches have indicated that the application of business process technology in film making is beneficial. They have also shown that the film business is inherently complex and that processes for their automated coordination need to be very flexible. In related work processes of different departments have been investigated. Our article contributes to these achievements through the documentation of processes, role descriptions and detailed document structures related to costume management.

5.3 Automated Production of Customized Clothes

The design of a costume comprises multiple phases. Starting from an idea of a costume, the costume designer draws some sketches of the costume. For the constituent parts of the costume that need to be manufactured, patterns need to be created that serve as template for cutting. For the creation of these patterns, typically computer-aided design (CAD) systems are employed. In this domain, significant progress has been made in recent years on automated customization of pre-defined patterns for mass production systems. With the approach of mass customization, clothes can be customized to fit particular customers while making use of mass production facilities. This approach is very relevant to support costume manufacturing for film productions, as the costumes need to be customized to fit particular actors and they should be acquired as cheap as possible. In [20], recent advances in this domain are discussed. The work compares the advances of 3D pattern systems with 2D pattern systems. The advantages of 3D patterns lie in visual simulation of clothes before they are actually produced. The study points out, that the so-called “virtual fit” is still in its infancy, but advances are currently being made. J.-M. Lu et al. discuss in [11] a computer-aided system used in production for mass customization in fashion. The advances over the state of the art include different ways to collect body dimensions out of 3D body scanners or 2D pictures. Based on the collected measures, a concretization of parameterized patterns is being performed. The patterns are then sent to automated laser-cutting machines. The subsequent production steps like sewing, fitting and adjustment are still manual. In the film business there is yet little usage of such advanced automated production systems.

6 Towards Advanced IT Support for Costume Management in Film Making

In this section, we discuss the major aspects to be considered for providing advanced support of costume management in film making through information technology. At first, the section covers a short-term outlook on the next steps required to provide a basis for integrated costume management (Section 6.1). However, in order to provide advanced IT support for costume management in film making, the work that still needs to be done is much more. The key questions are, what capabilities a workflow system must have, which additional tools need to be developed, and which are the feasible choices of technology for the targeted audience. Therefore, we also discuss the conceptual requirements for automating the coordination functions in costume management through business process technology (Section 6.2). Following that, we provide a long-term outlook on advanced software tools that could be built to support costume management (Section 6.3).

6.1 Next Steps to Provide a Basis for Integrated Costume Management

As noted in Section 4, most information exchange in film production is currently paper-based, resulting in redundancies and inconsistencies of information. Therefore, a data model without redundancies needs to be defined. Different views on this data model provide for the different information demands of the roles involved in costume management. Further, reporting functionality is needed to support the work on the set using document

formats and structures common in the film business. However, when building a system based on such a data model, version management and concurrent editing of data needs to be taken into account. For instance, a script is global for all departments, but the different script breakdowns represent co-existing variants. Changes in the script need to be synchronized with the head versions of the breakdowns. Parallel editing occurs on the set when different dressers like to update the set book at the same time.

In order to be able to provide advanced tools for costume management, the information depth of costumes needs to be extended, treating a costume not as an atomic unit, but as a complex composition of different pieces. A metamodel for costumes needs to be defined covering aspects like the context of usage, related costumes, constituent parts, semantics, relations between costumes, etc. An exchange format is required to support requests for lending, buying, manufacturing, hiring, or search, in general.

An architecture needs to be developed including a workflow management system for process enactment, a database system for user management, access control, a document and media file storage for costume data, and feasible client-server structures. Architectural decisions will likely be influenced by requirements such as localization, country-specific formatting guidelines and processes, and scalability. For example, scalability requirements for a medium-budget German film differ tremendously from a high-budget Hollywood production. Besides, localization also requires different process structures due to cultural differences in film making. Furthermore, the role models need to be flexibly changeable for each film production. For integration with other departments, the architecture needs to consider various interfaces for information exchange. Even in a medium-budget production, many different specialized companies are involved, for example for special effects, rendering, background music etc. Typical business approaches on cost saving like sub-contracting, outsourcing, and off-shoring also apply here. Due to different IT infrastructures in these companies and also with respect to different data formats and respective software tools used, the concepts of Enterprise Application Integration (EAI) [27] are relevant for the integration aspect. As a consequence, a flexible and scalable integration architecture for distributed collaboration between the departments needs to be developed, taking the special circumstances of the film business into account. In order to reduce costs for running such an infrastructure, a setup as a Software-as-a-Service (SaaS) offering might be most feasible for wardrobe departments. To allow access to the system in all production phases, portable devices and web-based interfaces need to be supported, which again indicate that a SaaS-based solution might be preferable.

6.2 Business Process Automation for Coordination of Costume Management

The processes in costume making are creativity-intensive and as well collaboration-intensive. Many tasks are performed ad-hoc, some with software tool support, but currently with little integration. This demands a workflow system to be very flexible and the processes have to be easy to adapt. ADEPT [22], to name one candidate platform, is a workflow system that allows much dynamics in processes. For example, the ADEPT system allows ad-hoc changes of processes, such as the integration of a process fragment to perform some additional steps that were not included in the original process model.

As discussed in [10], libraries of process fragments can be used to store frequently occurring requirements in terms of process structures. Further, multiple libraries can be used to integrate a process with the process of a business partner. For example, a clothing manufacturing company could offer process fragments to ease integration with their system. This is just one scenario that shows how technologies developed for business process management also apply in costume management in film productions.

To account for the creative nature of parts of the costume management processes, extensions to a chosen workflow system might be required to allow a mixture of structured and semi-structured parts. Besides the approaches on process fragments, further concepts may be taken into consideration. For example, we discussed the concept of “pockets of creativity” [13] in the section on related work (see Section 5.2). This concept resembles ad-hoc tasks, described in the BPMN specification [1]. Additional approaches on flexibility are originated by the BPM community, for example the concept of “worklets” [25] and “pockets of flexibility” [26]. These approaches resemble concepts from commercial workflow management systems. For example the notion of case processing denotes unstructured activities related to a shared context (e.g. a folder), the notion of ad-hoc workflows is also common in these systems [28]. Traditionally, the tasks in a workflow are performed according to a static definition of the tasks and their order. In contrast, case processing and ad-hoc approaches loosen this static definition and allow for more flexibility, as each instance of a workflow can then be modified to meet specific needs.

Regarding the management of human tasks, which applies to most tasks in the costume management processes, Unger et al. proposed using ad-hoc sub-structuring [7]. This approach allows refining a coarse-grained human task by specifying a human-oriented workflow to be performed. This approach might be applicable in the costume processes. However, the costume designer, assistants, and dressers already have a working routine. They know the steps they have to perform and they do not like to be bothered with a task management system informing them about tasks they have already performed, or notifying them about things to be done they are obviously aware of. We consider different approaches to address this circumstance. One approach, activity sensing [29], makes use of sensors to monitor which tasks are currently performed (or completed) by which actor. Through this approach, tasks can be marked as completed without explicitly interacting with a worklist application. Another approach is to manage tasks proactively, instead of performing a strict step by step processing. The idea is to identify connected task structures and to present them to a user "en bloc". The user can then decide based on urgency or current circumstances on the set like the availability of an actor what to do next. Some tasks could be annotated to draw attention, like "take connection photo", whereas others can be put on a backlog of work on which they can be checked when done. However, further investigation is required to realize such task handling functionality.

6.3 Advanced Tools for Costume Management

The review of currently available software for managing the wardrobe department revealed that existing tools mainly focus on inventory management (see Section 5.1). As most work on investigation, lending, buying, and manufacturing is currently based on spreadsheets and simple databases, there is a lot of room for improvement through advanced tools and features here. A metamodel for capturing the details of a costume (see Section 6.1) will allow building a new generation of costume management tools. With the use of available frameworks for building graphical editors, a tool could be built to support computer-aided costume design on a higher level of abstraction than CAD. With such graphical editors, costumes can be easily drafted and be stored in a computer-readable way feasible for further processing. A costume that has been modeled that way, can be stored in a repository, be used for searches (e.g. for lending), and for data mining (e.g. finding frequent costume patterns) etc. The constituent parts of a costume could be annotated with CAD-patterns for cutting, to enable more automation from design to manufacturing (see Section 5.3). To the best of our knowledge, such tools and an expressive metamodel of costumes do not exist, yet.

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