COVER SHEET

Creating a Reference Model for the Creative Industries – Evaluation of Configurable Event Driven Process Chains in Practice

Masters Thesis

Creating a Reference Model for the Creative Industries – Evaluation of Configurable Event Driven Process Chains in Practice

Master Thesis

in the subject *Information Systems*
at the Institute of Information Systems, Chair of Information Management

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List of Abbreviations

AD	Assistant Editor
ADR	Automatic Dialogue Replacement
AFTRS	Australian Film, Television, and Radio School
ARC	Australian Research Council
BPM	Business Process Management
BPR	Business Process Reengineering
C-EPC	Configurable Event-Driven Process Chain
CCI	Centre of Excellence for Creative Industries and Innovation
e.g.	exempla gratiae / exempli gratia (Latin: for example)
EPC	Event-Driven Process Chain
ER	Entity Relationship
ES	Enterprise System
etc.	et cetera (Latin: and other things)
et al.	et alii (Latin: and others)
Fig.	Figure
IATSE	International Alliance of Theatrical Stage Employees
IT	Information Technology
NLE	Non-linear editing system
OMF	Open Media Format
ORM	Object-Role Modelling
OSN	Optical Sound Negative
Tab.	Table
TQM	Total Quality Management
VFX	Visual Effects
QUT	Queensland University of Technology

1 Introduction

1.1 Motivation

"Just as every movie has a beginning, middle, and end, so does the process of making a movie."[1] This is the first sentence of a book about movie editing and post-production. It subsumes much more than what might be apparent in the first moment. Is there really a "general process" of filmmaking and, even further, can we actually split up this process into a sequence of logically consecutive tasks in order to apply a process-centred, IT-supported management approach? In the following it is briefly elaborated on how this question motivates the research objectives of this work.[2]

The Australian Creative Industries includes the production of feature films, TV series and other media content. According to the last survey of the Australian Bureau of Statistics for the years 2002 and 2003, 16,427 employees in the film and video production industry generated a total income of $1.6 billion Australian Dollars.[3] Increasing globalisation on the one hand offers new opportunities for service-related companies to attract a bigger market, but on the other hand raises the competition from other regions like New Zealand, South Africa or Eastern Europe to draw the attention of production companies. In 2004, the relatively high value of the Australian Dollar resulted in a slump in off-shore productions in Australia.[4] In 2005, there was a discussion about the non-unionised status of the New Zealand film industry for loosing the advantage over Australia in attracting Hollywood production in the case of an adjustment to Australian union standards.[5] In 2006, several new film funding and financing initiatives in eastern Asian countries, from South Korea to Singapore are emerging, showing various ways of supporting film productions.[6] These examples show the increasingly globalised competition and demonstrate how Australian businesses in the Creative industries have to interpret their organisations in an international setting. Both production companies and providers of production services, like visual effects studios and film laboratories, have to apply contemporary management approaches to stay competitive.

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1 Chandler (2004), p. XV.

2 This work emerged from the project "Business Process Management for the Creative Industries" of the ARC Centre of Excellence for Creative Industries and Innovation (CCI) at Queensland University of Technology, Brisbane, Australia. The project is funded by the Australian Research Council and is driven by a close cooperation between the Business Process Management Group of Queensland University of Technology (QUT) and the Australian Film, Television and Radio School (AFTRS). For further information regarding the project and the conducted case studies, see Seidel (forthcoming).

3 Compare Anon (2004b), p. 14.

4 Compare Groves (2004), p. 18.

5 Compare Drinnan (2005), p. A2.

6 Compare Frater (2006), p. A6.

Business Process Management (BPM) is seen as a successful means of sustaining competitive advantage in an increasingly global competition.[7] It is a holistic approach for a process centred management, aiming on business process improvements. The BPM philosophy states that management decisions require profound knowledge of the value chain and respective processes. This principle also applies for the Creative Industries because management tasks like budgeting require a good knowledge of production paths.[8] Nevertheless it was found, that literature so far insufficiently aligns management questions to the respective detailed processes within the Creative Industry. On the one hand, literature provides lots of practical guides and technical explanations, with isolated flowcharts concerning media productions on an in depth level. On the other hand, books address questions about financing, marketing and legal issues and discuss management questions without enough closeness to the respective processes. It is assumed that this lack of process-focussed management-methods, is due to domain-specific peculiarities, like the high degree of creativity and flexibility.

Motivated by this lack of process-centred management support, this work aims to deliver a starting point for a BPM application within the Creative Industries. It is intended to provide support to organisations meeting the new challenges in such a competitive environment. This has to happen with respect to the domain-specific peculiarities. Because of the focus on business processes, a central part comes to assessing the organisation's processes in the form of process models. They are the basis to business process improvements and measurements. To deliver a generic model that can be utilised irrespective of a certain project or company, it is required to develop a reference model. Reference models are information models that give a point of reference to create specific models.[9]

Configurable Event Driven Process Chains (C-EPCs) are used to develop the reference model within this study. This designated reference modelling language has initially been developed to support Enterprise Systems configuration.[10] The latter deals with the adaptation of Enterprise Systems (ES) to costumer needs. In this context, providers of off-the-shelf solutions like SAP, use Business Process Reference Models to facilitate the configuration of their standard software to an organisation's individual needs.[11] Based on the widely used Event Driven Process Chains (EPC), the developed representation language provides means of configuration to comply with identified configuration patterns.[12]

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7 Compare Hung (2006), p. 21 f.
8 Compare Gillezeau (2004), p. 29
9 Compare Thomas (2005b), p. 17.
10 Compare Rosemann, van der Aalst (2007), p. 2.
11 Compare van der Aalst et al. (2006), p. 76.
12 Compare Dreiling et al. (2005b), p. 696 ff.

Although C-EPCs have a solid theoretical foundation and the syntactical correctness of the grammar has been validated, there is still demand for further research.[13] The approach has not been thoroughly empirically validated, since no application in real-life cases has been conducted so far.[14] First studies on the user perception of configurable reference process models, deliver initial insights, but show limitations regarding size and comparability of the experiment.[15] Furthermore, no attention has been given to possible applications of configurable reference modelling languages in a broader perspective. VAN DER AALST recently proposed a discussion for an extended application of configurable reference models in the Business Process Management context.[16] Given these conditions, the study centres around the following two research objectives:

1.2 Research objectives

(1) Construction of a reference model for screen business post-production

The first research objective is the construction of a reference model for the post-production processes of the Australian screen business. The screen business is considered as a part of the Creative Industry with focus on the production of screen based products, such as cinema movies, TV series etc. With regards to the scope of this work, a further restriction to the post-production processes is made. The processes are assessed in literature review and a case study with the Australian Film, Television, and Radio School (AFTRS).[17] The configurable reference modelling language C-EPC is chosen to allow for comprehensive adaptation to project-specific scenarios or requirements. During the construction, useful applications of the reference model have to be considered. Therefore, an identification of configuration objectives and parameters is necessary. Corresponding example configurations will be the basis for an evaluation of the results with the help of industry practitioners. The modelling efforts can also give first answers regarding the suitability of BPM in the Creative Industries.

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13 Compare Recker et al. (2006b), p. 502 f.; Mendling et al. (2006), p. 26 f.
14 Compare Recker et al. (2006a), p. 379 f.
15 Compare Recker, Rosemann, van der Aalst (2005), p. 8 f.
16 Compare van der Aalst et al. (2006), p. 2.
17 The case study is part of the project “Business Process Management for the Creative Industries” of the CCI. For more information regarding the project and the case study refer to Seidel (forthcoming). Due to its origin, the content of the reference model is considered to be taught knowledge.

(2) Evaluation of Configurable Even-Driven Process Chains in practice

The second research objective is an evaluation of C-EPC in practice. The application in a real-life case gives a contribution to the empirical validation of the reference modelling language and allows a reflection regarding relevance and completeness of the language components. While previous research mainly concentrates on the configuration of existing C-EPC-models, the focus of this study also lies in the creation of such a model, thus on the use of the reference modelling language. Based on the presented application for the post-production processes, I will draw conclusions on the conceptual foundations of the configurable reference modelling language. It also has to be considered that the case study represents a first application of C-EPC in an extended BPM perspective. Consequently, my reflection also includes a consideration of adaptation mechanisms in a broader sense.

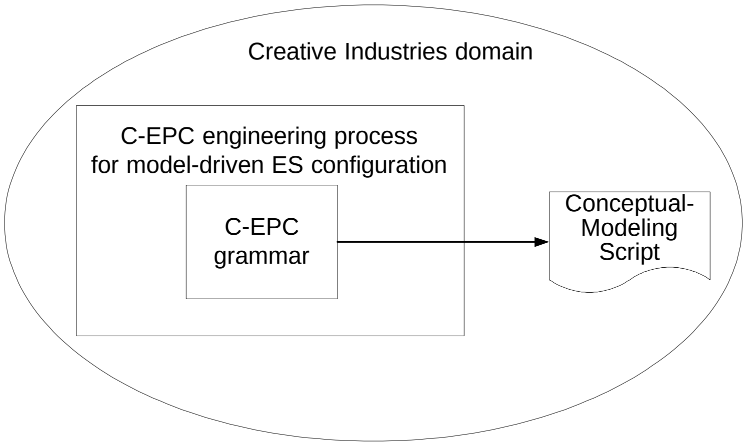
1.3 Research design

The conducted research follows a qualitative, exploratory approach and includes a single case study strategy. Both research objectives deliver qualitative results rather than quantitative evidence and refer to an exploratory type of research as they centre to some extent on unverified propositions. This research presents one of the first insights into a new application domain for BPM, namely screen business, and thus cannot rely on an extensive body of knowledge, which justifies its classification as explorative.[18] Furthermore, aside from the question of suitability of BPM within the Creative Industries, the first research objective exhibits a rather constructional character. The selection of a single case study stems from the fact that it serves as an organisational strategy and is particularly suitable to answer research questions of "how" and "why" on subjects with contemporary character, over which the investigator has little or no control.[19] In this case, this holds for both the investigations on process modelling in the Creative industries and the reflections on Configurable EPCs.

However, the two objectives focus on different areas of research. I utilise the Framework for Research on Conceptual Modelling by WAND and WEBER to demonstrate this difference.[20] Fig. 1.1 shows an adaptation of this framework with respect to my work. According to this framework, a conceptual modelling language consists of a grammar and a method that explains how to use this grammar. A script that is created this way is constructed within a certain context. In my case, this surrounding context is the Creative industries domain. The produced script is a reference model. The C-EPC modelling language in-

18 Compare Grix (2004), p. 51.
19 Compare Yin (2003), p. 9.
20 Compare Wand, Weber (2002), p. 364.

cludes not only the grammar but also methods of using it.[21] While the first research objective concentrates on the creation of the reference model, the second research objective aims at drawing conclusions from this process to the modelling language. Therefore, the second research objective focuses on Configurable Event Driven Process Chains as a conceptual modelling language for configurable process reference models.



Source: Compare Wand, Weber (2002), p. 364.

Fig. 1.1: Contextualised Framework for Research on Conceptual Modelling

1.4 Thesis structure

My thesis is structured as follows. This first chapter presented the motivation for the conducted research, as well as the clarification of both research objectives and the research design. The introduction closes with explanations regarding the research approach and the structure of the thesis.

The second chapter delivers the relevant concepts and related research regarding both objectives. It first elaborates the necessary background knowledge for a transfer of Business Process Management theories on the screen business. I start with an overview of the Australian screen business, then deliver demarcations and definitions for the crucial terms and finish with an explanation of the intended efforts for post-production. I then refer to the second research objective. Hereby, I go from general to specific by explaining the basics of information modelling, reference modelling and configurable reference modelling.

Chapter three addresses the construction of the post-production reference model. I first explain the construction method, which determines the three subsequent steps of this chapter: First, the assessment of the relevant processes, data and organisational structures, sec-

[21] Compare Recker et al. (2006a), pp. 370 ff.

ond, the specification of a configurable reference model, and third, the configuration of the created model and its evaluation.

The second research objective, the reflection on Configurable EPCs, is presented in chapter four. It explains the findings during the practical application of C-EPCs for the further development towards a mature reference modelling language. It is structured in findings from an external perspective, from an internal perspective and from a broader perspective of adaptation mechanisms.

I finish with a conclusion and outlook that summarises the conducted research and the resulting conclusions and highlights necessary further research. The structure of the thesis s illustrated in Fig. 1.2.

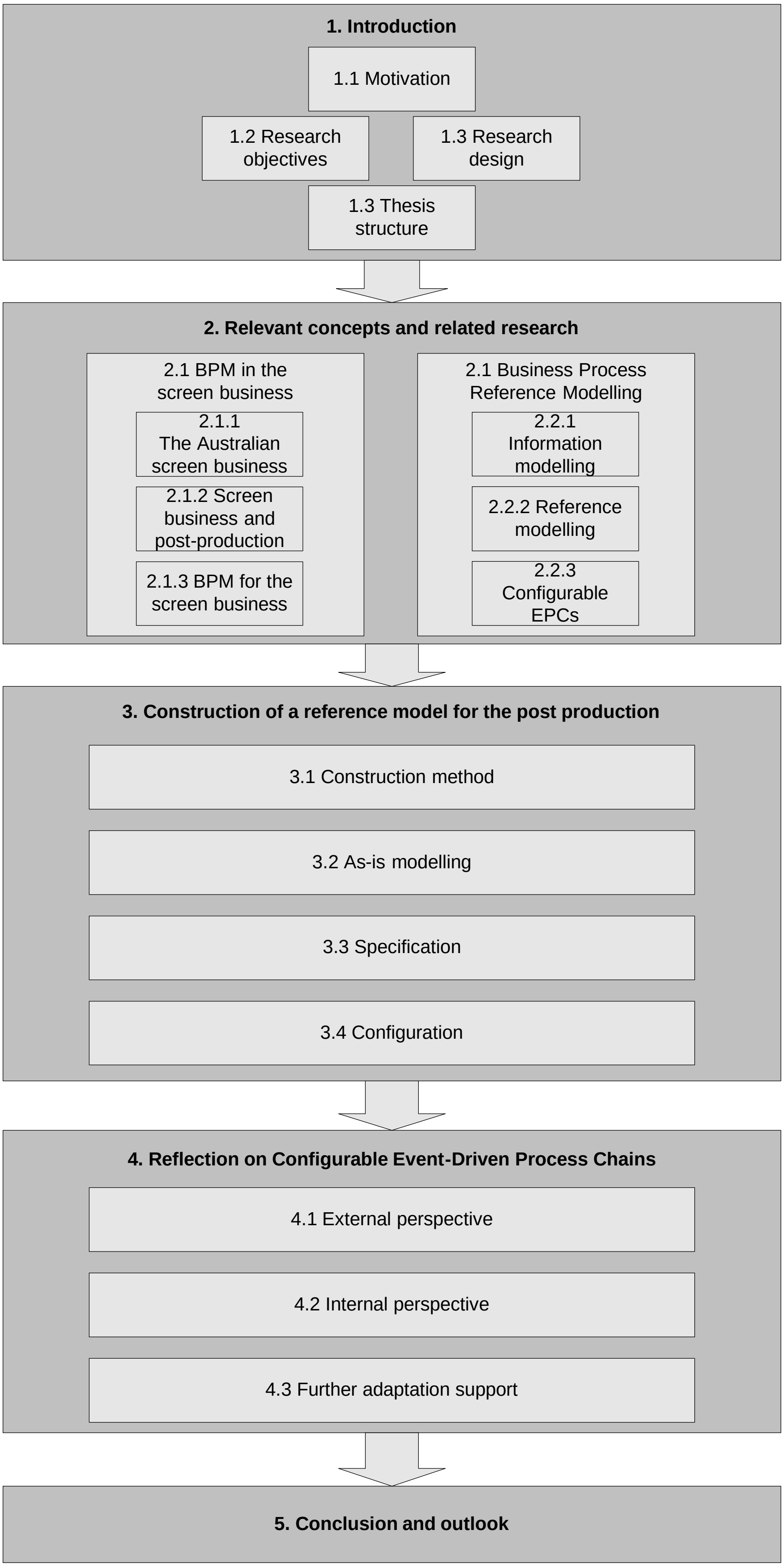


Fig. 1.2: **Structure of the thesis**

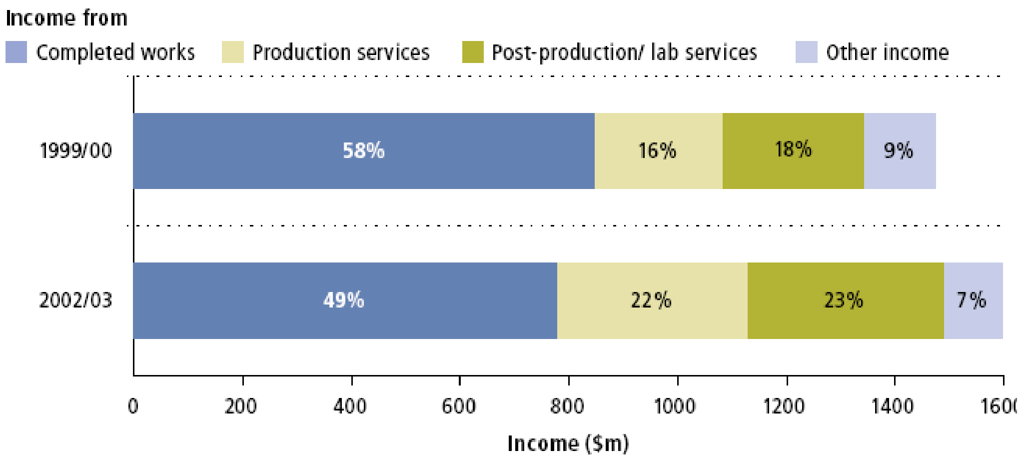
2 Relevant concepts and related research

2.1 Business Process Management in the screen business

Like every conceptual modelling, the construction of a reference model happens in a certain context.[22] In my study, the context is post-production of the screen business and in a broader sense the application of BPM theories and practices within the Australian Creative Industries. Consequently, the characteristics of the domestic industry and its position in a global context have to be examined. This highlights the relevance of such research efforts and is essential knowledge for the reference model construction. Afterwards, a demarcation regarding screen business and post-production is given and the application of business process management in this context is explained.

2.1.1 The Australian screen business

According to the last survey on this topic, 2,172 businesses were working in the Australian screen business in 2002/2003, employing 16,472 people. They generated a total income of 1,596.6 million dollars, which represents an 8% increase since 1999/2000.[23] Fig. 2.1 presents the distribution of the income to the segments of income for complete works, for production services, for post-production or film-laboratory services, and income for other work.



Source: Anon (2006b), p. 5.

Fig. 2.1: Income for businesses in the production industry

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22 Compare Wand, Weber (2002), p. 364.

23 Compare Anon (2006b), p. 5. Get the picture of the Australian Film Commission regularly publicises statistical information about the screen business, using the data of the Australian Bureau of Statistics and other research sources. Since 2001 all statistical information is provided online at http://www.afc.gov.au/gtp/.

The screen business has a strong, diversified contribution to the Australian economy.[24] However, it is relatively small, when put in relation to the biggest industries world wide. In comparison, the 2006-2007 Occupational Outlook Handbook states an employment of “about 368,000 wage and salary jobs in the motion picture and video industries” in the United States in 2004.[25] Tab. 1 presents an abridged version of a ranking of the top countries regarding investments for feature film productions. Australia is positioned on rank 18 with a share of only 0,36% of the total global investments, while the United States contribute by far the largest part, followed by Japan and Western Europe. Admittedly, the Australian industry fluctuates regarding the position in this ranking, with investments varying from 75 to 104 million US dollars since 1999, while the ranking varies from 11 to 18 respectively.[26]

Rank (2005)	Country	Investment in feature films in US$(m)	Share
1.	USA	13,945	61.71%
2.	Japan	1,841	8.15%
3.	France	1,601	7.08%
4.	Germany	1,043	4.62%
…	…	…	…
7.	New Zealand	289	1.28%
…	…	…	…
18.	Australia	81	0.36%
…	…	…	…

Source: Compare Anon (2006a), p. 4.

Tab. 1: Countries ranked by production investment for feature films 2005

The Australian screen business has a long tradition. The Australian feature film “The story of the Kelly Gang” from 1906 claims to be the “first continuous narrative feature film in the world”.[27] Until today the industry showed cycles of good and bad times. The two most influential external forces have been governmental initiatives and increasing globalisation.

The Australian government always had a strong influence on the development of the industry, with funding initiatives, or by giving other financial incentives to promote the growth

24 A thorough investigation on the various impacts on the domestic economy can be found in Anon (2004a), p. 49 ff.
25 The Occupational Outlook Handbook is a regularly revised online publication of the Bureau of Labor Statistics of the U.S. Department of Labor. See Bureau of Labor Statistics (2006).
26 See Anon (2006a), pp. 4 ff.
27 Anon (2004a), p. 1.

of the economy and to sustain a high-level skills base.[28] Especially in the 1970s, this yielded a continuous renaissance of the local production sector.[29] Until the 1990s these efforts led to a creative and technically proficient industry, producing both several million-dollar high-budget movies – internationally financed – and local, low-budget projects, of circa half a million dollars.[30]

As a second main influencing power, the trend of internationalisation changed the screen business, particularly in the 1990s.[31] What are the consequences of this globalisation for the Australian economy? While national drama production increased in value by 15% between 1993 and 2002, the value of foreign productions in Australia grew by nearly 300% in the same period of time.[32] It is estimated, that today the higher percentage of digital components in films helps to preserve or even amplify this development, because it facilitates to shoot footloose.[33] But what looks like a solely good trend for Australia also has its downside. To see the full impact of globalisation and to assess the standing of Australian productions within an international setting, both the advantages and the problems of the industry in a global context have to be discussed:

- *Advantages*: A report of the Committee on Communications, Information Technology and the Arts, commissioned by the Australian government, provides a comprehensive exploration on potential advantages and obstacles regarding international success of the domestic industry.[34] A competitive advantage results from the Australia's geographic position in the world. Because of different time zones, production or post-production work can be done while the partners in major production centres are sleeping.[35] On the other hand the similar time zones to evolving Asian markets in China, South-Korea, India, Singapore and Vietnam and the relative short physical distance to these centres, helps to develop a sustaining partnership through collaborations in projects, as well as through training and teaching.[36] The Committee further identifies using English as the dominant language as an advantage and sees opportunities in a variety of sectors, based on the existing infrastructure and

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28 The report about Australian government assistance to the film industry in 1997 by D. Gonski counts 33 types of assistance initiatives since 1901. Compare Anon (2004a), p. 2.
29 Compare Anon (2004a), p. 2.
30 Compare Reed (1999), p. 8.
31 Compare Maher (2004), p. 13; Reed (1999), pp. 8. f.
32 Compare Herd (2004), pp. 7 f.
33 Compare Boland (2006), p. C8.
34 Compare Anon (2004a), pp. 78-88.
35 Compare Anon (2004a), pp. 86 f.
36 Compare Anon (2004a), pp. 87 f.

the developing digital production segment.[37] The most obvious positive impact on the industry within the context of internationalisation can be seen in employment and economic effects. Local actors get better access to Hollywood roles, higher wages and better working agreements. Moreover foreign projects, dominantly from the US, provide a range of opportunities for technical crew and foster the development of production service industries.[38] From a monetary perspective, foreign productions and co-productions spend 140 million dollars in Australia per year in a ten year average.[39]

- *Problems*: It was found that certain distribution practices of international competitors have a negative effect on the Australian industry.[40] This relates to bundling of products like TV-series, to block all screening slots with their own material, or the utilisation of their financial power, to offer free or very cheap programs, to tie broadcasters to their products and merchandising goods. Other problems of Australia's film production industry are the cultural difficulties associated with access to foreign markets and the downsides of the physical distance from key centres of the international film industry.[41] In addition to that, the report of the Committee states that the screen business industry has some infrastructural problems that limit the amount of local productions in Australia.[42] Besides these factors, mainly affecting the success of Australian productions overseas, the local industry is threatened by two other aspects of globalisation. The first is the migration of the skilled and creative people to other countries.[43] The second are the negative effects of foreign productions in Australia. According to the Australian Film Commission, only about half of the credited roles of 44 foreign productions in the years 1996-2001 and notably few key creative roles have been occupied by Australians.[44] Another fear concerning foreign productions is the potential segmentation of local production facilities, cast and crew, in a part that is only working for international projects and in a

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37 A detailed explanation of the identified opportunities in the sectors of feature film, animation, documentaries, co-productions, children's programs, cross-platform content creation, television, and digital production can be found in Anon (2004a), pp. 88-100.

38 Compare Herd (2004), pp. 28 f. Further information about the major presence of the US in offshore productions can be found in Herd (2004), pp. 10-22.

39 100 million dollars are spent per year by productions under Australian creative control. See Anon (2005), p. 3.

40 Compare Anon (2004a), pp. 85 f.

41 Anon (2004a), pp. 78 ff..

42 Anon (2004a), pp. 82. ff.

43 WALTON gives a comprehensive investigation on the impact of the so-called "brain-drain" in the Australian film industry. He further elaborates the question if this represents a chronic illness or if it can be used to help the local economy. See Walton (2005).

44 13 foreign features and 31 foreign television dramas showed only 47% Australians occupying credited roles in feature films and 64% in television dramas respectively. Compare Herd (2004), p. 28.

local industry part.[45] The reasons for this fear are obvious when looking at feature film productions: In a ten year average, five foreign productions per year show a total value of 247 million dollar (per year), while 24 local productions per year only exhibit a value of 107 million dollar.[46]

At least the latter fear of industry segmentation has been proved only to a limited extent.[47] However, the investigation shows, that the Australian screen business is strongly influenced by governmental support and external factors. After increasing globalisation since the 1990s, it is facing new opportunities and challenges that question the continuous success of the industry, especially in terms of national productions. What makes these findings particularly interesting is that the Creative Industries is considered to be an industry of outstanding growth rates. According to a report by PriceWaterhouseCoopers “Filmed Entertainment” as a sub-category of the Creative Industries is expected to exhibit a global compound annual growth rate of 6.4% between 2003 and 2007.[48] I conclude that the Australian screen business needs to gain competitive advantage in a changing environment, to participate in the growth of a global industry sector. This situation makes the industry very suitable for an application of business process management techniques. The Australian screen business is exposed to external powers like globalisation and changing technology. These are key drivers for adopting BPM.[49] Before I explain what BPM is and how it helps organisations to face this changing environment, I will give the necessary demarcations of the considered subject.

2.1.2 Screen business and post-production

It is thought to support the application of BPM principles within the Australian screen business. Therefore, the terms screen business and the respective value chain must be clarified. This is necessary both for demarcation reasons and for a correct classification and definition of post-production. Afterwards a justification of the limitation to post-production and its relevance for the investigated research objectives is given.

45 Compare Herd (2004), p. 30.
46 See Anon (2005), p. 3. Note, that only about 50% of the total production value of foreign productions is spent in Australia.
47 Compare Herd (2004), p. 30.
48 Compare Anon (2004a), pp. 77 f. Cited from PriceWaterhouseCoopers, Australian entertainment and media outlook, 2003-2007.
49 Compare Lee, Dale (1998), p. 214 f.

Screen business

Due to having no consistent definition of the term *screen business* in literature, a working definition is elaborated in the following. The industry classifications of the Australian Bureau of Statistics can serve as a starting point, since my study focuses on the Australian industry. Within the catalogue of the Australian Culture and Leisure Classifications (ACLC), the understanding of the term screen business in this work can be compared to the industry sector *film and video production*. This sector is defined as a class of organisations "*mainly engaged in the production or post-production of films, video or other media containing moving images.*"[50] The production deliverables are further subdivided into feature lengths films and videos, short films and videos including documentaries, films, drama series and other programs for television, films and videos for advertising and corporate training, and other commercial videos. The post-production services are broken down to special effects, animation, editing, captioning, titling, subtitling, negative cutting, screen editing, and printing.

Besides the fact that the complex list of all included deliverables and post-production services is rather inconvenient, it must be questioned if the industry classification character of the definition of the ACLC is useful for this purpose. It is noticeable that production services like sound recording or film set constructions are excluded, as well as audio post-production services. This misses the point of a process centred perspective, because essential parts or contributions to the process of screen business productions are omitted. Moreover the definition includes the production and post-production without mentioning other parts of the value chain like pre-production.

I conclude that a definition of screen business has to clarify which parts of the value chain are included and what deliverables the industry is addressing. Based on these findings the following working definition is used for the term screen business in this study:[51]

> *The screen business comprises all creative and business related aspects and processes of audiovisual content on film, video and new media from concept to production and finally distribution.*

In the following the most important parts of the definition are explained in more detail:

- *Creative and business related aspects and processes*: The definition lays emphasis on the creative aspects of movie-making. This is intended to accentuate the aware-

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50 Anon (2001), p. 37.

51 The definition has been elaborated and introduced within the project "Business Process Management for the Creative Industries".

ness of the high degree of creativity in the domain. A holistic application of BPM theories and practices has to adapt to the peculiarities of the relevant domain. Therefore, not only common business aspects and processes but also the parts of high creativity have to be considered.

- *Audiovisual content on film, video and new media*: This part of the definition addresses the difficult task of classifying the essential product of the industry. It states that the organisations within the screen business deal with contents including audio and visual elements. There is no limiting commitment to recorded content or to artificially created content. Furthermore it states that this content is produced or delivered on one or more media of this non-disjunctive set of categories:[52]
    - *Film*: This includes any sort of 35mm, 16mm and 70mm film.
    - *Video*: This refers to any sort of analogue and digital videotape.
    - *New media:* This refers to any other media that is used for commercial distribution of audiovisual content with emphasis on new IT-enabled channels like internet or mobile distribution.

The *type of medium* as a classifying criterion allows for a reasonably detailed and complete classification of possible projects. A classification could also be based on the *types of screens* where the project is shown or on the *type of content*.[53] Examples of screen types, where the project can be shown are: cinema, television, computer, and portable devices. It is difficult, to clearly classify the content of a screen business project. PARER and JEFFREY give a comprehensive list of categories based on the content.[54] According to this list, film projects are grouped as animation, corporate, training, documentary, documentary feature, TV documentary, mini-series, features, and short film. It must be noted that other groupings by genre, principal audience, purpose and more, are possible too. Due to lack of completeness and validity in the long-term, I stick to the production media for a demarcating definition.

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52 The definition neither exclusively refers to the media that the project is shot on, nor to the media in which it is delivered. This is, because the medium of the shoot and the medium of the delivery can vary and especially a delivery in several media doesn’t allow for a consistent reference. Imagine a feature film that is shot on film and delivered on film for projection in cinemas. A trailer is also shown online which would represent a delivery as a file. For television broadcast it is also delivered on videotape and for video stores on DVD. That means, a screen business-project is not limited to one medium but always deals with audiovisual content on a medium of at least one of these categories.

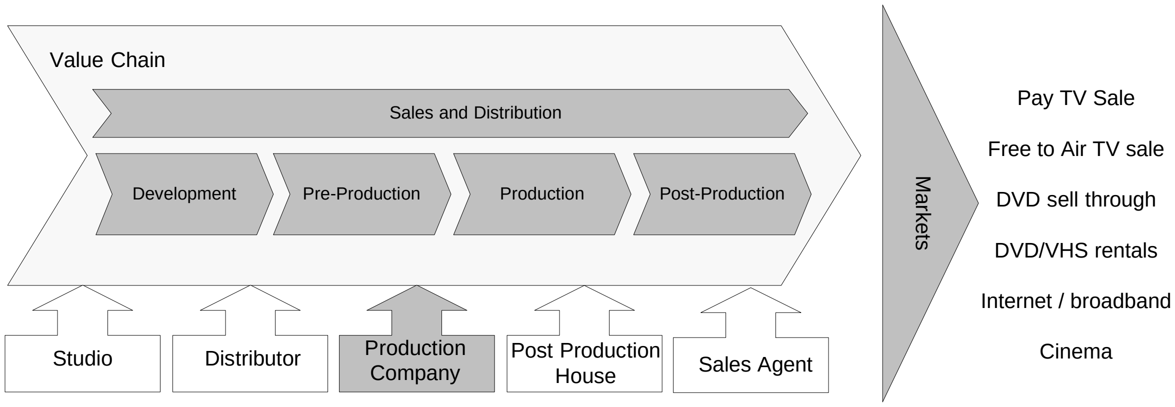
53 Compare Parer, Jeffrey (2006), p. 17.

54 Compare Parer, Jeffrey (2006), pp. 17 ff.

- *From concept to production and finally distribution*: The screen business comprises all steps from the very beginning of a project to the delivery of the final product. Therefore, the considered value chain starts with the concept which could be a script or just an idea for a movie and ends with the distribution. Further explanations on this value chain are given below.

A business process framework for the screen business

Fig. 8 presents the value chain of the screen business within a business process framework.[55] A business process framework divides the structures of an organisation on an abstract level. It aims to clarify the relationships between the parts of the framework and serves as an important guidance for more detailed process modelling.[56]



Source: Seidel (forthcoming), p. 7.

Fig. 2.2: Business Process Framework for the screen business for feature film productions

The Value Chain of the screen business consists of five main parts: development, pre-production, production, post-production as a consecutive chain of stages and sales and distribution as an accompanying process during all stages[57]. The value chain works towards the markets that comprise several sales opportunities like Pay TV, Free to Air TV etc. On the bottom are the companies that are involved in, or contributing to the value chain. It must be noticed that the involved companies in the framework in Fig. 2.2 are an example for a standard feature film production and can vary from production to production.

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[55] Seidel (forthcoming), p. 7. The Business Process Framework has been developed within the project “Business Process Management for the Creative Industries” of the CCI.

[56] Compare Becker, Meise (2003), pp. 99 ff.

[57] The distinction between in the four basic stages can be found in literature and was confirmed by industry practitioners. Compare Benedetti (2004), pp. 1 f.; Clevé (2006), p. 9; Jeffrey (1995), p. 19; Kindem, Musburber (2001), pp. 1 ff.; Koster (2004), p. 5; Laramie (2004), p. 9; Wales (2005), pp. 50 ff. Sometimes the development phase is not listed separately and is instead seen as a part of pre-production. It is taken as a main stage here because it is considered to be important in a BPM context.

The business process framework illustrates the placement of post-production in the overall context. Since the rest of my work will focus on post-production, the other four stages of the value chain are explained very briefly in the following. Afterwards a more detailed investigation on the term post-production is presented.

- *Development*: In the development stage the idea of the project is born and funding is secured: The producer looks for material that can be turned into a successful movie.[58] All rights for this material have to be acquired and the actual screenplay has to be written.[59] The producer or production company then obtains commitments from actors and a director, and composes a budget.[60] When financial support for the proposed budget is achieved, the project can proceed to the pre-production.[61]

- *Pre-production*: While the development stage is more concerned about the financial success of the overall project, the pre-production deals with more operational things, concerning the actual production, prior to the start of shooting.[62] This includes tasks like screenplay breakdown, shooting schedule, location scouting, casting and unions, hiring staff and crew, equipment rental and stock, insurance, post-production preparation and more.[63]

- *Production*: In most cases the production phase is the most expensive phase of the project.[64] It comprises of the work on the set or location, which can be divided in four distinctive phases called blocking, lighting, final rehearsals and shooting.[65] Accompanying to these main tasks are supporting processes like catering, costume and make-up.

- *Sales and distribution*: From the very beginning to the end, the producer of a project has to deal with issues concerning the distribution of the movie. Most important in this context are distribution agreements.[66]

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58 This can be an original screenplay, novel, stage play, real-life story etc. Compare Clevé (2006), p. 9.

59 Compare Jeffrey (2006), p. 387.

60 Compare Clevé (2006), p. 12.

61 The budgeting and financing of movie productions is a very complex field. *Budgeting* will be of further interest later in this work. Regarding different ways of *financing* a project, CONES provides a comprehensive compilation of approaches and suggestions for further reading. The four identified major types of film finance are studio/industry financing, lender financing, investor financing, and foreign financing. See Cones (1995).

62 Compare Jeffrey (2006), p. 402.

63 Compare Clevé (2006), p. 12; Herd (2004), p. 5.

64 Compare Gillezeau (2004), p. 74; Benedetti (2004), p. 2.

65 Compare Clevé (2006), p. 14.

66 There are various types of distribution agreements. A discussion on the different types can be found in Moore (2002), p. 87.

Post-production

Fig. 2.2 classifies post-production as the last stage of the value chain between production and delivery to the markets. This positioning of post-production takes place on an abstract level. A common misunderstanding is that it begins after the shooting stops.[67] Since in most professional productions the footage is handed over to post-production every day, it has already started while the shooting still continues. In this case post-production happens quite parallel to the production. In fact, the post-production stage itself comprises of a number of occasionally overlapping phases.[68] However, the logical order would still be that the production precedes, because all material treated must first be shot.

In literature it is quite common to solely use this positioning for a definition of the term post-production.[69] I propose that a definition should also include aspects of what actually happens during post-production. KELLISON names the joining of footage and audio to a "flowing coherent piece" as a constituent part.[70] In addition to the visual and auditory elements, BENEDETTI lists the "finishing of the final product" as the third main aspect for a completion of the product during post-production.[71] A wrong perception is that this completion of the product is a rather technical than creative process.[72] Editing is an essential creative part and therefore should be part of the definition as well as the technical aspect. On the basis of these findings and with regards to the definition of screen business, that has been introduced earlier, post-production is defined as follows:

> *Post-production is the editing and general technical completion of a screen business production to join footage, sound and all other elements to a coherent piece.*[73]

Fig. 2.1 already indicates an increasing importance of the post-production sector, with a share of the overall income jumping from 18% to 23% during 1999-2003. Tab. 2 shows the rising income from provision for post-production/film laboratory services to other businesses in the time between 1993 and 2003.

67 Compare Laramie (2004), p. 9.
68 Compare Newton, Gaspard (2001), p. 209.
69 Compare Chandler (2004), p. 14; Clark, Spohr (1998), p. 1; Clevé (2006), p. 19; Jeffrey (1995) p. 338;
70 Compare Kellison (2006), p. 143.
71 Compare Benedetti (2004), p. 2.
72 Compare Gillezeau (2004), p. 143.
73 It must be noted that my definition doesn't cover the creation of visual effects (VFX). Because of the producing character of the VFX production my reference model will only cover the potential joining of footage and VFX and not its actual creation.

	1993/1994	1996/1997	1999/2000	2002/2003
Income in million dollar	101,8	146,2	262,6	360,5

Source: Compare Anon (2006b), p. 6.

Tab. 2: Income from provision of post-production/film laboratory service to other businesses

In many ways post-production is special in the context of my research objectives. I want to discuss three of them briefly. GILLEZEAU argues that it is perhaps the most complex phase.[74] SILVERMAN adds that this *complexity* is the result of the techniques and their order, which both differ from project to project.[75] Consequently, it is particularly interesting to start BPM efforts for this phase, because people are often not aware of its complexity.[76] Therefore, it is assumed that this stage has a big potential with regards to management improvements. Information models can bring this complexity to light and also help to deal with it. Moreover, this stage is especially affected by the changes that occur in the industry due to *new technologies*. It is considered to be the area where the new digital production technology had the greatest impact over the last ten years.[77] As a result of this development, the post-production process, that used to be a quite straightforward job, today is "a highly elastic term that continues to be redefined by emerging markets and technologies."[78] WALES states, that the process of post-production is an "ever-changing practice" with rigorous changes within a decade.[79] This represents a challenge to managing post-production in terms of predictability and reliability. BPM can be an appropriate means of facing these challenges, by offering support for accurate calculations, as well as flexibility regarding process alterations. The third reason, why this stage is especially relevant in conjunction with my motivation, is the needed *efficiency* for cost reasons. During post-production there is often "a conflict between the demands of art and the restrictions imposed by time and money."[80] It is considered that implementing best practices with the help of a reference model helps to deal with these restrictions. To justify these conclusions, the central concepts of BPM and reference modelling have to be explained in further detail.

2.1.3 Business Process Management for the screen business

The construction of a reference model for post-production happens with the intention to promote BPM efforts within that industry sector. Therefore, this section first clarifies the

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74 Compare Gillezeau (2004), p. 142.
75 Compare Silverman (2005), p. 17.
76 Compare Silverman (2005), p. 17.
77 Compare Herd (2004), p. 32.
78 Compare Kaufman, Zone (2002), p. 64.
79 Compare Wales (2005), p. 219.
80 Laramie (2004), p. 13.

term b*usiness process management*, second arranges my goals in this context and then discusses existing efforts.

What is Business Process Management?

Business Process Management is a discipline that has roots in several concepts that evolved mainly in the early 1990s. Most influencing was the idea of process-orientation and concepts like Business Process Reengineering and Total Quality Management.[81] The process perspective on organisations derived from the finding that functional approaches create barriers when looking at organisational activities. A focus on customer-driven business processes avoids the limitations of managing by vertical functions and facilitates a market oriented strategy.[82] In 1990, HAMMER and DAVENPORT and SHORT introduced business process reengineering (BPR) as a radical redesign of business processes, to achieve substantial performance improvements.[83] In a repeatedly cited article, HAMMER concludes that only radical change is considered to help big, traditional companies to dispose of organisational overhead and to stay competitive.[84] In opposition to this, total quality management (TQM) proposes a constant and progressive improvement of business processes.[85] Although TQM is a widely accepted management system, there is not one consistent perception of what it means.[86] Most common in the different perspectives on TQM is the understanding that it affects several management dimensions like top management support, customer relationships, product design, and more.[87] Business process management incorporates radical and continuous improvements, leveraging the overall effect by using the advantages of both BPR and TQM.[88] The main goal is to increase effectiveness and efficiency by improving the core business processes of an organisation.[89] BPM is a popular term in theory and practice but there is still no consistent agreement on its meaning.[90] In this study I make use of the definition of the Australian Community of Practice:

> *Business Process Management is a structured, coherent and consistent way of understanding, documenting, modelling, analysing, simulating, executing, measuring and*

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81 Compare Elzinga et al. (1995), p. 119.
82 Compare Zairi (1997), p. 68.
83 Compare Zairi, Sinclair (1995), p. 8; Harmon (2003), p. 23.
84 Compare Hammer (1990), p. 96; Puah, Tang (2000), p. 110; For more recently information about Business Process Reengineering and radical business change see Hammer, Champy (2003).
85 Compare González-Benito, Martinez-Lorente, Dale (1999), p. 345.
86 A comprehensive investigation on the difficulties in defining TQM can be found in Boaden (1997).
87 A collection and analysis of common dimensions of TQM is presented in González-Benito, Martinez-Lorente, Dale (1999), p. 348.
88 Compare González-Benito, Martinez-Lorente, Dale (1999), p. 346.
89 Compare Hung (2006), p. 22.
90 Compare Reijers (2003), p. 11.

*continuously changing end-to-end business processes and all involved resources in light of their contribution to business improvement***.**[91]

Application of Business Process Management

For today's companies, managing business processes is considered to be the key to organisational effectiveness.[92] In a recent international survey of the Gartner Group, CIOs confirmed that improving business processes has the highest impact on their organisation.[93] Regarding the Australian screen business, the strategic component of BPM plays an important role. In a recent empirical study HUNG confirmed that the alignment of strategy, institutional elements and information technology with the business processes has a positive impact on organisational performance.[94] To achieve this alignment BPM has to be viewed as a holistic approach, enabling corporate-wide and cross-functional process management.[95] KILMAN points out the importance of such a holistic approach as against a singular or a series of singular approaches.[96]

Although I want to support long-term BPM efforts in this study, with respect to the scope of this work, I can not have the claim to show a holistic application of BPM for the screen business. I therefore address the question: What is the starting point from a practical perspective and what related efforts exist already? The start for any BPM activities is the understanding of the core processes of an organisation. ZAIRI defines seven rules for BPM governance: The first rule focuses on a thorough mapping and documentation of the major activities.[97] Other rules rely on this documentation of the business processes of an organisation.[98] Consequently, process models, as a way of this documentation, are a core part of BPM. It represents the basis for the mentioned alignment of management issues with the business processes. A systematic application of BPM thus starts with a comprehensive documentation of core processes. Before I go into detail, how process modelling and in particular reference modelling can fulfil the demand of a comprehensive mapping and documentation of major activities, I have to discuss related efforts in the existing literature.

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91 See Queensland University of Technology (2006)

92 Compare Armistead, Pritchard, Machin (1999), p. 105.

93 Compare Gartner (2006), p. 5.

94 Compare Hung (2006), pp. 36 f.

95 Compare Hung (2006), p. 23.

96 Compare Kilman (1995).

97 Zairi (1997), p. 65.

98 Documented procedures allow for sustained quality performance, measurements, horizontal linkages and more. Compare Zairi (1997), p. 65. A more detailed explanation of the advantages of process models is given in section 2.2.1.

Existing efforts in the screen business

A broad investigation of available screen business literature showed that there are no comparable efforts so far. Two main ways of approaching the subject can be differentiated within screen business literature. On the one hand there is literature with a *management perspective*, dealing with mainly business-related aspects, and on the other hand authors provide detailed instructions from a *practical production perspective*. The first category abstracts in most cases from the process. They concentrate on management-related topics of the screen business. Due to the domain-specific complexity in financing of projects, many authors concentrate on the development of business plans. They address questions like budgeting, financing, marketing, distribution, copyrights, and more.[99] But no widely accepted formal product development model exists so far.[100] The second category comprises of in depth descriptions and explanations regarding the process of film making, intended to function as advice and guidelines for people involved in that process.[101] They are close to the actual process and give technical instructions. However, these technical instructions are seldom connected to a more abstract, business-related context to make it valuable for management-decision. Furthermore, only few authors make use of models to illustrate and clearly structure the presented process.[102] These rudimentary and isolated flowcharts lack of conceptual foundation to allow for a systematic alignment of management questions with the correspondent process. I conclude that a theoretically well-founded reference model can bridge that gap because derived models allow for individual alignment of strategic questions to the processes of the value chain. This would fit in the concept of a holistic BPM application within the screen business.

2.2 Business process reference modelling

This section focuses on the foundations of my study from the perspective of conceptual modelling. This is necessary because of two reasons. First, I develop a reference model using a reference modelling language. Therefore, basic knowledge about the used grammar and construction method is necessary. Second, the reflection on Configurable EPCs as a reference modelling language requires a thorough understanding of the conceptual foundations of the modelling language. I proceed by going from general to specific. Conse-

99 Examples of recent comprehensive publications are Campisi (2004); Durie, Pham, Watson (2000); Koster (2004); Lee, Holt (2006); Levinson (2004); Moore (2002); Squire (2004).

100 Compare Rossiter (2003), p. 109.

101 Examples of recent publications are Benedetti (2004); Brown (2004); Campbell (2002); Chandler (2004); Clevé (2006); Gillezeau (2004); Irving, Rea (2006); Kellison (2006); Kindem, Musburber (2001); Mamer (2006); Wyatt, Amyes (2005).

102 Examples of flowcharts can be found in Clark, Spohr (1998), pp. 2 ff; Irving, Rea (2006), pp. 238, 287, 302 etc.; Jeffrey (1995), pp. 222-237; Jones (2003), pp. 370, 382, 388 etc.

quently, I start with conceptual modelling as the basic principle, continue with reference modelling as a more specific form of modelling and finish with details about Configurable EPCs.

2.2.1 Conceptual modelling

Conceptual models have a long tradition and are widely used in the field of Information Systems. They find various applications in areas from software development to business process reengineering.[103] In this study, the term conceptual modelling is considered to be formally documenting selected phenomena of a problem domain for the purpose of understanding and communication among stakeholders.[104]

In the field of Information Systems, there are various modelling languages that focus on business processes. They differ in their perspective on processes and consequently are of different pragmatic value for the different user groups.[105] Process models allow for the analysis of business processes in terms of their relevance to the value chain and in terms of their performance.[106] Furthermore they are a means to approach the misalignment of IT and business by delivering a platform for comparison and discussion. DESEL stresses the importance of models for today's companies as a technique for identification and analysis of business processes.[107] I conclude that process models bring benefits which make them in particular valuable within BPM efforts.

Before I proceed, I now briefly go back to conceptual modelling in general. The broad scope of use of conceptual models can be divided in a more technical part and a part that focuses mainly on the description of organisations.[108] This distinction is illustrated in Fig. 2.3. It is of particular interest for my study, as explained in the following.

In the case of more *technical* activities, the main goal of conceptual modelling is to deal with the complexity that accompanies the planning and designing of information systems.[109] This includes the support of all stages of software development like concept, re-

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103 Compare Thomas (2005b), pp.16 f.

104 Compare Siau (2004), p. 73. THOMAS gives a comprehensive investigation on term model in the field of Information Systems. See Thomas (2005a).

105 DREILING, ROSEMANN, and VAN DER AALST distinguish three major user groups "Management", "Business Process Analyst" and "Technical Analyst". For further information see Dreiling, Rosemann, van der Aalst (2005).

106 Compare Davenport, Beers (1995), pp. 63 f.

107 Compare Desel, Erwin (2000), p. 141.

108 Compare Becker, Rosemann, Uthmann (2000), p. 31; Fettke, Loos (2003), p. 35. The presented classification is simplified and particularly useful in the context of my study. A further segmentation of application areas, as well as references to more literature can be found in Fettke, Loos (2003), p. 38.

109 Compare Frank (1999), p. 695.

quirements analysis etc. In addition to this, the selection and configuration of standard software is a way to use models within rather technical activities. Here, they support the definition of criteria for the selection of a standard software product or facilitate the adaptation to organisational requirements.[110]

The other area where information models are used within the field of Information Systems is a more *non-technical* use. In this case, models "facilitate description and optimisation of organisational issues".[111] They can build a common understanding, thus supporting the communication between all involved parties and deliver additional input for organisational improvement activities.[112] *As-is models* hereby illustrate the current status, thus providing transparency regarding organisational structures and business processes. *To-be models* support the implementation and measurement of potential improvements.[113]

Conceptual modelling is part of the set of theories and practices that represents BPM. Consequently, Business Process Management can not be placed in the presented classification of conceptual modelling. In fact, adopting BPM can touch all areas of Fig. 2.3, but doesn't need to. Nonetheless, the presented classification is of particular interest in this study: While the chosen modelling language C-EPC has been developed mainly to support the configuration of standard software, the reference model of this study is primarily built for the description and optimisation of organisations. I will show that this is not a conflict, but an opportunity for the research on C-EPC and reference modelling in general. I will pick up this issue in Chapter 4 to justify an investigation on further adaptation support of C-EPCs in a broader sense of reference model modification.

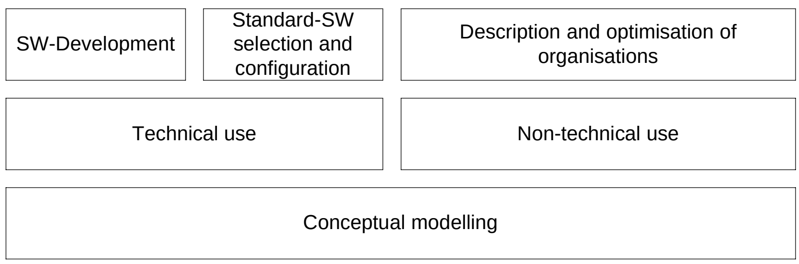

Fig. 2.3: Application areas of information modelling in the field of Information Systems

110 Compare Becker, Pfeiffer (2006), pp. 4 f.; Fettke, Loos (2003), p. 35.
111 Compare Fettke, Loos (2003), p. 35.
112 Compare Lübke et al. (2006), pp. 283 f; Wand, Weber (2002) p. 363.
113 Compare Becker, Pfeiffer (2006), p. 5.

2.2.2 Reference modelling

Reference Models give a point of reference to create specific models.[114] The two main advantages of using reference models are *cost-savings* and *quality improvements*. This derives from the problem that the modelling process can be very costly and time consuming.[115] The use of a reference model allows the reuse of the model-inherent knowledge. Organisations benefit from the documented process know-how that gives them an initial solution to start with, hence lowering the afore mentioned problems of time and cost. In 2000, the reduction of time factors and costs resulting from the use of reference models in projects, are estimated at more then 30%.[116] As a second advantage, it can increase the quality of the resulting models by incorporating best-practices.[117]

Reference modelling has been a popular research topic for years.[118] Recent surveys are proving that reference modelling is highly accepted within theory and practice.[119] However, the term reference model is not always used in the same way in literature. There are different opinions about what the constituent characteristics of reference models are.[120] DELFMANN states that often mentioned characteristics like universality, domain-specificity, completeness, and configurability are not compulsory but optional.[121] I concur with this statement and therefore follow the definition of DELFMANN: [122]

A reference model is an information model that is constructed with the intention to be re-used in varying application contexts.

The mentioned benefits are mainly from a user's perspective. As I deal with the construction of a reference model, I have to approach the topic from a developer's perspective, too. Reference models can be created with different intentions. BECKER summarises the following ways of usage based on the corresponding incentives for model developers:[123] A reference model can be used (1) as a means of knowledge management, (2) as a stand-alone product, (3) as an enhancement of other products like a modelling tool by embodying valuable and adjusted input to that product, (4) in connection with existing or for acquisition of new consulting contracts and (5) as a basis for the adaptation of standard software to or-

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114 Compare Thomas (2005b), p. 23.
115 Compare Fettke, Loos, Zwicker (2005), p. 1.
116 Compare Scheer, Nüttgens (2000), p. 380.
117 Compare Thomas (2005b), p. 17; Fettke, Loos (2003), p. 35; Recker et al. (forthcoming), p. 4.
118 Compare Frank (1999), p. 695.
119 See Fettke, Loos (2003).
120 For a comprehensive discussion of the term reference model refer to Fettke, Loos (2004), pp. 8 f.; Thomas (2005b), pp. 20 f.
121 Compare Delfmann (2006), pp. 46 f.
122 Compare Delfmann (2006), p. 47.
123 Compare Becker (2004), p. 40.

ganisational requirements. The last point of this list particularly demands attention, because C-EPCs have been developed to support this adaptation of standard software. The next section explains how the reference modelling language addresses this topic and delivers the necessary fundamentals to work with C-EPC models.

2.2.3 Configurable Event-driven Process Chains

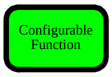
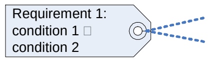
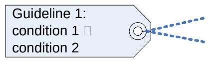
The development of C-EPCs as a configurable reference modelling language goes back to findings in conjunction with the increased use of reference models for the implementation of ES in organisations.[124] As mentioned above, hereby, the models support the adaptation to an organisation's requirements. The increasing functionality of ES makes the task of adapting the software packages very complex and time-consuming.[125] It has been found that traditional process modelling languages do not sufficiently support this aspect.[126] Traditional modelling languages are developed to describe individual models and not reference models.[127] Consequently they lack conceptual support for an adaptation to different requirements and provide no decision support for model variations. ROSEMANN and VAN DER AALST introduced Configurable Event Driven Process Chains (C-EPC) as a language for configurable reference modelling.[128] C-EPCs extend the widely used modelling language Event Driven Process Chains (EPC) with means for the specification of a configurable model. The specification supports the derivation of individual models by declaring *variation points* as well as their relationships to other affected model parts.

The research on C-EPCs can be divided in three main stages: First, an investigation on the theoretical foundation of configuration in the given context, second, the definition of the modelling language, and third, the testing and evaluation of the proposed technique. I rest my elaborations on Configurable EPCs on these three steps, as I will refer to parts of the development stages later in chapter 4.

In a first stage, *configuration patterns* have been identified and classified. A configuration pattern highlights distinguishable configuration alternatives.[129] The set of patterns has been developed from existing workflow patterns.[130] Eight of these patterns were found to be useful in this context and have been assigned to examples of Event-Driven Process Chains.[131]

124 Compare Rosemann (2000), p. 28.
125 Compare Dreiling et al. (2005b), p. 693.
126 Compare Recker et al. (2006a), p. 370.
127 Compare Rosemann, van der Aalst (2007), p. 2.
128 See Rosemann, van der Aalst (2007).
129 Compare Dreiling et al. (2005b), p. 694.; Rosemann, van der Aalst (2007), p. 6.
130 Compare Dreiling et al. (2005b), p. 697.
131 Compare Rosemann, van der Aalst (2007), p. 6.

The eight configuration patterns with the identified corresponding elements of EPCs are listed in Tab. 3.[132]

Configuration pattern	Corresponding C-EPC element	Configuration options	Graphical representation
Optionality	Configurable function	Included (ON), excluded (OFF), conditionally skipped (OPT)	
Parallel Split	Configurable AND-connector	Regular AND or limitation to an amount of n available sequences ANDn	
Synchronisation			
Exclusive Choice	Configurable XOR-connector	Regular XOR or a single sequence SEQn	
Simple Merge			
Multi Choice	Configurable OR-connector	Regular OR, regular AND, regular XOR or a single sequence SEQn	
Synchronising Merge			
Sequence Interrelationships	Configuration requirement	Describes constraints between variation points	
	Configuration guideline	Describes recommendations regarding variation points	

Compare Dreiling et al. (2005b), pp. 697-701.

Tab. 3: Configuration patterns and corresponding graphical elements

In the second step, a *language for configurable reference modelling* has been developed and formalised.[133] The starting point for the definition was establishing a set of requirements for a configurable reference modelling language. Then, the process modelling language of Event Driven Process Chains has been selected as the basis for an extension because of its popularity for reference modelling. On the foundation of a formal definition of

132 For further information on the development of the configuration patterns refer to Dreiling et al. (2005b), pp. 696-701.

133 Compare Rosemann, van der Aalst (2007), p. 6.

EPCs, C-EPCs have been specified formally with a set of definitions:[134] A Configurable EPC extends an EPC with the following elements:

(1) configurable functions

(2) configurable connectors

(3) configuration requirements

(4) configuration guidelines

(5) a partial order over the configurable nodes.

(1) and (2) allow for a specification of variation points by highlighting nodes that offer configuration alternatives. Hereby, it has to be considered, that a configurable connector may only be mapped to a connector type that restricts its behaviour.[135] (3) and (4) connect variation points with either mandatory rules (*configuration requirements*) or optional rules (*configuration guidelines*) to facilitate the configuration of the model. (5) specifies the suggested order of configuration. The latter corresponds to the derivation of lawful EPCs from the C-EPC model. An algorithm addresses this topic, defining each step of model configuration in detail.[136] Related to this are additional investigations on the engineering process for a model-driven configuration of Enterprise Systems.[137] The development of the graphical representation of the configuration patterns happened by carefully considering the complexity of the models. Configurable nodes are simply equipped with thick border-lines while requirements and guidelines are logical expressions connecting the affected nodes with dashed lines. Tab. 3 summarises the discussed topics by showing the graphical extensions to the EPC notation and the configuration options of the configurable nodes. It must be noted, that a configurable connector only supports a configuration to itself or to a connector that restricts its behaviour.[138] Fig. 2.4 shows a simplified example of a C-EPC model.

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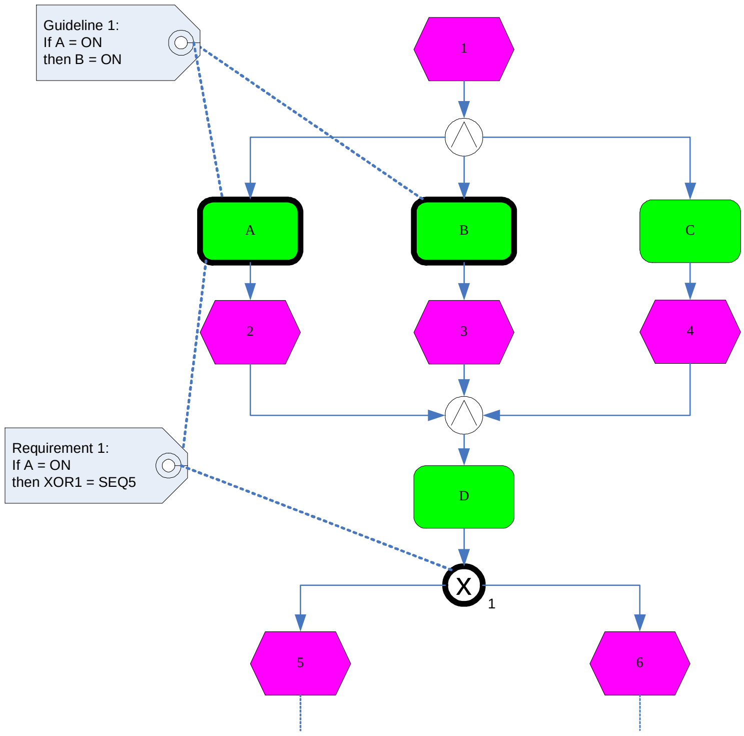
134 For the a comprehensive and formal definition of Configurable EPCs refer to Rosemann, van der Aalst (2007), pp. 8-19.

135 Compare Recker, Rosemann, van der Aalst (2005), p. 3.

136 Compare Mendling et al. (2006), p. 1509; Rosemann, van der Aalst (2007), pp. 16 f.

137 See Recker et al. (2006a).

138 Compare Rosemann, van der Aalst (2007), p. 12.



Source: Compare Rosemann, van der Aalst (2007), p. 12.

Fig. 2.4: Example for a Configurable EPC

The third step deals with the *testing and evaluating the language* and with related further research. First studies on the user perception of configurable reference process models verify advantages in comparison to languages without configuration support.[139] C-EPCs successfully enhance the recognition and ease of selection of configuration alternatives. Nevertheless, a lack of tool support as well as a needed refinement of both definition and notation was found.[140] Further research includes the validation of derived models and XML schema-based representation of the C-EPC language for a simple interchange of artefacts and for automated validation of model configurations.[141]

With respect to the research objectives of this study, there are several issues to consider. As mentioned above, further refinements of definition and notation of the C-EPC language were found to be necessary. FETTKE and LOOS state, that especially in the field of reference modelling, not enough findings, which are gained from real cases, flow into the development of modelling languages and that too little concepts are measured with empirical results.[142] I will address this lack of practical justification. The construction of a configurable reference model for post-production offers the opportunity to use the gathered practical

139 Compare Recker, Rosemann, van der Aalst (2005), p. 8.
140 Compare Recker, Rosemann, van der Aalst (2005), p. 9.
141 For further information refer to Mendling et al. (2005); Recker et al. (2006b); Recker et al. (forthcoming).
142 Compare Fettke, Loos (2004), p. 17.

experiences to reflect on the conceptual foundations of the C-EPC development. I hereby investigate both on the *requirements for configurable reference modelling languages* that were established in conjunction with the development of the C-EPC language and on the *configuration patterns* that are covered by C-EPCs.[143]

In addition to this, my study focuses on configurable reference modelling in a broader sense. Regarding the presented application areas of information modelling in Fig. 2.3, the development of C-EPCs originally belongs to the support of standard-software configuration, thus to the more technical area of use. This is of particular interest, because the approach for the Australian screen business – and therefore the reference model for post-production as well – aims to be a holistic BPM approach. It is possible that this includes technical issues, for example efforts of workflow automation of suitable areas. But at this early stage, and regarding the construction of the reference model in this work, I am focussing on the area of organisational optimisation. Consequently, the development of the reference model will represent a transfer of C-EPCs to a broader BPM context. This goes along with the idea of VAN DER AALST et al., who also propose a discussion on an extended scope of use for configurable models.[144] This case study can give initial insights to this subject and deliver practical examples on the issue. I conclude that this topic should be considered when drawing conclusions from the modelling experiences. Therefore, my reflections in chapter 4 will also discuss adaptation mechanisms in a broader context.

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143 Compare Rosemann, van der Aalst (2007), pp. 7 f.; Dreiling et al. (2005b), pp. 696 ff.
144 Compare van der Aalst et al. (2006), p. 76.

3 Construction of a reference model for post-production

This chapter approaches the first research objective, the construction of a reference model for post-production in the Australian screen business. The first section presents the applied construction method, which determines the structure of the rest of the chapter. This includes the three major steps As-is modelling, specification, and configuration that are following this section.

3.1 Construction method

In general, I follow the approach of ROSEMANN and VAN DER AALST and the engineering process of RECKER et al.[145] Tab. 4 puts the major stages of the reference model lifecycle model in relation to the proposed engineering process for model-driven ES configuration. The structure of my construction process slightly varies from what has been presented. This is mainly due to the different area of application and the emphasis on certain parts. The design or specification phase contains the model development, using available individual models as an input.[146] Since no suitable models could be found that can be used as a basis for the specification of a reference model in the domain, I depict As-is modelling as one of the major steps. I emphasise this step by considering it as an extra step instead of including it in the specification. The configuration stage comprises the selection of configuration alternatives to derive an adapted model from the configurative model. This is also part of my study, as an evaluation of the constructed model needs the confirmation of validity of derived models. The transformation of configured models to individual models on the other hand is not regarded as an extra step in my context. This doesn't mean that the transformation does not need to happen. It is rather taken as a straightforward task that has already been validated in research and therefore is of minor interest to this work.[147] In my approach the transformation takes place at the end of the configuration phase. The last stage is the deployment of the derived models on a running enterprise system.[148] In my case, this means the final application for organisational improvements in the described holistic BPM approach. This will not be covered within the scope of my study. Nevertheless, this phase has an important impact on the construction of the reference model, as the

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145 See Rosemann, van der Aalst (2007), pp. 4 f.; Recker et al. (2006a).

146 Compare Rosemann, van der Aalst (2007), p. 5. RECKER et al. also mention the "development from the scratch". Compare Recker et al. (2006a), pp. 372 f. Additional emphasis should be laid on the configurative extensions of the models. My approach satisfies this demand by separating the construction of the individual models from the integration of the configuration elements.

147 See Mendling et al. (2006);

148 This goes back to the development of the engineering framework for Enterprise Systems configuration. Compare Recker et al. (2006a), pp. 375 f.

construction can only happen with knowledge about the intended use of the derived models. An extensive investigation on the surrounding context has been given in Section 2.1.

<table>
<tr><th>Reference model lifecycle
Rosemann, van der Aalst (2007)</th><th>Engineering process for model-driven ES configuration
Recker et al. (2006a)</th><th>Presented reference model construction process</th></tr>
<tr><td rowspan="2">Build-time
(Design-phase)</td><td rowspan="2">Specification</td><td>As-is modelling</td></tr>
<tr><td>Specification</td></tr>
<tr><td>Configuration-time</td><td>Configuration</td><td rowspan="2">Configuration</td></tr>
<tr><td>Build-time</td><td>Transformation</td></tr>
<tr><td>Run-time</td><td>Deployment</td><td>(Deployment)</td></tr>
</table>

Source: Compare Rosemann, van der Aalst (2007), p. 5; Recker et al. (2006a), p. 371.

Tab. 4: Comparison of configurable reference model stages

For the purpose of my study the reference model engineering process has been simplified to the three main stages As-is modelling, Specification and Configuration.[149] In the following this structure serves as a guideline. The partitioning particularly allows for an arrangement with regards to the type of model that is the outcome of the phase. Fig. 3.1 presents a framework for reference model construction considering this issue. The produced models of the As-is modelling stage are meant be on an individual level. In an abstract way, the specification phase lifts the input models from an individual model level to a reference model level, because it provides the model with additional information that supports re-utilisation. The terms individual model level and reference model level hereby can be seen as a set of characteristics that describe the corresponding model class. During Configuration, there is a shift backwards from the level of reference models to the individual model class. This happens through decisions regarding the variation points. The result is an individual model that is adapted to a certain context and provides no more explicit configuration mechanisms.

149 The boundaries of these stages can't be set fully accurately. One stage sometimes partly overlaps the following stages. However, they help to structure the overall procedure.

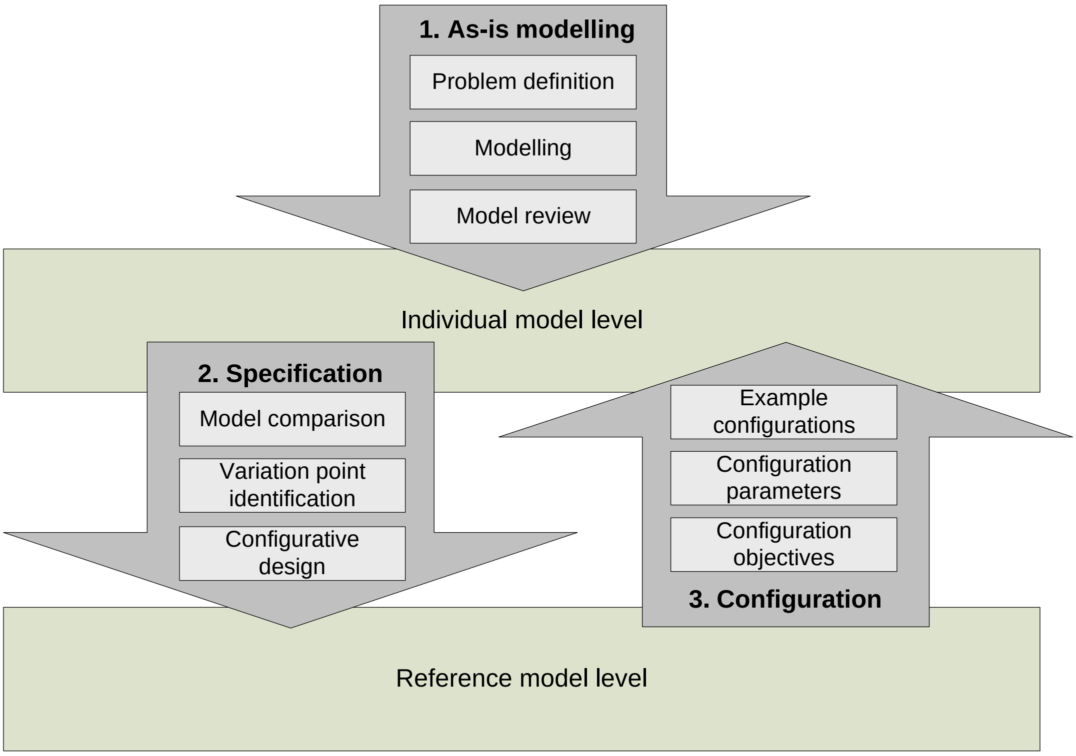

Fig. 3.1: Configurable reference model construction framework

3.2 As-is modelling

As illustrated in Fig. 3.1, the As-is modelling stage consists of the parts (1) problem definition, (2) modelling, and (3) model review. However, the main focus of the thesis lies on the outcome and not on the process itself. Therefore, I only briefly address the three main steps and explain how I put them into practice. Afterwards, I present parts of the results of the As-is modelling efforts. A full presentation of all results would not be helpful for this purpose. As my reference model is supposed to be a consolidation of the As-is models, there would be a lot of redundancies if I explained both the set of individual models and the reference model in the same detail. Instead, I want to give a brief overview of the conducted steps and then present the outcome from an organisational and data perspective. This includes elaborations regarding the main involved persons and data objects that have been identified during that stage. This will be the basic knowledge to allow for a later, more thorough presentation of the process models with a reference model character.

3.2.1 Procedure

Problem definition

A sound problem definition is necessary to start the As-is modelling phase. This has been done thoroughly in chapter 2. The modelling efforts have been arranged in an overall context and a definition of screen business and post-production has been introduced. I repeat that I want to model the essential processes of the post-production part of screen business productions, thus achieving an explication of the tacit knowledge of the industry. Special attention is spent on the identification of model variants that are based on different shooting and delivery types, as this is a major source for complexity and hinders transparent management and planning of post-production. Furthermore, budget implications of process parts are of particular interest. As practitioners repeatedly mentioned their dislike of flowcharts due to their potential of restricting creativity, special attention has be spent on the identification of creative areas. It is thought to manage creativity without sacrificing it. The models are constructed with the modelling language of Event-Driven Process Chains to allow for a subsequent specification of a configurable model.

Modelling

The next step addresses the modelling of processes, data, and the organisational structure. It was performed with the information from literature review and from the collaboration with the Australian Film Television and Radio School (AFTRS). The AFTRS is a federal statutory authority that provides professional education and advanced training in the areas of film, television and radio since 1973.[150] The collaboration within the project "Business Process Management for the Creative Industries" allowed for an active communication and interviews with industry practitioners to obtain detailed knowledge of the domain.[151] Given this, one can say the models mainly incorporate "taught knowledge". Additional interviews with further industry partners that have been conducted in conjunction with the project of the CCI, allowed an identification of topics that are of particular relevance in practice.[152]

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[150] Compare Australian Film Television and Radio School (2006).

[151] One of the first steps was to establish a common glossary of domain-specific terms. It can be found in appendix F.

[152] For further information on the project "Business Process Management for the Creative Industries" and the involved industry partners, see Seidel (forthcoming).

The post-production processes were modelled with respect to different views.[153] The main focus in this work lies on the process-view. This is because identification and structured illustration of the essential processes had the highest priority. It was necessary to distinguish between more static areas which have in some way a constant order and creative areas which are mainly based on creative work. In addition to the process view, I modelled the organisational and data view. These views also provide a valuable source of information to enrich the process models and at the same time ensure consistency concerning included elements. The allocation of organisational and data objects to functions in the process models can be seen as a consolidation of the views.

Review analysis

The third stage comprised several iterations of reviewing and altering the models. This also allowed going into more detail in those parts of the model whose arrangement in the overall process has been verified. The review process included a modelling session with Katie Shortland and several telephone interviews with industry practitioners of the AFTRS.[154] The reviewed models finally served as a basis for the specification of a configurable reference model.

3.2.2 Organisational view

The organisational view on post-production is depicted in Fig. 3.2 as a hierarchical organisational model. According to the classification of SCHEER, it represents an organigram on type level with the element position as the smallest unit within the organisational structure.[155] A position comprises the work amount that a single employee can handle. Therefore, it can be mapped to an individual person.

The organisational model exhibits some restrictions. First, it doesn't qualify for completeness. The different character of screen business projects brings along varying organisational structures. Especially the divide in independent low-budget productions and internationally financed high-budget productions in Australia leads to different organisational

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[153] Basis to the distinction of the views is the Architecture of Integrated Information Systems (ARIS) house of SCHEER. It distinguishes between organisation, function, data, control and output view. Compare Scheer (1999), p. 1. The function view doesn't provide truly new content. All information in the function diagram – the functions – is implicitly incorporated in the process models. For this reason it is not included here.

[154] Katie Shortland is film producer and project officer of the centre for screen business at the AFTRS. In several interviews she supported the modelling and review process with her comprehensive knowledge and experience on the topic.

[155] Compare Scheer (1999), pp. 53 ff.

concepts.[156] Consequently, it was quite difficult to determine a common composition of organisational units. The presented organisational chart in is an exemplary arrangement of positions to organisational units. It contains all positions that are depicted in the process models. Both the names of the positions and their arrangement to functions can vary in practice.[157] If, for example, a project has an executive producer and a line producer it has to be considered that the tasks of the producer are split up between both people.[158] Despite these restrictions, it is still important to have this organisational chart, not only as an arrangement and overview of all included positions but also as a basis for the mapping between a company's organisational composition and the process models. It provides a repository of positions thus making sure that the use of organisational elements is consistent throughout all other models and the project. In the following, the elements of the model are briefly explained.

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[156] Compare Reed (1999), p. 8.

[157] I am aware of the fact, that – regarding he organisational model – the reference model looses a bit of its universality. A subsequent extension towards a configurable organisational model can help to satisfy the claim of universality.

[158] This is not in conflict with the presented definition of a position, because the amount of work is assumed to be more in the case of high budget productions with an executive producer and a line producer.

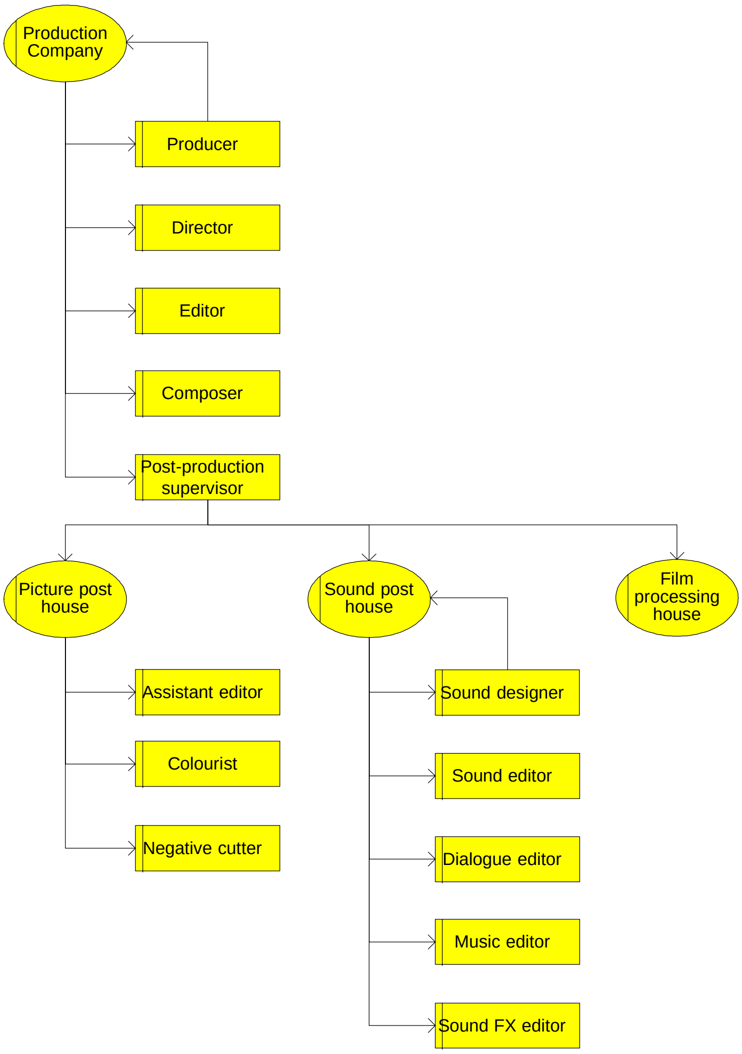

Fig. 3.2: Organisational chart

Production company

The production company in the model is an abstract representation of what can be an official company or coalition of key people only for a certain project. For an independent film production, the film company can consist of only one person, while high-budget productions are in most cases backed up by large studios.[159] Still both types of projects need some key people. In my approach, I consider the people main responsible to be part of or hired by a production company. This is the producer that is depicted as organisational responsible for the production company, the director, the editor and the post-production supervisor. These people make sure that all other necessary people are scheduled and available. The

159 Compare Jones (2003), p. 30.

final creative authority also lies on the people of the production company. All other positions of post-production are consolidated in the groupings picture post house, the sound post house, the film processing house, and the printing house. These groups can be internal departments or external parties hired for post-production.

Producer

The producer has two main jobs. Firstly, he deals with the financial topics of the project like funding and distribution and secondly, he gathers a set of people who are critical to the success of the production like director or key actors. In large productions the tasks of the producer can be split up to an executive producer and a line producer. In this case, the executive producer mostly arranges the financial setup while the line producer is responsible for everything else that ensures a successful production. Most of this work happens during the early stages of the value chain. However, the producer remains as the responsible person that is blamed in case of failure. Therefore, he is integral to post-production, because he can have the final creative authority and hence is involved in approval procedures. How much the producer is engaged in the creative part of the production process varies from person to person.[160]

Director

The director is certainly one of the key persons of every project. He is mainly working on the vision of the project during pre-production and its realisation during production and post-production. At the post-production stage, the director cooperates with the editor to achieve the desired outcome. Depending on the experience and influence in the industry, the director may have even greater creative authority than the producer.[161] Therefore, he is also involved in approval processes during post-production. A difference between medium and high-budget projects, concerning the director, can be found in the experience of the director and in the support he gets from one or even more assistant directors. As the assistant directors are mainly involved during pre-production and production phase, they are not considered here.[162]

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160 Compare Wales (2005), pp. 48 ff.
161 Compare Wales (2005), p. 51.
162 Compare Wales (2005), pp. 86 ff.

Editor/Assistant Editor

The Editor is the person who creatively assembles picture and sound to tell the desired story.[163] In high budget productions, the tasks of the editor are limited to this creative part while assistant editors are supporting him.[164] In this case, the assistant editor (AD) is the most important member of the editor's team. What work the director actually delegates to his assistant director depends highly on their relationship and the experience of the assistant director. An inexperienced AD mainly wants to learn the editing job and gain from the experience of the editor.[165] In a well coordinated team, a skilled AD can even take control of the first or second cut of a certain scene.[166] In general the editor- with or without assistant editors – works in the editing suite and has to make sure that the cut of picture and sound follows the vision of producer and director.[167]

Composer

The composer creates the underscore of the project. The composing happens in accordance with the producer or director. Therefore, the composer discusses the intended music support and creates melodies for characters or scenes. When the final cut is complete, he can create music sections that fit exactly to the music cues the director or producer agreed on.[168] It must be noted, that the *music* is often treated separately from the audio aspects that belong to the *sound* track.

Post-production Supervisor

In general, the producer is considered to oversee the project from the beginning to the end. In large projects though, he can delegate the task of supervision to other people. In the case of post-production, this is the post-production supervisor. [169] This person then has to coordinate all tasks and is responsible for the time schedule.[170] KELLISON states that the post-production supervisor is essentially the producer of the post-production stage. [171] Therefore, this person has the organisational responsibility for all other involved parties, indicated by the arrow from the post-production supervisor to the aggregating organisational units in Fig. 3.2.

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163 Compare Jeffrey (2006), p. 389.
164 Compare Wales (2005), p. 206.
165 Compare Brown (2004), p. 71.
166 Compare Wales (2005), p. 211.
167 Compare Kellison (2006), p. 149.
168 Compare Wales (2005), p. 231.
169 Compare Kellison (2006), p. 143.
170 Compare Wales (2005), p. 205.
171 Compare Kellison (2006), p. 143.

Colourist/Grader

The colourist is an important person in the early stages of the post-production phase. He is a professional telecine operator who performs the transfer to tape in the telecine suite. Furthermore he can synchronise the sound and picture during that process and make a first colour correction (grade).[172] Due to the quite similar meaning of grading and colour correction the colourist is sometimes also called grader.[173]

Negative Cutter

As the title says, the negative cutter is simply the person who cuts the negative.[174] This happens in instances when the project is finished on film. The editing-decisions, which have final approvement, are realised on the actual negative print, as the negative cutter cuts the footage according to the provided information and splices the resulting parts into a coherent piece. Sometimes the splicing is also done in the film processing house.[175]

Sound Designer

In high budget production, the sound designer supports the post-production supervisor in developing the sound concept and coordinating its realisation. Hence he is sometimes called the sound supervisor or supervising sound editor. He first discusses the sound concept with the director or producer and then superintends all aspects of the sound track. This includes hiring people for the audio post-production, the creation of sound tracks like sound effects track, Foley tracks or music tracks and finally the sound editing and mixing.[176] He is therefore the organisational manager for the sound post house. The latter is the assembly of all sound related persons. It can be an external audio facility with a studio and all necessary audio equipment to record and edit the sound tracks. In low-budget productions, it is possible, that only one sound editor or even the video editor is responsible for all sound-related tasks, so no sound-designer is needed.[177]

Sound Editors

The appearance of a sound editor, dialogue editor, sound FX editor, and music editor again highly depends on the budget of the production. They are responsible for the creation and

172 Compare Chandler (2004), p. 33.
173 Compare Jeffrey (2006), p. 392.
174 Compare Chandler (2004), p. 17.
175 Compare Chandler (2004), pp. 317 f.
176 Compare Wales (2005), p. 212.
177 Compare Kellison (2006), p. 158.

editing of a range of sound tracks. Hereby, the sound editor may assemble the tracks that have been created by the other sound editors.[178] Further breakdown to other sound editors is possible, as even more specialised experts are potentially used in high-budget productions. With respect to the scope of my study and regarding the potential use for low and medium budget production I forbore from doing so.

Film processing house

The film processing house is in most cases an external company that undertakes all film processing and printing. Any film footage first must be made both visible and permanent. Therefore, the film processing is the first place where footage goes after the shoot. It has all necessary technical equipment for this chemical process and can also be consulted for film printing services.[179]

3.2.3 Data view

To model the data view is a complex task and includes modelling numerous objects of mixed granularity.[180] With respect to the intended use of the models and the complex data structures during post-production, more than a single layer of the data view has been analysed. The necessary exhaustive support for the process models has been provided with the less detailed macro description of the data view, using technical terms, information carriers, and application systems.[181] To illustrate the required data for a process, it can be more comprehensible to use partly preliminary objects of this kind.[182] The individual elements are explained later in conjunction with the actual process models.

As SCHEER states, it is not necessary to move to a more detailed micro description until the business related analysis stage.[183] However, with respect to an intended subsequent potential workflow automation of suitable parts of the processes, which benefits from a formal description of the involved data, I developed a first data model of the micro data view. It presents selected parts in greater detail, which are – if possible – already represented in the

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178 Compare Wales (2005), pp. 212 ff.

179 Compare Wales (2005), p. 224 f.

180 Compare Scheer (1999), p. 67.

181 Appendix A contains a list that has been used for the conversion of rather colloquial terms, which were used by industry practitioners or found in literature, to the more formal description, required for the process models. The list shows the distinction between the carrier of the information and the actual information itself.

182 The investigation of a macro view makes especially sense in conjunction with the generic character of a reference model. For further information on the difference of the macro and the micro view see Scheer (1999), pp. 69-71.

183 Compare Scheer (1999), p. 69.

process models. The diagram is depicted in Fig. 3.3 in the form of an Object-Role Modelling diagram.[184] Object-Role Modelling (ORM) has its roots in the early 1970s as an approach for semantic modelling. It is driven by the principle to look on *objects* regarding their part in the relationship to other objects, thus, what *role* they are playing.[185] ORM is chosen because of some advantages over other data modelling techniques like ER modelling.[186] Hereby, I especially refer to the suitability of its notation for validating models with domain experts. ORMs conceptually support the task of verbalising the model content in natural-language sentences. In my case, this certainly facilitates the communication with industry practitioners who are not used to formal data representations.

For the same reasons as the organisational model, the data view model is subject to restrictions regarding completeness and adaptability. However, the model can serve as a basis for further research and can be easily extended. Due to the focus on process models, I only briefly discuss the most important parts of the model. Hereby, I concentrate on two major topics: The parts regarding the composition of a final product of a screen business project and the parts regarding the edit in the form of an edit decision list.

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[184] I apply the ORM version used in Halpin (2001). It is based on extensions to the natural-language information analysis method (NIAM). Compare Halpin (2001), p. 8. The different parts of the data view model including a sample population can be found in appendix

[185] Compare Halpin (2001), p. 8.

[186] For further explanations on the advantages of ORM over ER modelling see Halpin (2001), p. 11.

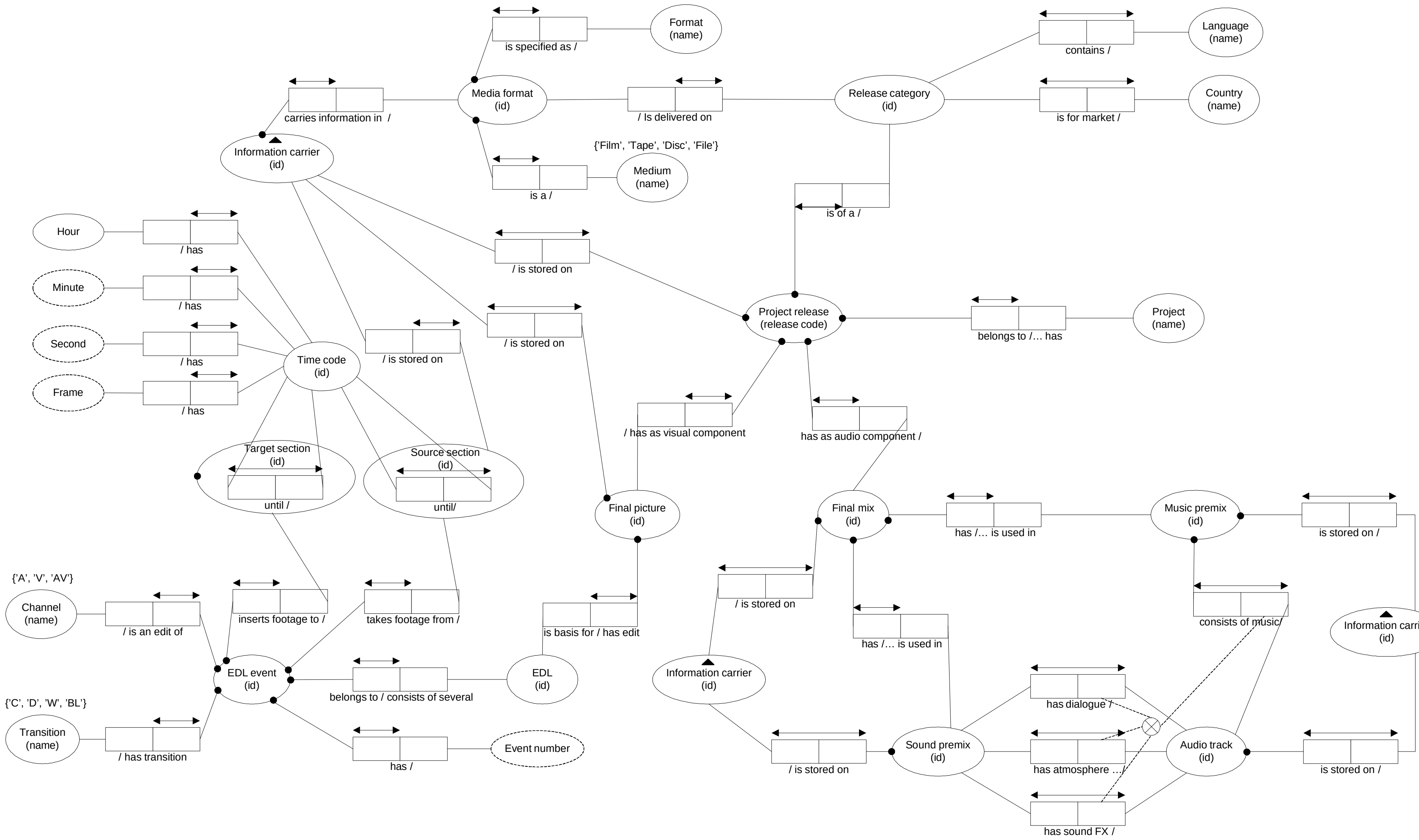

Fig. 3.3: Data view diagram

I use the `project release` as a starting point, to explain of what comprises a screen business product. It represents the final version that is distributed to the market. Every project release belongs to a `project`. The latter can have several project releases which can be for different markets, etc. These different purposes are specified as every project release is of a certain `release category`. The various possible release categories can be defined with several characteristics: (1) The market they are addressing, specified by one ore more `countries` they are related to; (2) the assortment of `languages`, the release offers; (3) the `media format`, the release category is delivered on. More characteristics for a release category are possible and can be added easily.

A project release furthermore consists of one visual and one audio component. The visual component is the `final picture`; the audio component is called the `final mix`. I have chosen to illustrate the composition of the final picture through the composition of the `edit decision list (EDL)`, due to its importance for the post-production process. The final mix comprises of a `sound premix` and a `music premix`. Both of these are assembled by several `audio tracks`.[187] The music premix consists of one or more music audio tracks. Regarding the sound premix one can distinguish between the role of the audio track as a dialogue, atmosphere and sound FX tracks. These are – from a data modelling perspective – of the same kind as the music audio tracks. However, an audio track can be used multiple times for sound or music premixes but can only be used as one these kinds, e.g. only as a dialogue audio track or only as a sound FX track. A further decomposition to more specific audio tracks is possible but considered as not useful in this context.

The named elements of the data model, which are related to a visual or audio artefact, are all stored on an `information carrier`. This rather unusual inclusion of physical storage in a data model is based on the finding that there is an immense amount of data, often with physical exchange of this data in form of tapes or film reels throughout the whole post production process. A basic way to support this aspect is to keep track of the location of all data.[188] My schema therefore includes the information carriers which can then deliver facts about the physical location. In my model the information carrier is further specified to carry information in one certain `media format`. This comprises a certain `format` and clarifies the kind of `medium`, which can be film, tape, disc or file.[189]

The data model also contains a decomposition of the elements of an edit decision list.[190] Here, the entity type `EDL event` serves as a starting point for my explanation, as follows:

187 Compare Laramie (2004), pp. 57 f.
188 Compare Chandler (2004), pp. 82 ff.
189 Compare Laramie (2004), pp. 60 f.
190 The presented structure of an EDL refers to the structure of the most common and most compatible EDL standard called “CMX3600”. Compare Chandler (2004), p. 287.

An EDL event always belongs to one certain EDL, while an EDL can consist of several events. Events are further specified. First of all, each event has a certain event number. Second, an EDL event has to be provided with a `transition`, which can be a cut (C), a dissolve (D), a wipe (W) or a black screen (BL). Further on, an event is an edit of a certain `channel`, which is limited to an edit of audio (A), video (V) or both of it (AV). Last but not least, each event has a set of `time codes` that indicate the footage that has been chosen and the place where this footage is inserted in the actual project. The combination of starting and ending time code, where the EDL event takes the footage from, is depicted as `source section`. The `target section` contains the combination of starting and ending time code for the resulting composition respectively. Both target and source sections consist of combinations of time codes that have a value of `hours`, `minutes`, `seconds` and `frames`.[191] Still they have to be kept separate: While the target section specifies a section on a future composed piece of footage, every source section is stored on exactly one information carrier. This reference is considered to be important for already mentioned reasons of data storage and retrieval.

The decomposition of an EDL into its elements shows as exemplary, how the content of documents in the post-production process is related to other information objects. It has yet to be investigated what other well-structured documents could be usefully examined in this way. Potential examples are the cutlist or documents of the rushes paperwork.[192]

3.3 Specification

This section focuses on the outcome of the specification phase. This is a set of detailed process models, which have been specified for configuration. For a better understanding of the variation points and to avoid redundancies, I present the process models here for the first time. Therefore, this section also explains the content of the process models. [193] The specified variation points are included in the comments to each model. Fig. 3.1 subdivides the specification phase in (1) model comparison, (2) variation point identification, and (3) configurative design. I first give an overview of these three stages regarding the construction process itself and then present the set of process models.

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191 Compare Chandler (2004), p. 29.

192 The rushes paperwork is a set of reports that arrives in the cutting room before the edit starts. Compare Chandler (2004), p. 53.

193 The descriptions of the models with no exact reference, have been constructed with the help of industry practitioners or on the basis of the following main literature: Chandler (2004); Clark, Spohr (1998); Gillezeau (2004); Jones (2003); Kellison (2006); Laramie (2004); Wales (2005).

3.3.1 Procedure

Model comparison

The processes modelled before this stage included alternative and substitutional procedures, due to various factors that influence post-production like the type of delivery. I aim to consolidate the alternative post-production paths in my reference model. Therefore, the first step was a model comparison with focus on the *content* of the models and the *relations* between them. On the one hand, the investigation on the content concentrated on the similarities and differences of models that belong basically to the same part of the overall process. Thus, I identified and marked alternative methods to cope with a task. On the other hand, the investigation on the relations between the models aimed for a consolidated control flow with clearly specified boundaries of the several parts. Consequently, I compared the already identified alternative methods, with focus to their arrangement in a consolidated overview process and the consequences of such a consolidation for adjacent processes. Consolidation in this context means the mergence of alternative process models within one process model, including considerations on the necessity of conserving the alternative processes. The main process presented later in section 3.3.2 especially shows this consolidation of alternative procedures.

Variation point identification

The preceding model comparison allows for going one step closer to a configurable model. The next task is to identify the variation points. Here, the discovered differences or alternatives in the model have to be traced back to the underlying decisions that trigger these process variants. After the exact place of a variation point within the process has been determined, the context that corresponds with this variation point has to be defined. All process variants can somehow be translated to a choice by the responsible person. As every film is the result of numerous choices, every post-production path taken is the result of certain decisions made.[194] Thereby it has to be considered that no unnecessary variation points are inserted because the extension of the model increases its complexity.[195] This step entails important findings about potential *configuration objectives* and the related *configuration parameters*. I will address these issues later, when I explain the configuration of the reference model in section 3.4. Therefore, I don't focus on these findings in the following model descriptions.

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[194] Compare Gibbs (2006), p. 5.
[195] Compare Rosemann, van der Aalst (2007), p. 20.

Configurative design

The configurative design finishes the specification phase. The two preceding steps delivered the findings on how the model could be consolidated and where and what kind of variation points exist. The configurative design implements the configurability by means of using the model extensions provided by the C-EPC notation. All model extensions employed in the models have been introduced in Tab. 3.[196] The results of this step are presented in the following.

3.3.2 Main process

The *main process* model in Fig. 3.4 gives an overview to the overall process. It contains several complex functions that are described in further detail in additional sub models.[197] This way, the main process visualises very well the consolidation of the different As-is models. As a result of this consolidation, the sub models especially are subject to configuration options. Post-production can be divided very roughly into three groups of tasks: Before the edit, the edit, and after the edit.[198]

Before the edit

The main process starts at the beginning of post-production, thus, when the footage from the shoot arrives. I distinguish two different types of shooting, according to the media used for the shoot because of their strong impact on the following tasks. This is indicated by two separate starting events: `Tape shoot is finished` and `film shoot is finished`. In both cases, the footage arrives and in some way has to get into the editing system for the edit. In the case of a film shoot, the footage arrives in the form of an exposed negative. This `original camera negative` (OCN) must first be carefully processed at the `film processing house`.[199] The `rushes paperwork` arrives together with the footage. It is a set of reports that contains notes regarding the script, camera reports and sound reports. They are an important source of information about the shoot and the foot-

196 The other elements allocated to the function like elements of the organisational or data view are not made configurable, as I only apply the C-EPC notation. The latter focuses on the control flow. A specification of configuration options for the other views has not been considered, but can be added later.

197 It must be noted, that for reasons of clarity, only the most important elements are attached to complex functions that have an underlying sub model. This follows the concept of vertical structure through hierarchical decomposition. Compare Davis (2001), pp. 242 ff.

198 Compare Chandler (2004), p. 46.

199 Compare Chandler (2004), p. 46; Laramie (2004), p. 26.

age. They are normally filed and can be used throughout the post-production process.[200] The `processed negative` is sent to the `picture post house` where the editing happens. `Prepare film for edit` is described in a sub model that defines how the film is prepared for the editing process. In case of a tape shoot, the footage must be prepared in a different way. This is described in the sub model of the function `prepare tape for edit`. All mentioned functions are only necessary in the case of the respective shoot. The configurable connector `OR1` can be configured to depict a model for tape shoot, film shoot or a combination of it.

The edit

The edit itself is divided in several steps. First of all, picture and audio is done separately. Second, the edit of the picture can be divided in low resolution and high resolution edit. This is reflected by following elements of the model. The low-res edit is called `offline`. The lower resolution requires less processing power and therefore allows for faster work on the picture. The result of this highly creative part of the edit is the `edit decision list` (EDL). Now, both the `sound and music editing` and the high-res edit can commence. The audio editing hereby delivers the `final mix`, which is included in the project during the project finishing. The high-res edit realises the edit decisions of the EDL on distribution quality. The model offers two alternative ways. The traditional film path starts with the `negmatching`, where the original negative is cut in pieces and spliced back to a coherent piece. In a subsequent step, it is printed with final colour corrections (`answerprinting`). In the case of a so-called `online`, the picture is put together in high resolution in an online editing suite and is then recorded to a tape `master`. The configurable connectors OR2 and OR3 permit a configuration regarding the high-res edit from a restriction to one of the two alternatives up to a parallel execution of both tasks. `Requirement 1` states that the film-based variant can only be configured if at least parts of the show have been shot on film. None of the functions is configurable to ensure that a high-res edit is done in all cases. Hence in all cases the picture and the sound have been edited before the project is completed in the last phase.

After the edit

After the edit the project must be finished for delivery. Again, several combinations are thinkable here. There are not many restrictions because the finish on certain formats can

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200 Compare Chandler (2004), pp. 53 ff. I also count any other reports and files from the production phase, which could be used in post-production to the rushes paperwork. Examples of other production paperwork can be found in Wales (2005), pp. 100 ff.

theoretically happen quite independently from what has been done before. A finish on film, tape, disc & file or any combination of these can be represented depending on what configuration is chosen. This configuration is based on the configurable connectors `OR4` and `OR5` and the configurable functions of the three central ways of finishing a project: `Film finish`, `tape finish` and `disc & file finish`. Each finish has the respective output in the form of a `final master` tape, a film `release print` or any `release version` on disc or file.

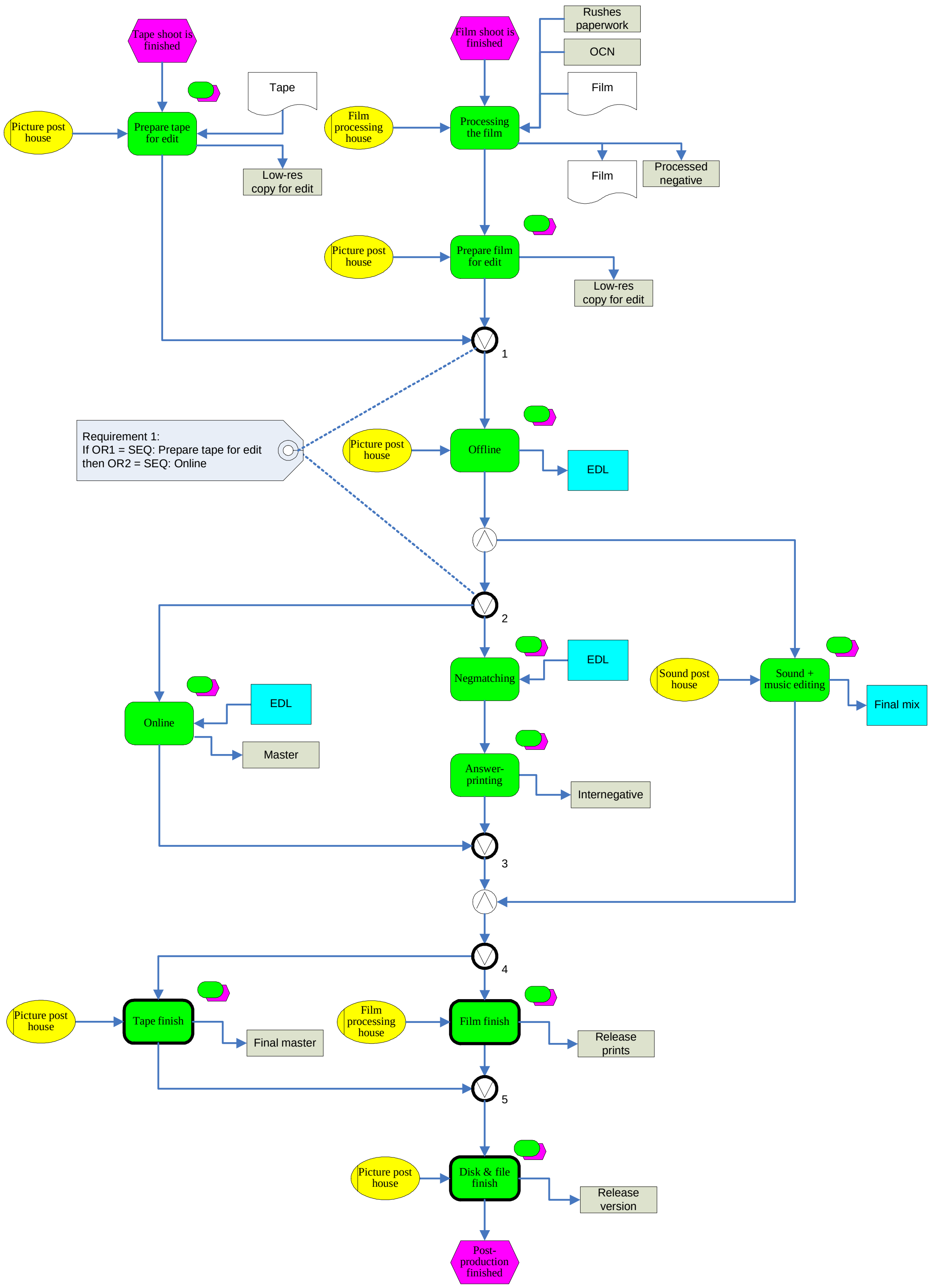

Fig. 3.4: Main process

3.3.3 Prepare tape for edit

I now explain the sub models of the complex functions in the main process. The first of these decompositions is *prepare tape for edit*, which is depicted in Fig. 3.5. It is a rather straight forward process, as it contains 4 functions that have to be executed and no model variations exist. To get the footage ready for the edit, the `editing assistant` first needs to digitise the incoming footage (`dailies`) to make it available to the editing software `(Digitise footage)`.[201] Afterwards the `location sound` is imported and synched with the picture (`synch sound and picture`). In practice, the footage is generally logged after the input to the system with the intention to make the footage available for viewing as fast as possible. The `logging` happens according to a predefined `logging protocol` and is an important and potentially very time-consuming job.[202]. In addition to what has to be done during logging, the footage needs to be organised (`organising clips`). This refers to the database creation and categorising of the digitised clips on the system.[203]

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[201] Compare Gillezeau (2004), p. 145; Wales (2005), p. 211.
[202] Compare Chandler (2004), pp. 80 ff; Gillezeau (2004), pp. 147 f.
[203] Compare Chandler (2004), p. 82.

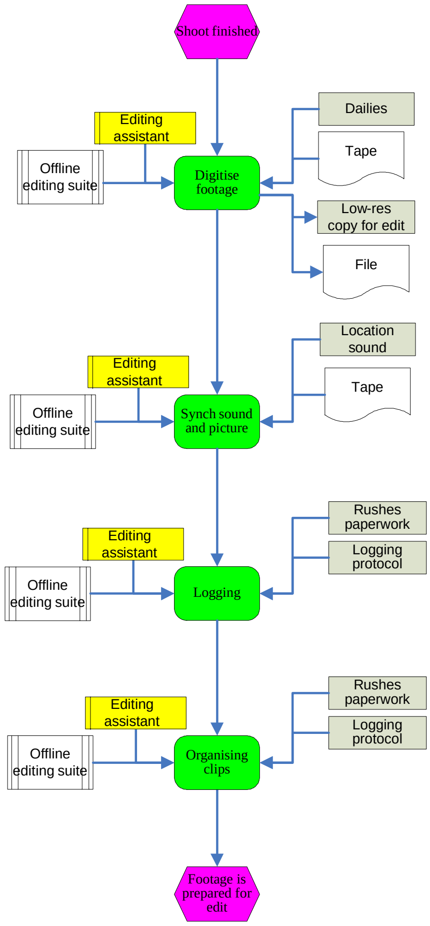

Fig. 3.5: Prepare tape for edit

3.3.4 Prepare film for edit

The process *prepare film for edit* in Fig. 3.6 is more complex compared to the just presented analogous process for tape. The input is the processed negative and the output is digitised footage, which is ready for the edit. Four main tasks have to be accomplished during this process, while the order and way of doing it can vary:

1. The synchronisation of sound and picture
2. The first grade of the picture
3. The telecine transfer of the processed film
4. The digitising of the footage

After the `processed negative` arrives from the film processing house (`receive processed negatives`), the `colourist` has to telecine the rushes, which represents the input of the footage to the telecine suite (`telecine rushes`). If the `location` sound is synchronised in telecine, he also has to digitise the sound and subsequently perform the synchronisation.[204] The corresponding functions digitise sound and synch picture and sound in telecine are made configurable to allow for a specification of the synchronisation at this point or later in the editing suite. Best light grade and one light grade refer to the colour correction possibilities during the telecine transfer. The telecine operator hereby has control over colour, contrast, saturation, gamma and hue to achieve a certain look of the picture or to match previous and subsequent shots.[205] Best light grade or full grade represents more thorough grading, treating each cut separately. A one light grade is a colour correction of a complete film roll in one setting. This is cheaper because it includes less manual work and time. Due to this importance for the budget, the respective functions and the connectors XOR6 and XOR7 are configurable to provide several model variants for the first grade. The traditional output of the telecine is, to play the footage out to tape (play out to tape). The corresponding function is depicted configurable because a telecine suite may also allow for a transfer directly to HD, thus already digitising the picture (play out to HD). If the footage is not digitised in telecine, it must be digitised later in the offline editing suite (Digitise to HD in editing suite). Requirement 3 makes sure that the footage is not digitised twice. Transfer to tape is still possible in the case of a transfer to HD in telecine because the so-called dailies could be demanded for test screenings for the director, the producer etc. After the footage arrives from the telecine – no matter in what form - the editing assistant can synchronise the sound with the picture in the offline editing suite (synch sound and picture in editing suite). Requirement 2 connects this option to the already mentioned variant of sound synchronisation earlier in the telecine, to prevent the sound being synchronised twice. Afterwards the editing assistant logs the material analogous to the logging in the case of a tape shoot (logging).Finally, the footage is organised properly, to save time and money during the edit (organising clips).[206]

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[204] Compare Chandler (2004), pp. 32 f; Laramie (2004), p. 25.

[205] Compare Gillezeau (2004), p. 152.

[206] For more information regarding this part of post-production see Chandler (2004), pp. 97-118; Laramie (2004), p. 25 ff.; Rea, Irving (2001), pp. 223-238.

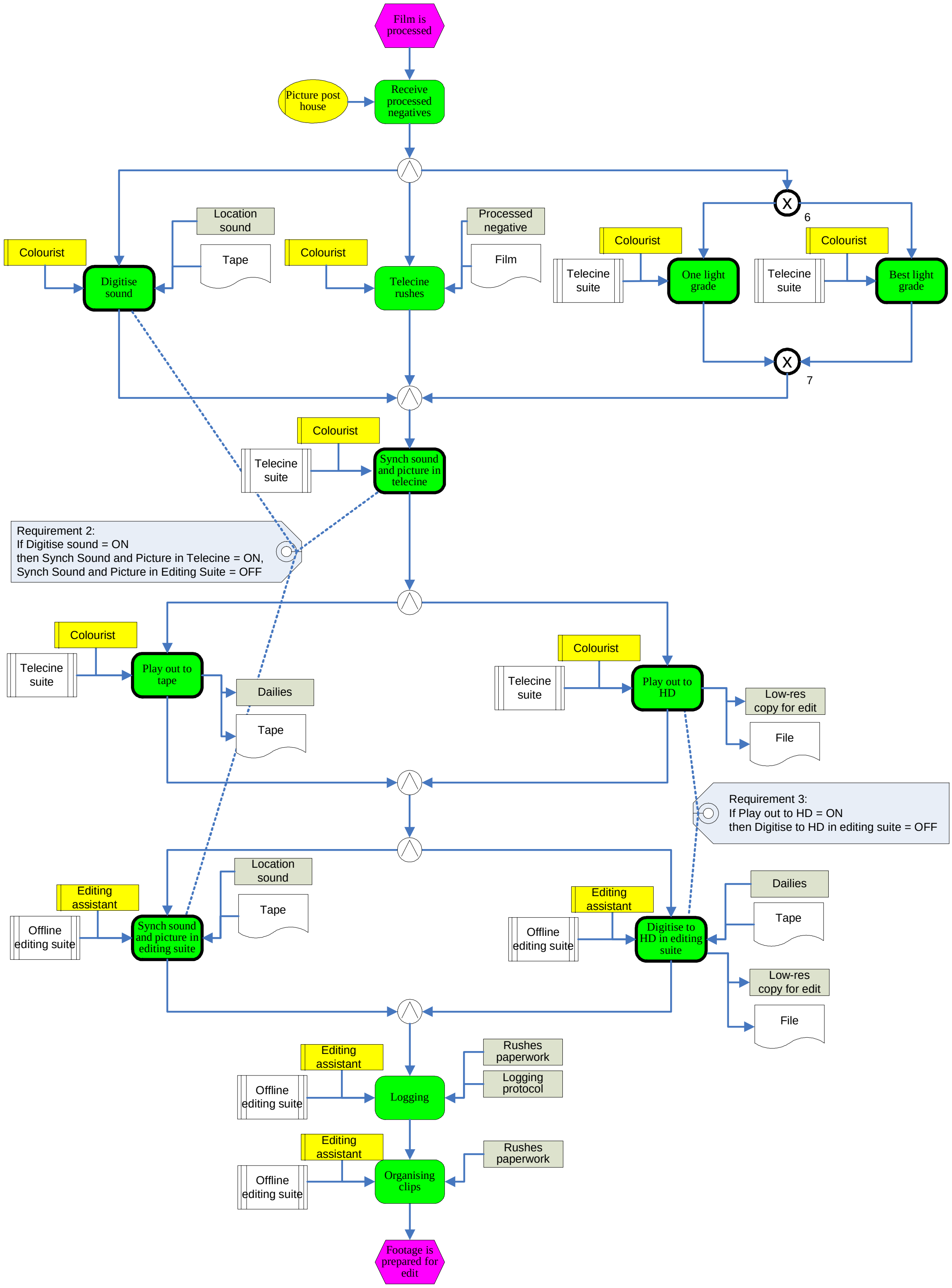

Fig. 3.6: Prepare film for edit

3.3.5 Offline edit

The *offline edit* depicted in Fig. 3.7 comprises the main creative editing work on the picture. The editing team works on a copy of lower resolution and decides how the footage is assembled to tell the story of the project.[207] Hereby, one can distinguish the following steps.

The offline edit starts with the rough cut (`offline editing (rough cut)`). This can be a time-consuming and complex task. However, due to the large creative portion of this task it is not further decomposed in the model. The editor works in the offline editing suite on the picture and may need the information from the shoot, provided in the rushes paperwork.[208] The results are a preliminary `EDL` that contains the editing decisions of the rough cut and a guide tape (`low res guide picture`), which is used for a first screening (`screening and approving the rough cut`). This screening is attended by the director, the producer or other persons of the production company that may have the creative authority. The editing team adjusts the rough cut until they have approval and can approach the fine cut (`offline editing (fine cut)`). The editor refines the previous edit decisions, identifying superfluous material and produces a new version of the EDL containing the fine cut.[209] Before the fine cut is again approved by the responsible people of the production company (`screening and approving the fine cut`), it may be screened before a selected test audience in conjunction with an evaluation of their impressions on the material (`hold test audience screening`). Once, the fine cut is approved, the post-production supervisor performs the so-called `lockoff`. This includes sending out the final version of the EDL as well as the `Cutlist` and an extended version of the EDL in the form an `OMF` (Open Media Framework) file to the departments that execute the next steps.[210] At this point, the edit is fixed, although it still needs to be transferred to the high-resolution footage. A final guide tape may be used at several points during the rest of post-production. It is optional, but very common, as it can be helpful as guidance for the completion of some tasks.[211]

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207 Compare Rea, Irving (2001), p. 235.

208 The process abstracts from a more precise definition of the used editing system However, I basically assume that the offline edit is done in a non-linear editing system (NLE), as linear editing are considered to be rather obsolete. Alongside cost savings, NLEs have several other advantages like the random access of footage and more flexibility during the edit. Compare Chandler (2004), pp. 39 ff. For detailed information on non-linear editing see Morris (1999).

209 Compare Mamer (1996), p. 395.

210 Compare Chandler (2004), pp. 18 f.

211 It must be noted that during the offline editing phase, a lot of the VFX work is done, as well. Depending on the amount of VFX, this involves a lot of communication with the VFX department, as the director, the editor, and the VFX department continuously have to agree on the inserted VFX elements and their location within the edited show. Since I excluded the VFX production from this work, this aspect is not illustrated in the model.

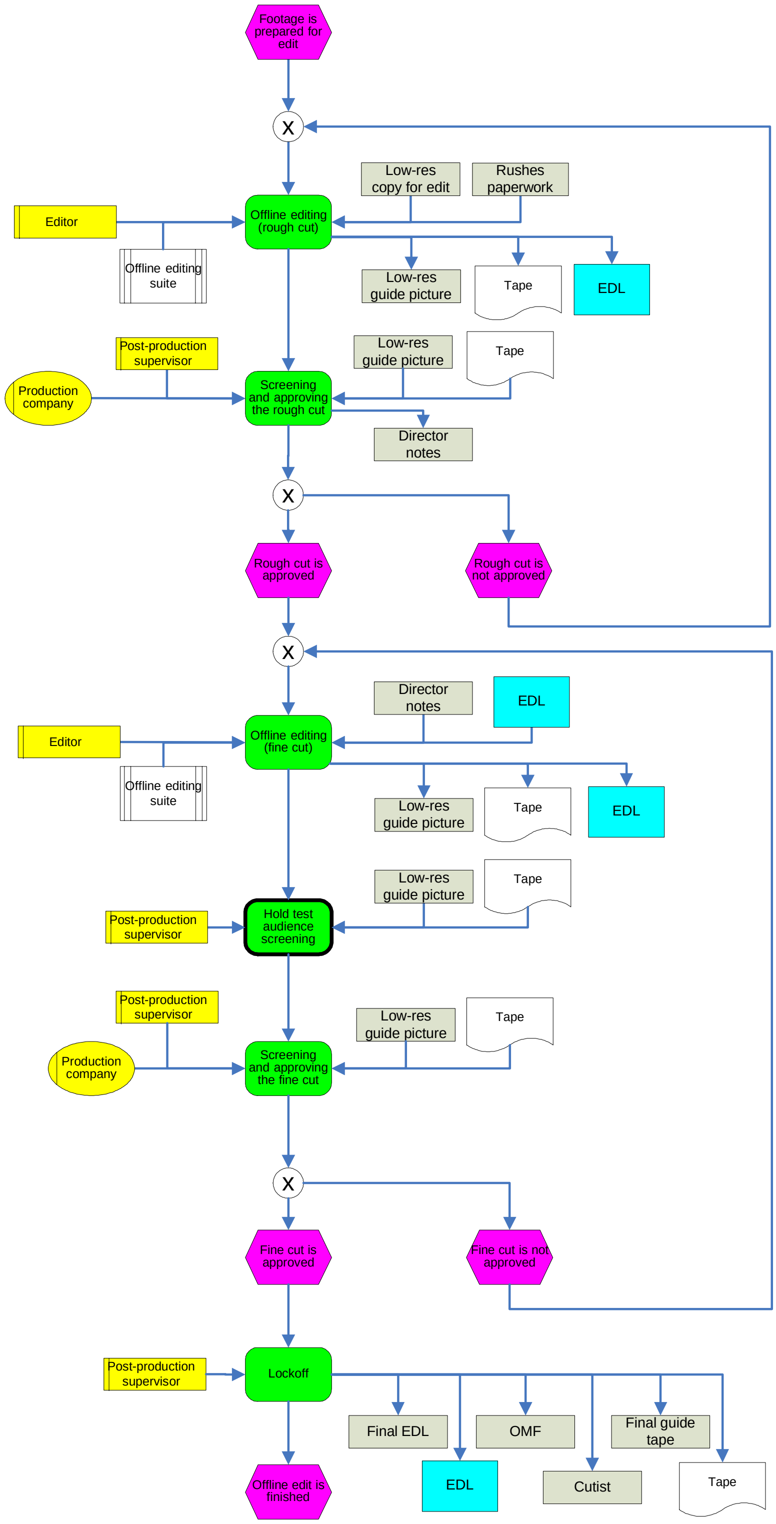

Fig. 3.7: Offline edit

3.3.6 Negmatching

The edit, which is fixed and represented in the final EDL, must now be applied on the footage of original quality. The *negmatching* model in Fig. 3.8 captures the first out of two steps of a high resolution edit on film. The process is structured as follows:

The basic principle of the negmatching is to go back to the original processed negatives to reach the highest possible quality. VFX elements and graphics like the credits have been produced externally during production or during the preceding steps of the post production. Since they need to be included in the show, they must first be transferred to film (`record VFX and credits to film`).[212] Because the original negative is unique and invaluable, the cut is first realised on a so-called workprint to ensure with an additional approval that the project really looks as intended. According to the information from the EDL, the film processing house can print the right set of positive copies of the original negatives (`create workprints`). These copies are called the `positive workprint`. The `negative cutter` cuts and splices together the positive workprint according to the specification in the cutlist and may have the visual support of a final guide tape (`create pos-conform`). The resulting completed project, called `pos-conform`, is screened and must be confirmed by the responsible people of the production company (`pos-conform screening and approval`). The irreplaceable processed negative must not be cut until this approval is given. This important job is called `negmatching` (or conforming), because the negative cutter essentially matches (or conforms) the original negative to the edited version.[213] The negative cutter delivers a report about his work and the cut negative, which can now get a final grade.

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212 It is assumed that the final credits and final VFX shots are delivered on tape and therefore first must be transferred to film.

213 Compare Campbell (2002), pp. 191 f; Gillezeau (2004), p. 277.

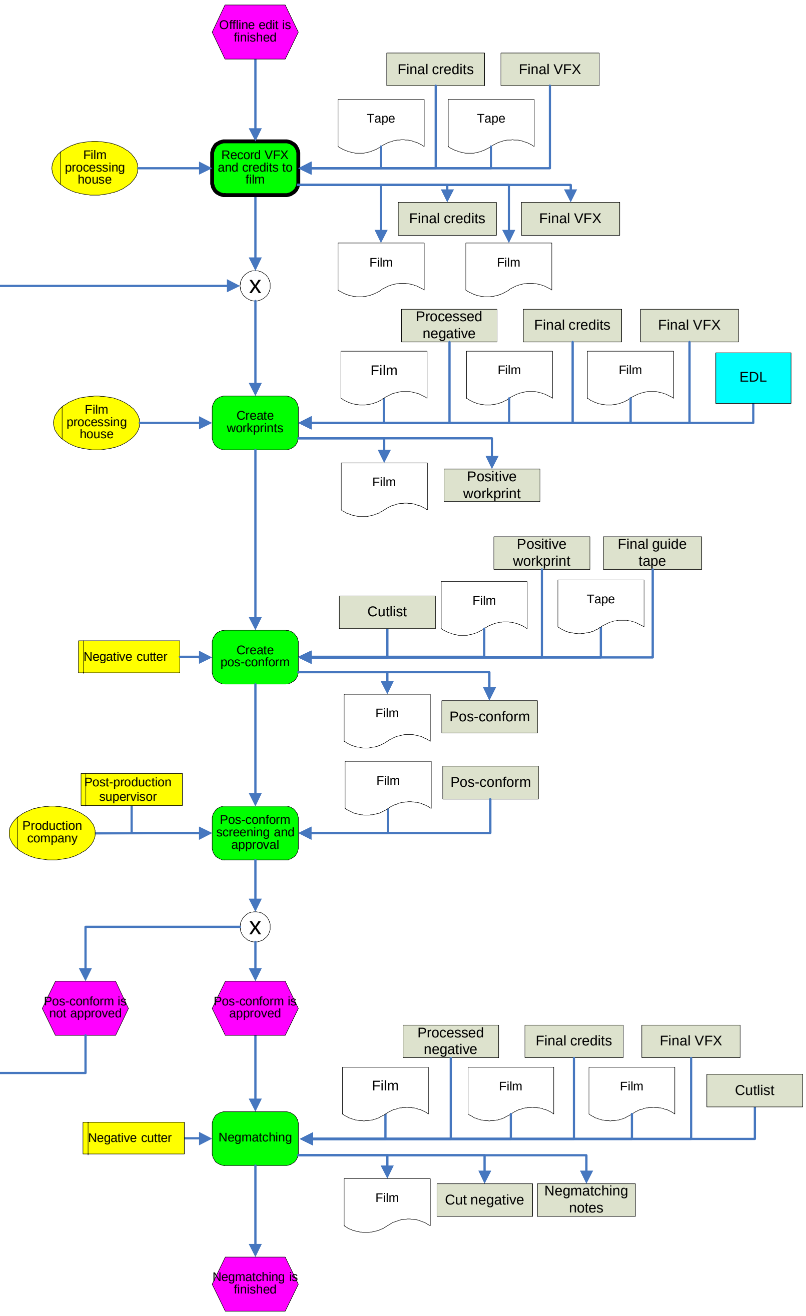

Fig. 3.8: Negmatching

3.3.7 Answerprinting

Fig. 3.9 shows the sub model for the *answerprinting* process. The original negative that has been cut during negmatching doesn't have any colour corrections so far, because any previous grading happened on basis of the low-res version. The answerprinting is the process, were the final look of the film-based picture is achieved. This comprises of the following steps. [214]

First, the colourist tries to achieve the final look and produces a `trial print`, using the pos-conform (`establish grading settings`). Again, the responsible people of the production company approve the look of the show (`examine trial print`) before the cut negative is processed with the same settings (`answer printing (with final grade)`). The resulting `answer print` is screened for another approval (`answer print screening and approval`). This is the first time that the picture can be seen in the final quality and look. The final steps of the answerprinting focus on a first copy of the final picture so that the original can be stored safely. Independent of an approved final grade the film laboratory of the film processing house goes back to the cut negative to carefully create the `interpositive (create interpositive)`. In the case of a final grade the laboratory applies the grading settings during this process. The cut negative can finally be stored safely (`store original`). The interpositive is used to create another copy, the `internegative`, because an optical printer copies film only from positive to negative and the other way round (`create internegative`). The internegative is needed later during film finish.

214 Compare Chandler (2004), p. 299.

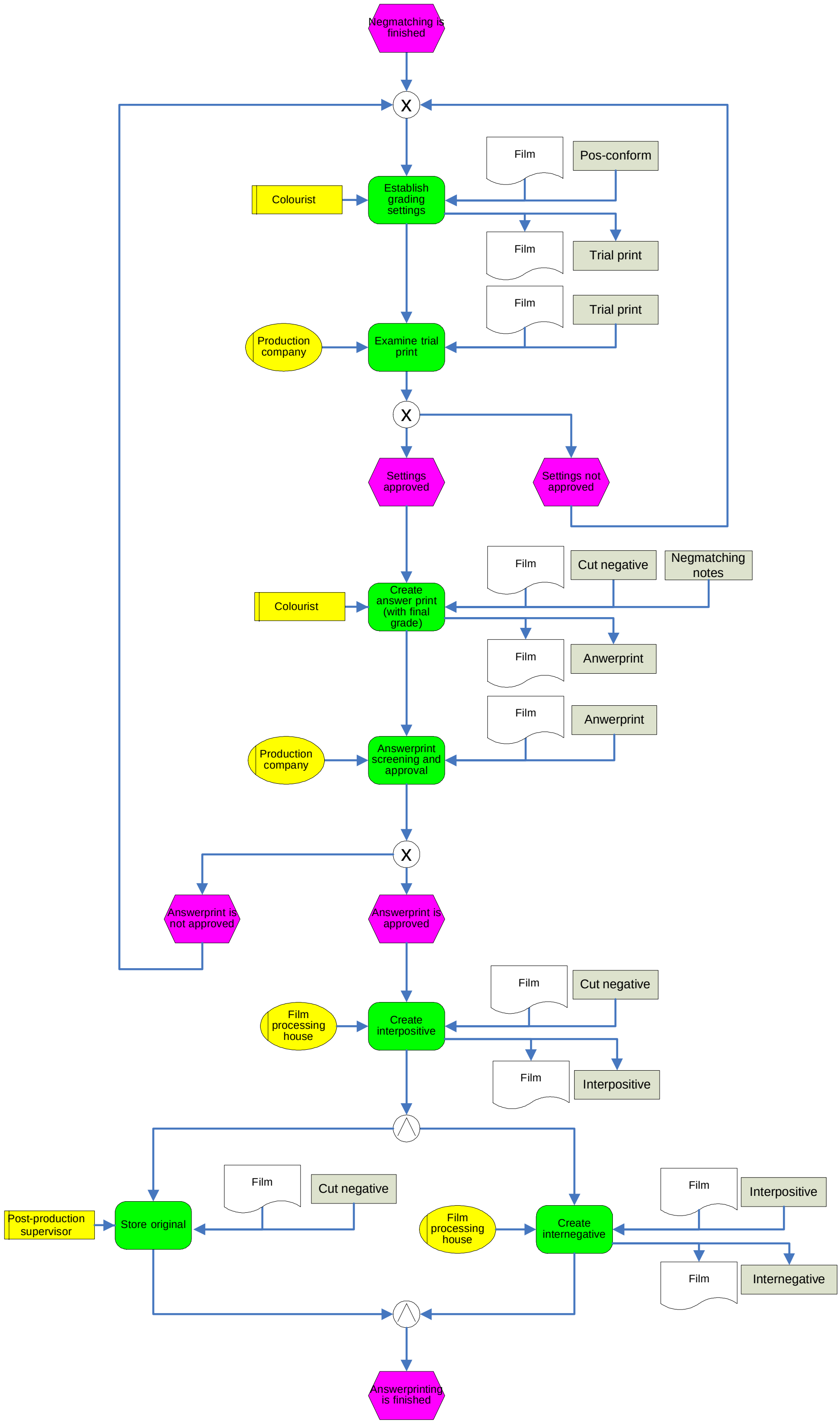

Fig. 3.9: Answerprinting

3.3.8 Online

The *online* is the second variant of editing on the original quality. The corresponding model is depicted in Fig. 3.10. Analogous to the negmatching, it basically applies the editing decisions contained in the EDL on the high resolution footage. The difference is that – unlike in the negmatching process – the footage is edited on an online suite and recorded to tape in the end.[215] The model describes this process as follows:[216]

First, the EDL is imported to the `online suite` (`import EDL`). The configurable connectors `XOR8` and `XOR9` reflect the first configuration option for this process. This variation point addresses the option to perform an online edit in the case of film shoot. In this case the original `processed negative` is transferred to tape in the telecine (`record to tape`) and is graded during this process (`full grade`). Requirement 6 makes sure, that this variant can only be chosen when the project is at least partly shot on film. The resulting `dailies` on tape can then be digitised to the online editing suite in the same way as it is done in the case of a tape shoot (`digitise selected shots`). The online editor hereby simply follows a certain order, determined by the assembly mode, to record all necessary shots for the final show. Meanwhile, the online suite puts them together as specified in the EDL.[217] The editing suite also needs the other visual elements that have to be assembled with the original shots (import additional elements). Before the editing effects are applied, both video and audio must be checked. This includes a comparison to the final guide tape (`compare to final offline picture`) and a synchronisation with the location sound `(check synch audio)`. Afterwards, effects and transitions like dissolves and fades are applied on the footage (`apply editing effects`). At this point, the titles and related artefacts like credits and subtitles are added to the project. They can be created in the online suite or externally and then be imported. The configurable connectors `XOR10` and `XOR11` allow for a configuration regarding these two variants. An optional `Online grading` at this moment is another way to perform a final tape grade, since new online suites provide powerful colour adjustments. As the work in an online suite is very expensive, `guideline 1` states that no online grade is advisable if a full grade in the telecine has been done previously. `Guideline 2` adds that no tape-to-tape grade is necessary later in the tape finish process, if the project is already graded in the online suite or in the telecine. Now that all elements of the show are assembled, a `master` tape is recorded (`mastering to tape`). This is processed during the last stages of project completion.

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215 The online editing system can be a dedicated online editing suite or actually be the same system as the one used during the offline edit. Compare Rea, Irving (2001), p. 235.

216 Compare Gillezeau (2004), pp. 182 ff.

217 Compare Chandler (2004), pp. 288 ff.

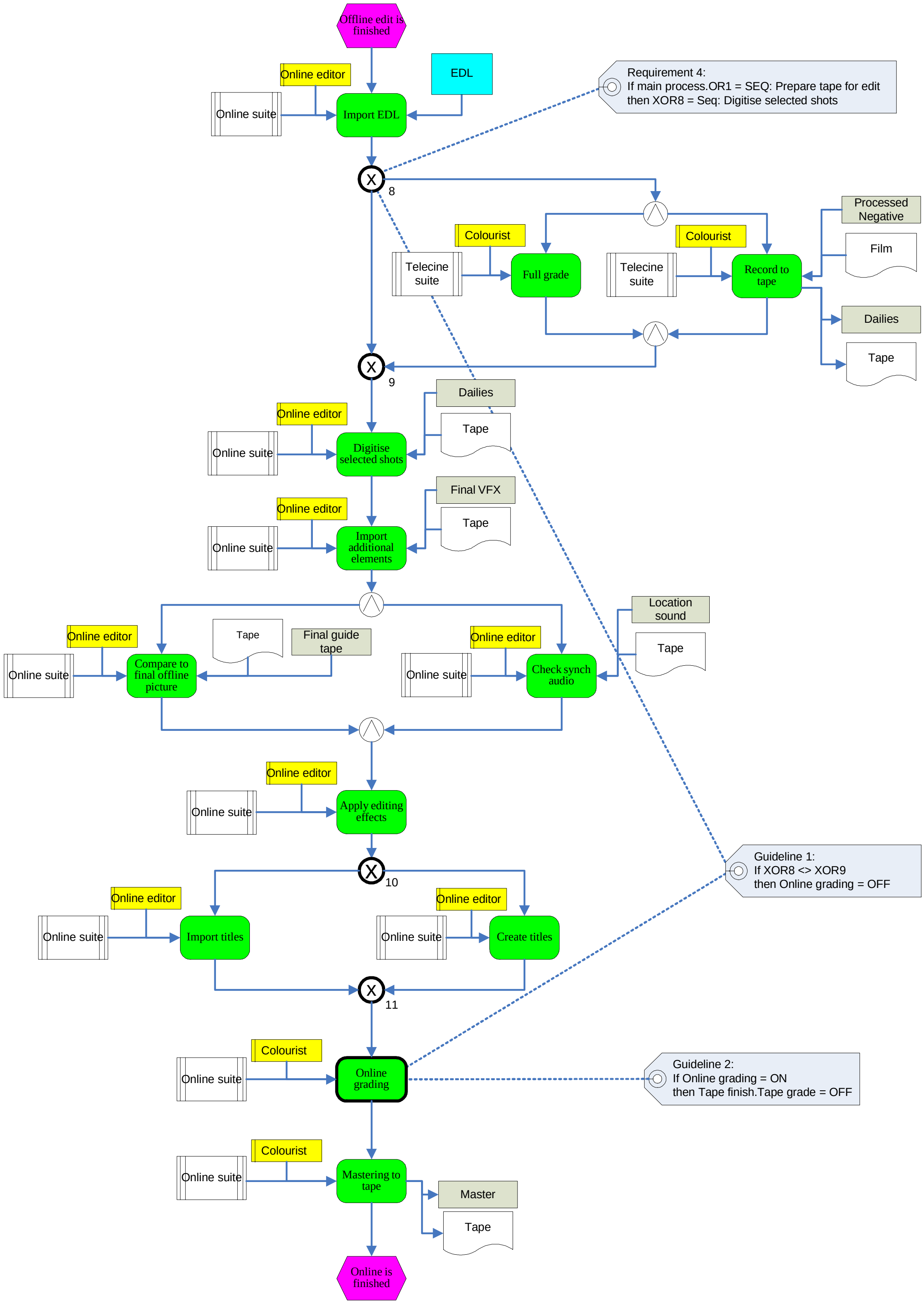

Fig. 3.10: Online

3.3.9 Sound and music editing

Beside the just explained high resolution edit, the lockoff of the offline edit also triggers the *sound and music editing*. It concentrates on the assembly of the audio elements that are supplementary to the location sound. The result of this process is the final mix that has been introduced in the data view model in section 3.2.3. Consequently the elements that are incorporated in the final mix have to be created here. Due to its size, the first part of the sub model is depicted in Fig. 3.11, the second part in

First, the director holds a spotting session with the responsible sound persons (`hold spotting session`) to decide on the `music cues` and `effect cues`.[218] They use the edited picture of the offline to discuss at which point of time what music and what sound should be added. From now on the process of creating the music premix and creating the sound premix happens quite independently.

Music premix

The composer may use a final guide tape to create a first `temp score` according to the specifications of the music cues (`Composing`). If the director approves the temp score (`temp score approval`) the music tracks must be recorded in their final version. Because recording the music with musicians or even an orchestra can be very expensive the configurable connectors `XOR12` and `XOR13` allow for the specification of two variants. `Record music` is the more expensive orchestral method while `create music artificially` refers to an electronic method which is often done in the composer's home or studio.[219]The resulting audio tracks then are mixed to a `premix` during `music mixing`. If the premix gets approval from the responsible people of the production company (`music premix approval`) the music editor can edit the music exactly to the picture (`edit music`).

Sound premix

Since the sound premix comprises of several elements, its creation is more complex. Hence, the function `sound designing` is decomposed in another sub model. The produced sound tracks of this process are presented to the director for an approval (`sound tracks approval`). In the case of consent, the sound designer assembles a `sound premix` (`sound premixing`) which again needs a final approval (`sound premix`

218 Compare Clark, Spohr (1998), pp. 122 f.
219 Compare Clark, Spohr (1998), p. 128.

approval). Now the sound editor can edit the sound premix so it perfectly matches the picture (edit sound).

Final Mix

When both the sound premix and the music premix are finished, they can be assembled to final mix (final mixing). The people with creative authority might want to see the picture with the married sound at this stage. Besides the final mix a track with music and effects (M&E Track) and a track with dialogue and effects (D&E track) are created. These can be used later to add dialogue in different languages or for trailer versions where the music track needs to be adjusted. The final mix must be mastered to an optical sound negative (OSN), if the project is released on film (sound mastering). In this case, the show needs a Dolby approval for screening. This is depicted with the configurable function Dolby approval. Requirement 5 ensures, that the configurable function is set to ON, if the project is released on film.[220]

[220] For further information on music and sound design and editing see; Chandler (2004), pp. 219-270; Kellison (2006), pp. 160-163; Laramie (2004), pp. 55-59; Wales (2005), pp. 212-219; Wyatt, Amyes (2005).

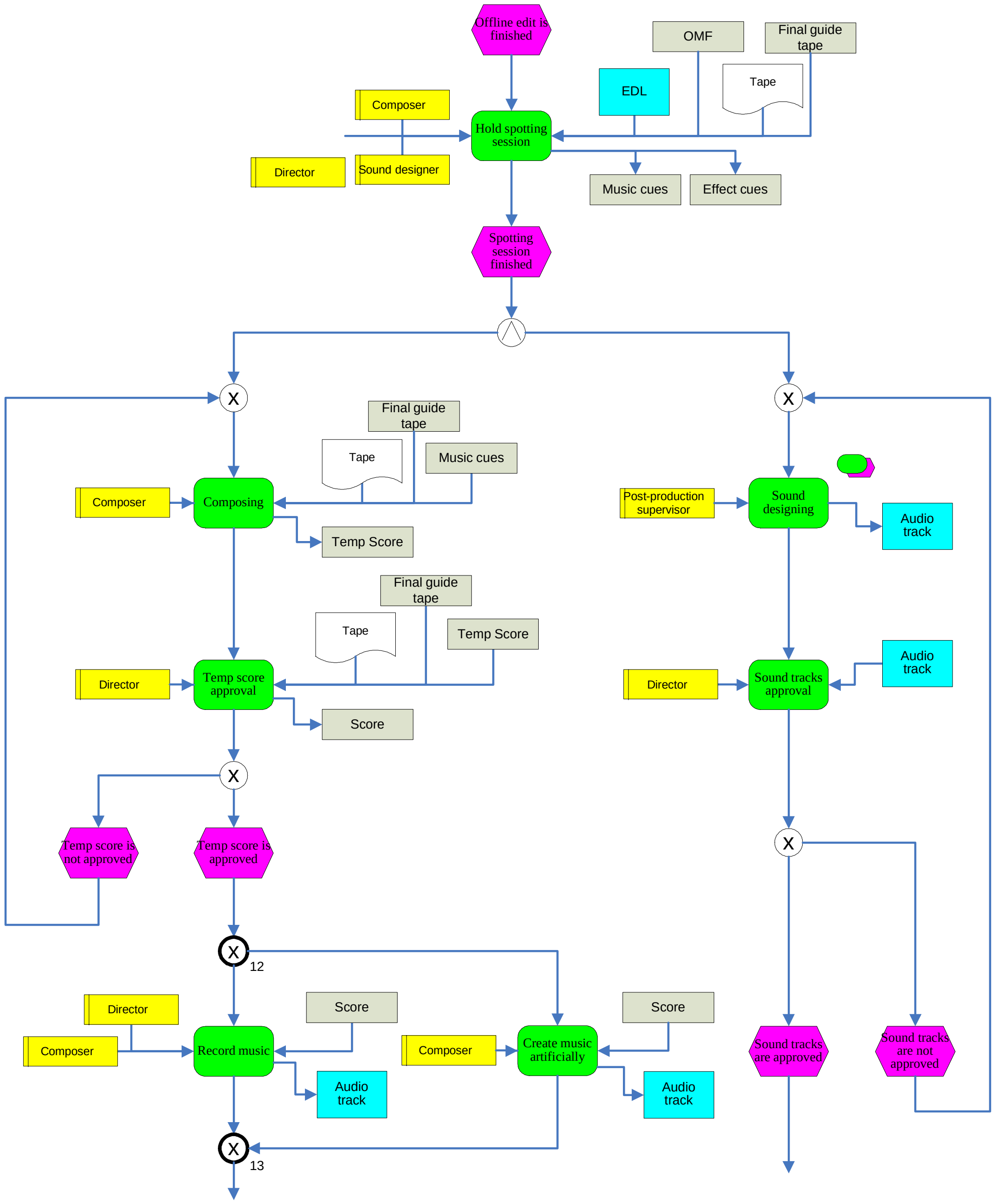

Fig. 3.11: Sound and music editing (first part)

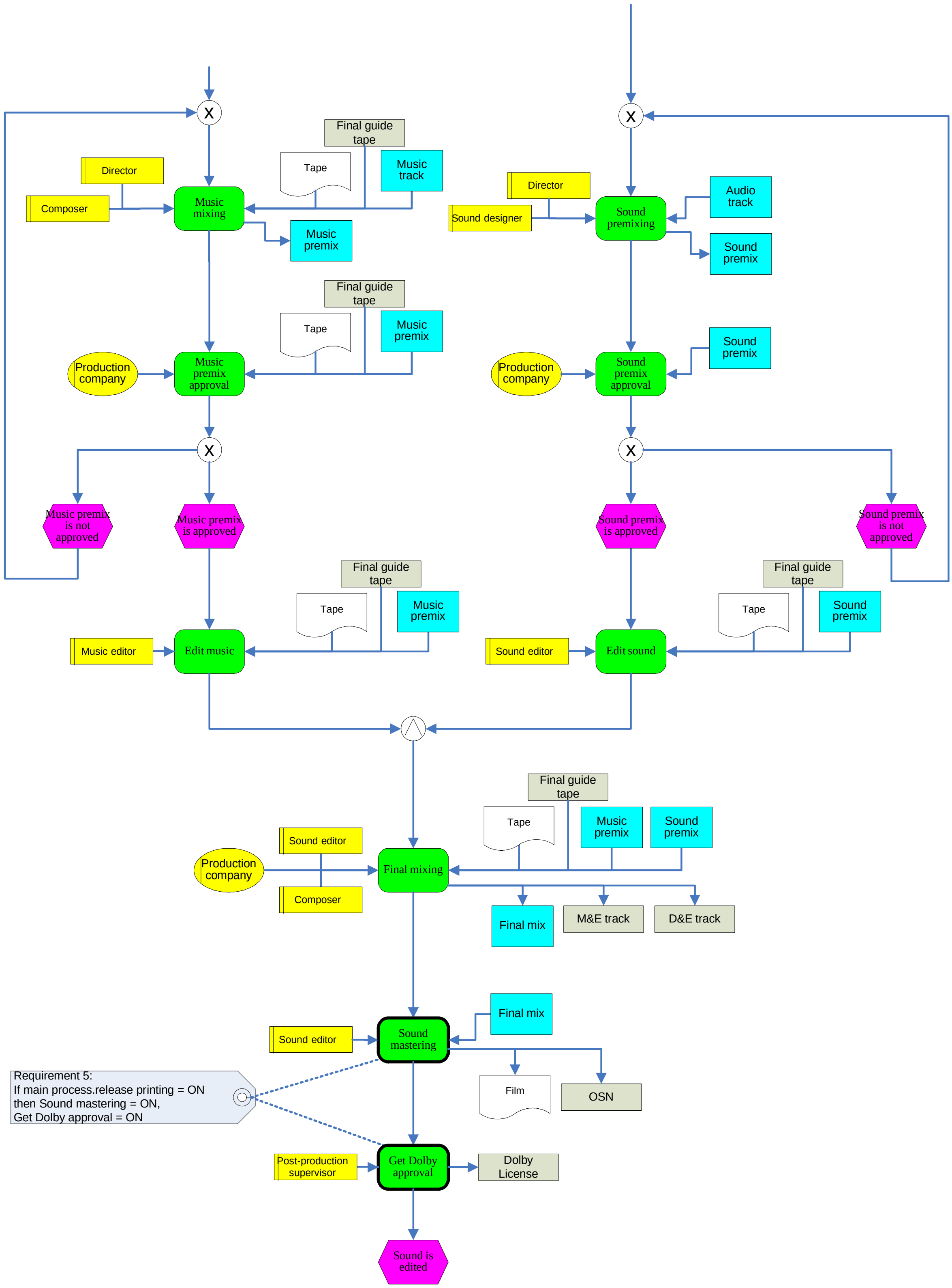

Fig. 3.12: Sound and music editing (second part)

3.3.10 Sound design

The sub model *sound design* is depicted in Fig. 3.13. It comprises the steps to produce the audio tracks that become part of the sound premix. They are divided into the dialogue tracks, sound FX tracks, and atmosphere tracks, which can be created at the same time.

The first step towards the dialogue tracks is a `dialogue cleanup`, which fixes some routine problems on the production track like clicks or damaged lines.[221] Depending on the budget and the type of project, additional automatic dialogue replacements (`record ADR`) or voice recordings like a narrator (`record voice over`) may be desired. The configurable connectors `XOR14` and `XOR15` allow for a configuration of the model without any of these options. Moreover, the configurable connectors `OR16` and `OR17` permit a specification of variants like the combination of ADR and voice over. The sound designer is responsible for a subsequent dialogue mix (`mix dialogue`). `Record foley` is the process where sounds like footsteps are created and recorded with respect to the actions on the picture. Since low-budget production may want to take pre-recorded sounds from a database instead of recording them new for the show, this function is made configurable. In any case, the sound FX tracks have to be mixed afterwards, which is depicted in `mix sound FX`. The third sound aspect that can optionally be recorded new for the show is the atmosphere (`record atmosphere tracks`). Analogous to the dialogue and sound FX tracks, the atmosphere tracks are mixed and delivered for the premix (mix atmosphere tracks).

[221] Compare Chandler (2004), p. 254.

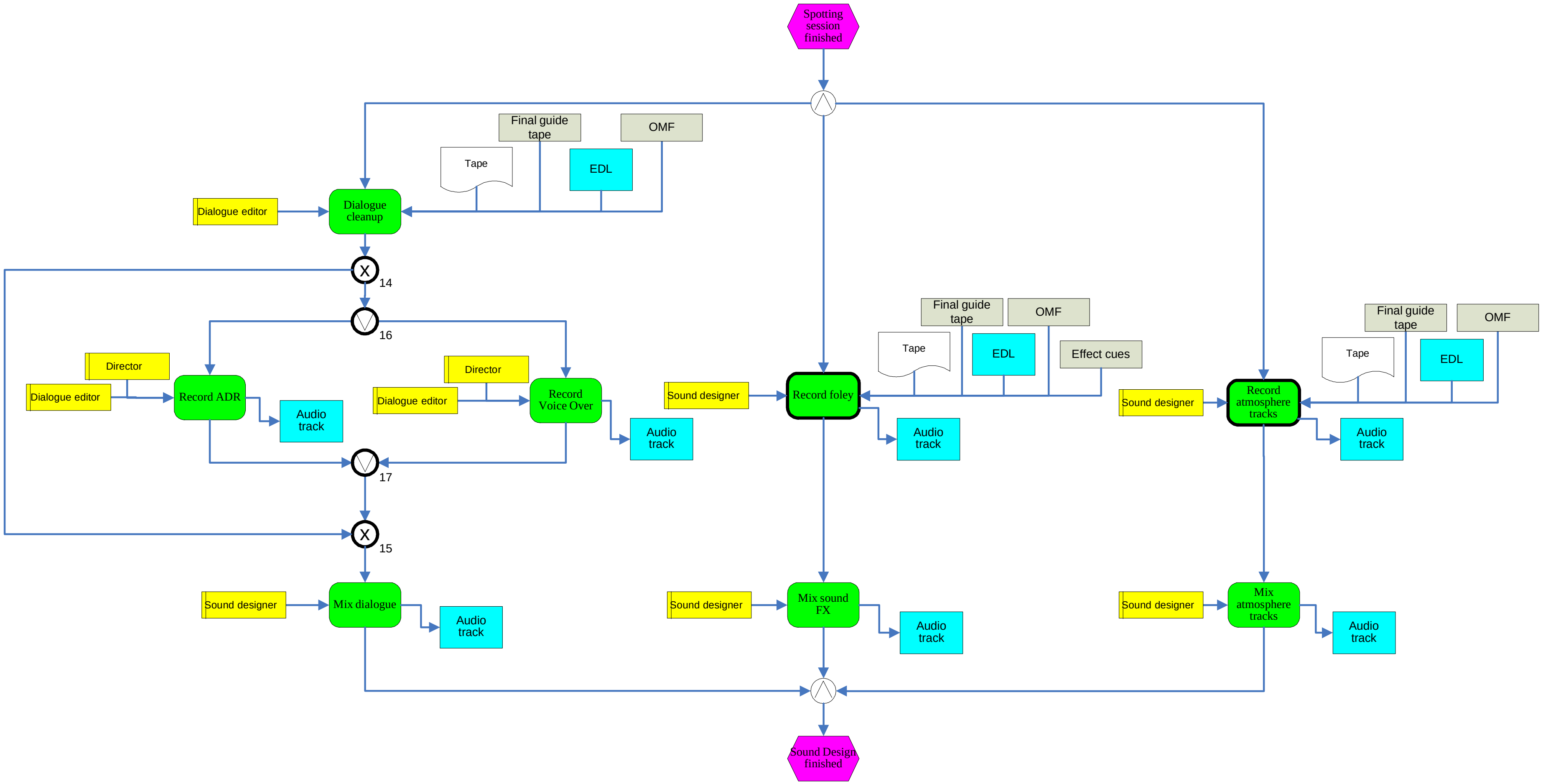

Fig. 3.13: Sound design

3.3.11 Film finish

At this moment, all visual and audio elements are edited and ready for completion. For a theatrical release on film, the project goes through the *film finish* process, illustrated in Fig. 3.14. The main task is to print sound on the internegative of the film finish and produce copies for release. No internegative is available, if the high-resolution edit has been done in the online. Consequently, the master tape must first be printed on film (`record digital film master`).[222] `Requirement 6` states that this must be done if no film is available. The optical sound negative (OSN) is then printed on the internegative with a optical contact printer, that way creating the `composite answerprint` (`print optical soundtrack on IN`). This print is compulsorily a positive print; hence it can't be used to create positive releases. Instead it is used to create several dupe negatives (`create copies for mass duplication`), which then are deployed for mass duplication, because theatre releases must be sent out in high numbers (`high-speed mass duplicating`). This high-speed duplication can wear out the dupe negatives; therefore it is advantageous to have several carefully made copies of the composite answerprint, thus maintaining the quality of the material. The film finish is completed, when the prints are sent out (`send out release prints`).

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[222] Compare Chandler (2004), pp. 323 ff.

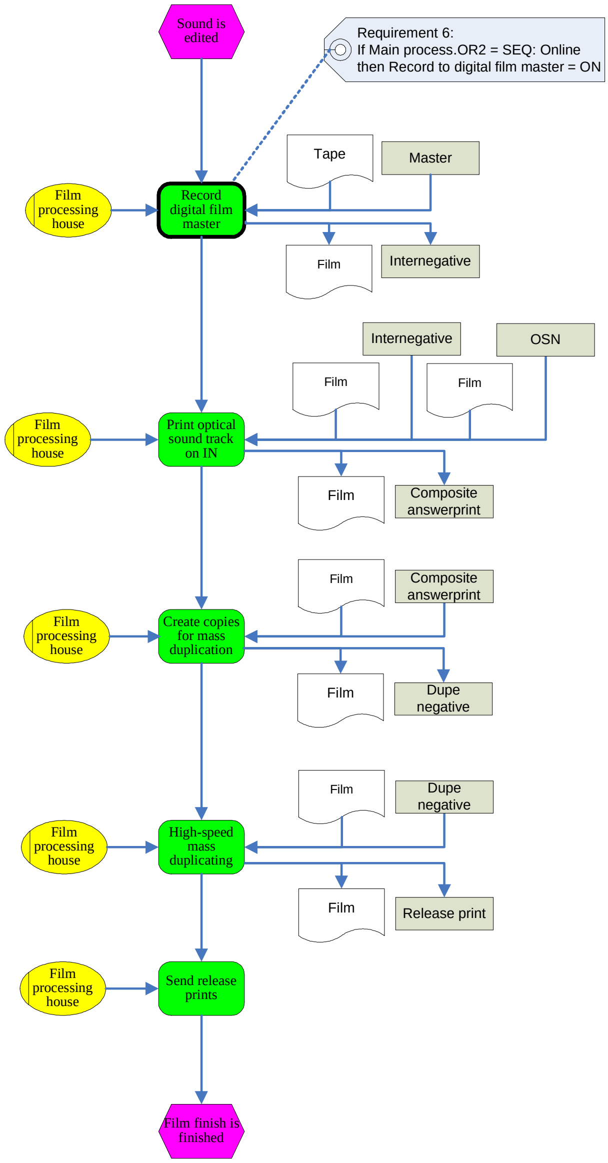

Fig. 3.14: Film finish

3.3.12 Tape finish

The *tape finish* model in Fig. 3.15 describes the completion of the project for a tape release. Again, this includes the assembly of picture and sound. To allow for a tape finish independently from the medium used before, two cases must be distinguished, which can be preconfigured with the configurable connector `OR18`.

In the first case, the picture has been cut in the online suite. Therefore, the project is already available on tape. The master from the online process can get an optional grading (`tape grade`) before the project is finished with the `layback` of the sound.[223] `Requirement 7` makes sure, that this variant is activated when only a master tape and no internegative exists. The other variant reflects the tape finish after the project has been cut on film. Consequently, a telecine transfer to tape is necessary, hence it requires the interpositive of the answerprinting process. `Requirement 8` ensures that this path is activated, when no tape is available. In conjunction with requirement 7, it essentially secures that no invalid configuration is possible. The configurable connectors `XOR20` and `XOR21` represent a choice regarding the final grade. The picture can receive colour corrections while it is transferred from the interpositive to tape (`transfer to tape with grade`). The resulting tape, the `broadcast submaster`, now just needs the layback for completion. Because of budget restrictions, the project can go without a grade in the telecine (`transfer to tape without grade`). The show then gets the final grading in the editing suite. The `ungraded submaster` that arrives from the telecine suite is graded tape to tape to receive the broadcast submaster (`tape to tape grade`). The final mix is laid back on the broadcast submaster in a final step to combine picture and audio.

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223 Compare Chandler (2004), pp. 298 f.

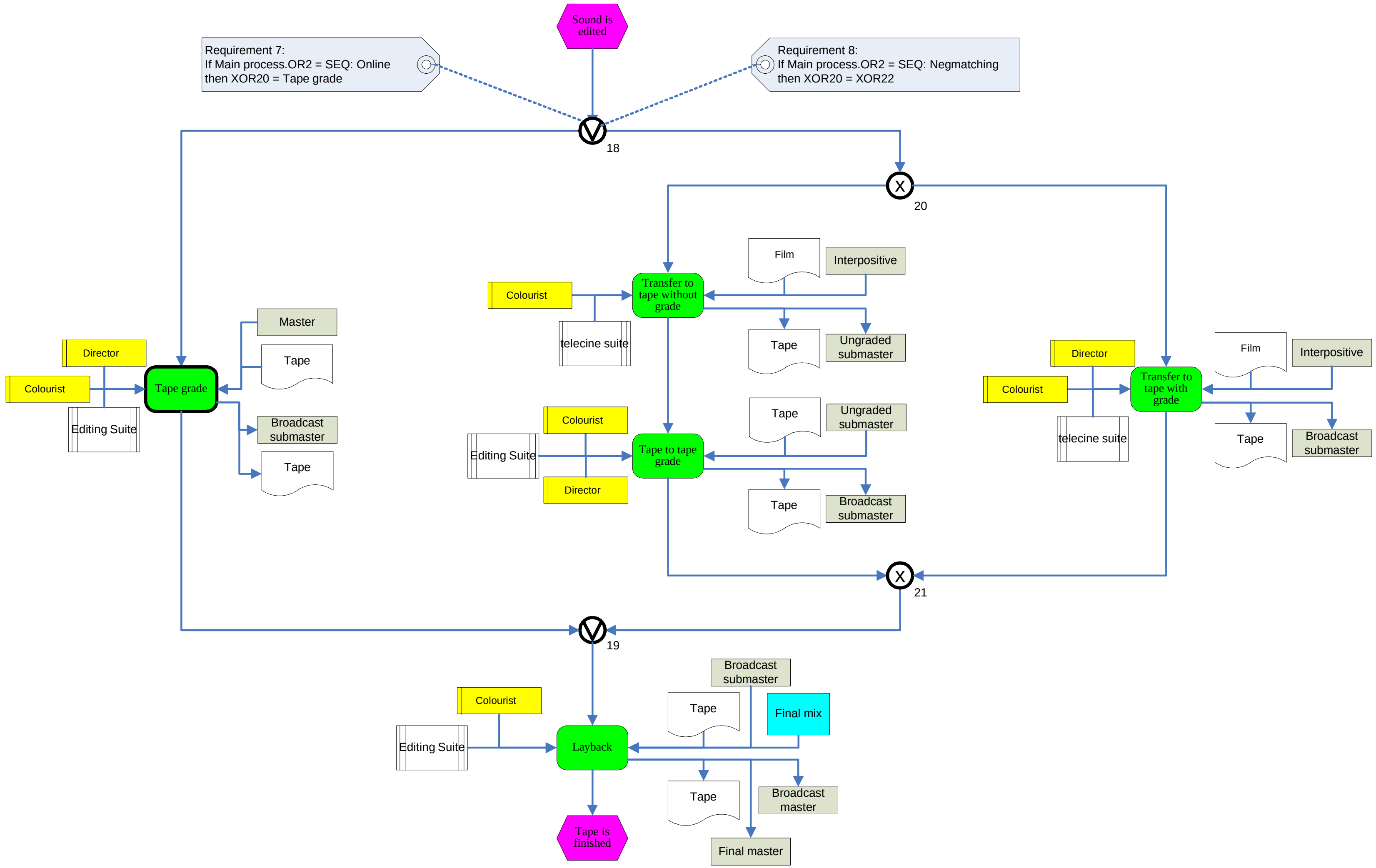

Fig. 3.15: Tape Finish

3.3.13 Disc and file finish

The *disc and file finish* is the third option for completing a model. It comprises of the finish on file form for distribution on disc, internet, etc. and is depicted in Fig. 3.16. It happens, after the tape and/or film finish is completed. It must be considered though, that the main process permits solely a finish on disc and file as well.

Therefore, `requirement 9` contains the rule that the configurable function `digitise finished project` is configured ON, if the project has been finished and completed on film only. As no digital version of the show exists in this case, the `interpositive` must be digitised now. The configurable function `import sound` addresses the same question regarding the audio. If the final mix has not already been imported to the editing system during the layback, it must be done here. `Requirement 10` addresses this issue. The full project is then imported to the chosen compression software (`import project to compression software`) and compressed to the desired size (`compress project`).[224] Finally, it is transferred to the respective delivery medium in the form of a release version. The abstraction from a more detailed process description in terms of the delivery options of this kind is intended, as the process is mainly done by one person on the same system and is expected to change continuously due to new technologies and distribution channels.

224 Compare Chandler (2004), pp. 304 ff.

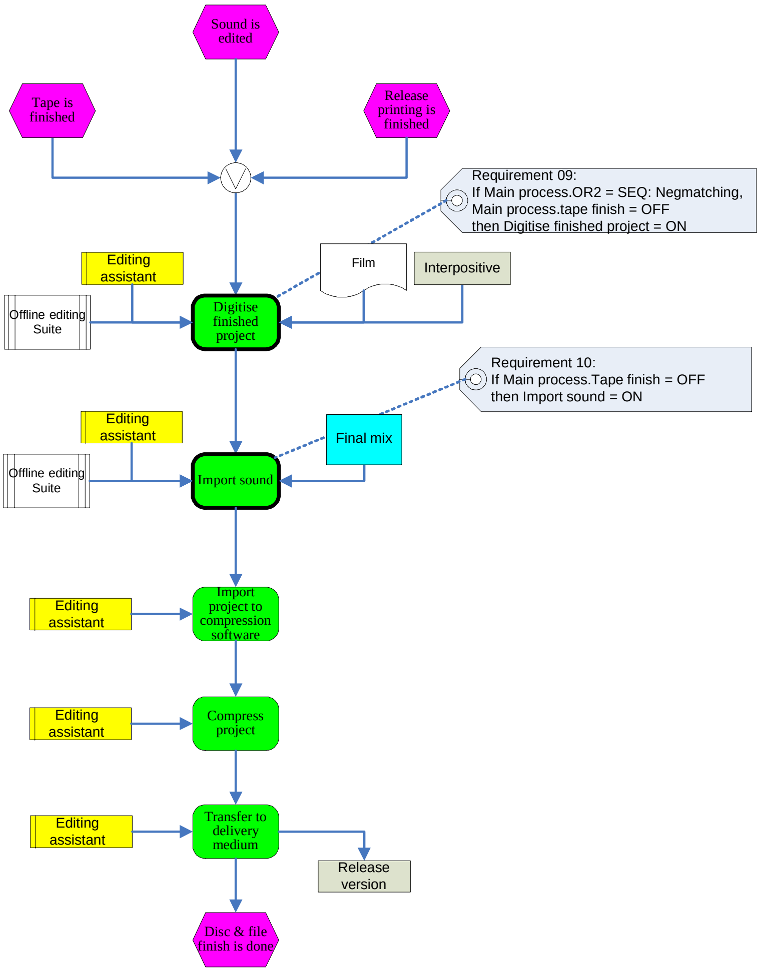

Fig. 3.16: Disc and file finish

3.4 Configuration

This section focuses on the configuration of the presented models. It is the third and last phase of the configurable reference modelling framework introduced in section Fig. 3.1. As has been shown in the framework, it is structured in three steps: The identification of *configuration objectives*, the connection of configuration objectives and models with the help of *configuration parameters*, and the *deduction and validation* of example configurations. I will first explain these three-layers of configuration and then apply it to the reference model described above.

3.4.1 Configuration layers

The context of the case study exhibits aspects that require a particular consideration of the configuration procedure. This is mainly due to preferences regarding the use of the model by industry practitioners. First, it is thought to include the models in the teaching schedule of the AFTRS to support the lecturers with a conceptually founded process depiction. Lecturers are not experienced in formal model configurations and consequently need further assistance. Additional guidelines would certainly facilitate the acceptance of the reference model, especially if, in a second step, independent producers and students of the AFTRS are given the opportunity to configure the models themselves, for example to compare the impact of decisions on the post-production path. A second aspect is the goal to communicate the power of process definitions together with the flexibility that derives from configurability to industry partners. In this context it is crucial to show the variety of options that makes the reference model adaptive to business requirements without going into too much detail on the formal notation. I conclude that it is necessary to provide the reference model with additional support for transparent and uncomplicated configuration without restricting the configurability.

I approach this task with a set of configuration layers that allows mapping concrete model variations to a set of preferences of the reference model user. *Configuration objectives* refer to these configuration preferences. It is assumed that different user preferences lead to different requirements regarding model variants. Configuration objectives must hence be seen in a broader context. They do not only exhibit pertinence to model configuration but also to construction. Intended application domains of the reference model have to be considered right from the beginning of the modelling efforts. In the case of this research, the underlying problem definition, presented in section 3.2.1 specifies certain requirements for the model construction. These requirements are the basis for the two configuration objectives I will refer to later in this section. Since my model is rather generic and is meant to be suitable for a variety of situations, it allows for configurations in accordance to a wide range of suitable configuration objectives. However, the awareness of configuration objectives during model construction – especially during the specification phase – supports the later actual configuration regarding these objectives.

Configurability is based on *variation points*.[225] Due to the obvious limitations of configuration options to those variation points that are included in the model, it may be required to ex-post extend or adjust the reference model, if further configuration objectives need to be taken into consideration. The presented system of *configuration parameters* facilitates this by giving a flexible connection of configuration objectives to concrete process model variants. Fig. 3.17 shows how configuration objectives, configuration parameters and variation points are arranged with respect to both their abstraction to the models and their direct impact on the models. Configuration parameters are the link between configuration objectives and variation points. While configuration objectives abstract more from the actual process

[225] Compare Rosemann, van der Aalst (2007), p. 7.

models and have a rather indirect impact, the variation points are an explicit component of the configurable model and implicitly specify certain variants. The configuration parameters group the variation points and map the implicated variants to the business context. This context is consolidated by means of configuration objectives. The grouping of affected variation points to a certain configuration parameter happens in conjunction with a decision that has implications on these variation points. The definition of configuration parameter consequently has to take into consideration the complete semantic field of this decision.

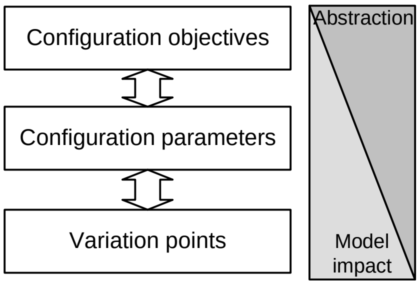

Fig. 3.17: Layers of configuration

The relationships between the three configuration layers are established by the following three rules:

1.) Configuration objectives determine a set of requirements for specific configuration parameters.

2.) Configuration parameters hold a set of possible values and cover the semantic field of one specific configuration decision.

3.) A value of a configuration parameter is linked to an exact value of one or more variation points in the models.

It must be noted that the relationship between configuration objectives and configuration parameters is rather fuzzy compared to the more formal link between parameter values and variation points. This is due to a more general and abstract character of configuration objectives (see Fig. 3.17). In the following, I present the two major configuration objectives that were considered during model construction in this study.

3.4.2 Configuration objectives

Budget

Budget has been repeatedly mentioned as a major topic by industry practitioners. A distinction of model variants based on their budget implications is assumed to be of particular benefit. The AFTRS intends to incorporate example configurations in their teaching programme. Lecturers are said to be very interested in the possibility of visualising and comparing the impact of different budget-related decisions on the process. The budget is furthermore of particular interest with respect to the characteristics of the Australian industry. The high amount of domestic independent productions with low budgets verifies the importance of a configuration with respect to budget consequences.[226] Besides these reasons, a distinction of cost-related process variants already at configuration time, amplifies the advantage of process modelling to provide transparency regarding costs and processes. This especially applies for post-production, as the complexity and continuous change of included techniques hampers planning ahead. I conclude that the configuration parameters and their values must be checked and defined regarding their consequences on the budget.

It must be noted that I focus on the awareness of budget implications only during model configuration. The process models deliver numerous other findings regarding the budget. Example: The illustrated negmatching and answerprinting processes exhibit significantly much exchange of physical information carriers. An assumed time and cost-disadvantage compared to an online edit can now be calculated with the help of the process models. This can be the basis for the decision about which online suite to rent, since high-end digital systems are very expensive and can potentially be a budget plus instead of a minus.[227] The scope of this study wouldn't allow for a complete elaboration of all findings that the models brought to sight. Measurements like this are part of the employment of the configured models in a concrete business context that happens after the configuration phase covered in this study.

Type of Content

The second considered configuration objective focuses on the *type of content* of the screen business production. I hereby refer to the classification of productions according to their type of content like feature film, TV series, documentary etc presented in section 2.1.2. In this context, a configuration of the reference model happens with certain preferences for

226 Compare Anon (2005), p. 3.
227 Compare Chandler (2004), p. 41.

model adaptation to different types of content. A model user for example may configure the reference model to match the requirements for documentary productions.

This raises the question, what effects the type of content has on the process of post production. It was found, that the impact is significant, even though rather indirect. The type of content mostly determines the delivery requirements and these delivery requirements strongly influence the post-production process. In fact, they particularly shape the main process, thus being vital for the overall procedure. Delivery requirements are formats and other regulations that must be fulfilled for distribution of the show. Regarding post-production this mainly determines visual and sound deliveries like release prints, sound masters, etc.[228] The quality expectations that are related to certain types of contents like theatrical releases can have , first, implications on the shoot, thus on the incoming footage, second, on the edit, and third, on the completion part of the post production. Film festivals may only accept film or even only 35 mm film for projection.[229] On the other hand, new technologies narrow the gap between tape and film quality, which allows taking more and more formats like digital video into consideration.[230]

Configuration objectives have to be seen in a broad context. The related preferences affect various aspects of a production. High-level decisions during configuration are not only made with respect to the advantages and disadvantages during post-production. The format used for delivery and shoot obviously has serious implications for the shoot.[231] This principle applies for decisions about both the budget and the type of content. Furthermore, the configuration objectives can’t be addressed completely separately. This means that the impact of decisions regarding a certain configuration objective can overlap with implications of other configuration objectives. The presented configuration objectives particularly exhibit this kind of overlapping: A tape shoot can be on the one hand cheaper, thus be the result of a configuration according to budget restrictions;[232] On the other hand it can conform to the format of broadcast, thus it can derive from the configuration for a certain type of content like an Australian TV series.[233] This has to be considered during configuration.

3.4.3 Configuration parameters

Configuration parameters bridge the gap between the configuration objectives and the process models. For this reason, every configuration parameter is linked to a set of varia-

[228] Compare Jones (2003), p. 517.
[229] Compare Clevé (2006), p. 58 f.
[230] Compare Clevé (2006), p. 59.
[231] Compare Clevé (2006), p. 59.
[232] Compare Laramie (2004), p. 28.
[233] Compare Chandler (2004), p. 303.

tion points that can be part of more than one model. A parameter value exactly determines the configuration of the linked variation points, thus labelling them with context information. The model user can hence choose the values of the parameter which imply the configuration of all corresponding variation points. These choices are the crucial part of the reference model configuration. In the context of screen business productions these choices have to be defined with consideration to the domain's peculiarities. As GIBBS states, a finished show is the result of an enormous number of choices, but drawing the outcome of a project back to these decisions is considered "the crux of the artistic process: the relationship between decisions taken and a work's meanings."[234] Consequently, the configuration parameters have to be defined with caution, to avoid compromising the creative aspects of the project.

In conjunction with the introduction of configuration parameters, I want to justify the need for a model driven configuration in case of a reference model for the screen business. One could raise the question, why a set of predefined models for each type of production is not sufficient. The model user then simply chooses the appropriate specialised model e.g. "documentary production", which gives him a reference model that is adjusted to the requirements of documentary productions. This static adaptation is insufficient due to the domain-inherent complexity. A project can exhibit various combinations of factors that influence the project and can't be reduced to one simple decision. A static set of predefined models therefore wouldn't allow for a comparing good alignment or the definition of hundreds of model versions would be necessary. I want to explain this with a brief sum-up of potential project variants on a comprehensible level of detail. A content type like documentary production may restrict the model in some way, but this restriction can't be exactly predefined. The semantics of a certain type of content must be considered from case to case. A screen business production can thus practically be a feature film, short film, TV Commercial, TV series, documentary, animation, corporate training or any other product type, but is produced for the *distribution channel* cinema, television, new media, video store etc., is *shot* on film or tape, is *cut* on film or in an online suite, and is *delivered* on: film, tape, disc or file.[235] All these parameters have an impact on the post-production process. A combination would afford an apparently too large number of static models. Furthermore, it must be considered, that these are by far not all the decisions that can be taken in advance of the project, thus can be input during build time. The inclusion of any preceding choice in the model adaptation improves the alignment of the model to the actual business. I conclude that a configurable reference model allows a more comprehensive model adaptation and configuration parameters support the configuration by mapping the influ-

[234] Compare Gibbs (2006), p. 5.
[235] See the discussion on different ways of classifying types of content in section 2.1.2.

encing factors to the model variations. Tab. 5 lists the configuration parameters that shape the presented reference model for post-production. The column labelled with “possible values” contains the corresponding configuration options that are supported by the model. The table also delivers the related configuration objectives, which the parameter is of interest to, and the affected models and variation points. For reasons of size, a complete listing of the exact connection of parameter values and variation point configurations is only presented for the example configurations in the next section.

Configuration parameter	Possible values	Configuration objectives	Affected models	Affected variation points
1. Shoot	Film, tape, film and tape, film or tape, film xor tape	Content, budget	Main process	OR1
3. Cut	Online, film, online and film, online or film, online xor film	Content, budget	Main process, disc & file finish, tape finish, film finish	OR2, OR3, digitise finished project, OR18, OR19, tape grade, record digital film master
2. Finish	Film, tape, disk & file, film and tape, film and disk & file, tape and disk & file, film and tape and disc & file, film or tape, film or disc & file, tape or disc & file, film or tape or disc & file, film xor tape, film xor disc & file, tape xor disc & file, film xor tape xor disc & file	Content, budget	Main process, sound and music editing, disc & file finish	OR4, OR5, Tape finish, film finish, disk & file finish, sound mastering, digitise finished project, import sound
4. Telecine transfer	Record to tape, record to HD, record to tape and HD	Content, budget	Preparing film for edit	Play out to HD, play out to tape, digitise to HD in editing suite
5. Synchronisation sound & picture	In telecine, in editing suite	Content, budget	Preparing film for edit	Digitise sound, synch sound and picture in telecine, synch sound and picture in editing suite
6. First grade	One light grade, best light grade, no grade, one light grade xor best light	Content, budget	Preparing film for edit	One light grade, best light grade, XOR6, XOR7

	grade, one light grade xor no grade, best light grade xor no grade			
7. Audience screening	Yes, no	Budget	Offline	Hold test audience screening
8. External VFX & credits	Yes, no	Content, budget	Negmatching, online	Record VFX & credits to film, XOR10, XOR11
9. Final tape grade	Telecine grade, online grade, tape-to-tape grade	Budget	Online, tape finish	XOR8, XOR9, online grading, tape grade
10. Music	Record, artificial	Budget	Sound & music editing	XOR12, XOR13
11. Dialogue re-cording	No dialogue re-cording, ADR, voice over, ADR and voice over, ADR or voice over, ADR xor voice over, no dialogue recording or ADR, no dialogue re-cording or voice over, no dialogue recording or ADR and voice over, no dialogue or ADR or voice over, no dialogue recording and ADR xor voice over	Content, budget	Sound design	XOR14, XOR15, OR16, OR17
12. Foley	Record, artificial	Budget	Sound design	Record foley
13. Atmosphere	Record, artificial	Budget	Sound design	Record atmosphere
14. Film-to-tape grade	Telecine, tape-to-tape	Budget	Tape finish	XOR20, XOR21

Tab. 5: Configuration parameters and affected variation points

3.4.4 Example configurations

In the following, I present two example configurations. The two derived models have been presented to an industry practitioner for validation in terms of certain criteria.[236] The verifi-

[236] The answered questions and presented set of parameters of the evaluation can be found in appendix D.

cation was successful aside from minor refinements, which are already incorporated in the presented models. Based on this validation, I derive conclusions on the validity of the reference model. The verification of example configurations can't ensure full validity of the reference model. But it is assumed satisfactory for a preliminary validation. The reference model itself has not yet been presented to industry experts, since the practitioners are not experienced with the specification of a configurable reference model.

Regarding the composition of the two example configurations, I tried to choose configurations that are on the one hand realistic and on the other hand different in their implications on the process. Example one is titled "high-budget feature film production", example two "low-budget documentary production". Although not necessary, in this case both configurations are related to both configuration objectives presented earlier.

In a first step, the necessary decisions regarding the presented variation points have been taken for both example configurations. These decisions are listed in Tab. 6. To generate a correct EPC, the derivation rules for C-EPC were followed. This comprises the derivation of a partial EPC model for the configured functions and connectors, and the recalculation of the entire process model to eliminate superfluous parts.[237] The resulting EPC models can be found in appendix D.

Configuration' Parameter	**Possible Values**	**Configuration example 1: "high-budget feature film"**	**Configuration example 2: "low-budget documentary"**
1. Shoot	Film, tape, film and tape, film or tape, film xor tape	Film	Tape
2. Completion	Film, tape, disk & file, film and tape, film and disk & file, tape and disk & file, film and tape and disc & file, film or tape, film or disc & file, tape or disc & file, film or tape or disc & file, film xor tape, film xor disc & file, tape xor disc & file, film xor tape xor disc & file	Film and tape and disc & file	Tape and disc & file
3. Cut	Online, film, online and film, online or film, online xor film	Film	Online

[237] Compare Mendling et al. (2006), p. 1507.

4. Telecine transfer	Record to tape, record to HD, record to tape and HD	Record to tape and HD	-
5. Synchronisation sound & picture	In telecine, in editing suite	In telecine	-
6. First grade	One light grade, best light grade, no grade, one light grade xor best light grade, one light grade xor no grade, best light grade xor no grade	One light grade or no grade	-
7. Audience screening	Yes, no	Yes	No
8. External VFX & cred-its	Yes, no	Yes	No
9. Final tape grade	Telecine grade, online grade, tape-to-tape grade	-	Online grade
10. Music	Record, artificial	Record	Artificial
11. Dialogue recording	No dialogue recording, ADR, voice over, ADR and voice over, ADR or voice over, ADR xor voice over, no dialogue recording or ADR, no dialogue recording or voice over, no dialogue recording or ADR and voice over, no dialogue or ADR or voice over, no dialogue recording and ADR xor voice over	ADR and voice over	ADR or voice over
12. Foley	Record, artificial, record or artificial	Record	Record or artificial
13. Atmosphere	Record, artificial, record or artificial	Record	Record or artificial
14. Film-to-tape grade	Telecine, tape-to-tape	Telecine	-

Tab. 6: Configuration examples – configuration parameter values

4 Evaluation of Configurable Event-Driven Process Chains

This chapter addresses the second research objective, the evaluation of the C-EPC language in practice. I deliver the findings from the application of C-EPCs on real-life processes during the construction of the reference model. Hereby, I refer to different perspectives on the modelling language. I first use the requirements for configurable reference modelling languages to identify new findings from an external perspective on configurable reference models. Afterwards I undertake an investigation from an internal perspective by reflecting on the configuration patterns that are defined in the C-EPC technique. Then, in a third step, I have a look on model adaptation mechanisms in a broader sense.

4.1 External perspective –requirements for configurable reference modelling languages

This section reflects on the requirements that should be fulfilled by a configurable reference modelling language. In conjunction with the development of the C-EPC language, ROSEMANN and VAN DER AALST establish a set of requirements for a configurable reference modelling language.[238] They also reviewed Configurable EPCs in terms of these requirements and concluded that the proposed language focuses on the core functionality of configurable reference modelling but doesn’t cover all requirements.[239] I intend to deliver new findings on this review. My investigation happens in a different setting, as I applied the modelling technique in practice and can now draw conclusions from this application. In the following, I examine each requirement in terms of its relevance in my reference model construction context and, if possible, elaborate on the resulting implications for further research towards a more mature reference modelling language.

a) *Support of configurations regarding entire processes, functions, control flow, resources and data:* The presented reference model contains variation points that allow for configurations regarding entire processes, functions and control flow. Three complex functions with underlying sub models have been made configurable. This permits an optional exclusion of the entire process of the sub model. A total of 22 functions can be configured while 21 configurable connectors define a configurable control flow. The attached resources and data elements exhibit no aspects of configurability since this is not supported in the C-EPC definition so far. To provide the model with variation points in terms of resources and data, this should happen

[238] Compare Rosemann, van der Aalst (2007), pp. 7 f.
[239] Compare Rosemann, van der Aalst (2007), pp. 19 f.

with consideration of the related organisational and data models.[240] Therefore, an alignment to approaches for configurable models of this perspective should be taken into consideration. I conclude that the requirement is partly fulfilled and was found to be strongly relevant in the context of my reference modelling efforts. However, I suggest extending this requirement by explicitly demanding validity of the derived elements and models regarding the respective modelling language. Further findings concerning the definition of the configurable nodes of the C-EPC notation will be given in conjunction with the related configuration patterns in section 4.2.

b) *Distinction of mandatory and optional decisions:* The presented approach doesn't explicitly differentiate mandatory and optional decisions.[241] So far, every variation point must be configured, hence refers to a mandatory decision. However, the C-EPC definition implicitly supports optional decisions, as the decision regarding a variation point can be postponed to runtime by simply configuring a function as optional (OPT) or a configurable connector as an instance of the connector type. Consequently, the C-EPC language only lacks the explicit depiction of mandatory and optional decisions. To provide the variation points with this additional information, interrelationships to other variation points must be considered. Based on the presented system of configuration layers, I therefore suggest adding the specification of mandatory and optional decisions on the level of configuration parameters. If a configuration parameter is labelled as mandatory, it ensures that no conflict to related variation points arises, because the parameter covers the semantic field of one decision. This decision must then be taken in advance, while decisions of configuration parameters that are labelled optional can be neglected at this stage. The latter case implies a previous specification of a default value for all variation points. A simple solution is the least restricting value of a variation point, thus the value "OPT" for a configurable function and the connector itself for a configurable connector. In terms of my study, the reference model construction didn't raise a specific need for mandatory and optional decisions. However, a distinction of this kind would have been possible for the presented models. An example specification with respect to the given context is presented in appendix 0.

c) *Distinction of global and local decisions:* I refer to the definition of global decisions as taking a decision without studying the process model, while the constituent characteristic of local decision is the necessity for an explicit study of the corre-

240 For in information on configurable reference data models see Rosemann, Shanks (2001).
241 Compare Rosemann, van der Aalst (2007), pp. 19 f.

sponding process model.[242] C-EPCs don't support the distinction of global and local decisions so far, so no explicit specification of this kind is included in the presented C-EPC models.[243] However, the specification of configuration parameters provides an abstraction from the models. This realises the requirements for global decisions, as the decision associated with a configuration parameter can be taken without the study of the respective model. Hereby, it was found, that the support of global decisions is particularly helpful with respect to the communication with industry practitioners and for an uncomplicated presentation of the model-inherent flexibility. ROSEMANN and VAN DER AALST further refer to the context factors of global decisions. In my case, the global decisions related to configuration parameters have been identified within the system of configuration objectives and variation points. An investigation on the influence of other relevant context towards context-aware process modelling has not been performed. As context-awareness is a topic in current research, such an investigation could be of interest in future. I conclude that the principle of global and local decisions was found to be relevant in practice. However, my single case study doesn't allow for a statement in terms of a general relevance. Furthermore it must be analysed, if the aggregation of all decisions to configuration parameters makes the concept of local decisions obsolete.

d) *Distinction of critical and non-critical decisions:* In accordance to the specification of C-EPCs, no explicit distinction of critical and non-critical decisions can be found in the created reference model. The conducted case study didn't show a particular need for such additional information so far. I assume that this distinction is rather necessary for process modelling in conjunction with software development. In the case of further advanced BPM efforts within the Creative industries including workflow automation and development of associated information systems, this topic can become of interest. In this case the additional information can be added fairly easy in the same way as the mandatory and optional decisions.

e) *Depiction of interrelationships between configuration decisions:* The presented Configurable EPCs contain 10 requirements and 2 guidelines that define the relationships between variation points. Without these constructs the complex linkages of the variation points are hard to detect for model users. The possibility to define these constraints enabled a sound reference model specification and provided transparency in terms of interrelationships. ROSEMANN and VAN DER AALST mention the problem of highlighting interrelationships between two process models.[244] I utilised

[242] Compare Rosemann, van der Aalst (2007), p. 7.
[243] Compare Rosemann, van der Aalst (2007), p. 20.
[244] Compare Rosemann, van der Aalst (2007), p. 20.

a quite intuitive notation of linking to other process models with the name of the respective process model followed by a dot and the related variation point. Example: To refer to the configurable function `tape grade` in the sub model `tape finish` I use the code "`Tape finish.Tape grade`". I conclude that interrelationships have been a crucial element during the practical application of C-EPCs. Further research is necessary on the logical expressions of configuration requirements and guidelines as well as on the specification of interrelationships to other types of models e.g. data models or organisational models.

f) *Different levels of configurations:* The presented configurable reference model doesn't include the definition of different levels of configuration. These *levels* must be distinguished from the configuration *layers* presented in section 3.4.1. It must be noted though, that the two principles are not conflicting. The configuration layers refer to the degree of abstraction from the model, while levels of configuration specify a sequence of configuration iterations that lead to the final configured model. Such iterations are not explicitly intended in the presented reference model. However, based on the configuration parameters this can be realised as follows: If the configuration of the first level determines the values of several chosen configuration parameters, the rest of the set of configuration parameters is available for a second, or even more levels of configuration. Regarding the actual process models, this refers to partially configured C-EPCs.[245] With regards to my study, a practical example for a sequence of configurations could be the following: A production studio decides to focus on feature films shot on film and uses an online suite for the high resolution edit because of the availability of company-owned facilities. These decisions refer to configuration parameters 1 (Shoot) and 3 (Cut). Other decisions, like music recordings for a project are postponed to the sub divisions that are responsible for the budgets of their productions. I conclude that the conducted case study didn't show a particular need for an explicit highlighting of different levels of configuration. Instead, a rather unconstrained partly configuration based on the given configuration parameters is suggested. Promising fields of application and a fairly easy realisation have been identified which suggests further research on this topic.

g) *Reference from variation points to related information in the ES:* As the construction of the reference model didn't happen in the setting of ES configuration, variation points don't refer to any related information. Thus I can't draw any conclu-

[245] Compare Rosemann, van der Aalst (2007), pp. 18 f.

sions or implications on this requirement for configurable reference modelling languages.

h) *Configuration recommendations or guidelines:* The post-production reference model contains n configuration guidelines, which have been added on the basis of the discussions with industry practitioners and findings in literature. An application of the reference model should go along with a continuous model maintenance and model improvement. New findings that support configuration decisions like benchmarking data thus should be added to the model by extending the configuration guidelines.

i) *Consideration of the impact of modelling language extensions on the perceived model complexity:* The C-EPC notation is a natural extension of EPCs and addresses an intuitive use by typical reference model users.[246] Based on the presented reference model I consider myself to be able to confirm the assumption, that particularly interrelationships, depicted as configuration requirements and guidelines, increase the perceived model complexity. This can be seen in the models “main process” (Fig. 3.4) and “preparing film for edit” (Fig. 3.6), where several requirements or guidelines apparently decrease the clearness. Another aspect in the context of my work is the potential model user, who differs from the typical reference model user. This topic has been addressed in section 3.4.1. As a result of this investigation, I suggest to approach a configuration of the model based on three layers of abstraction. This way, the model user focuses on decisions regarding certain configuration parameters and consequently doesn’t need to deal with a potential higher model complexity. From the perspective of reference model development, I experienced that the variation points and their interrelationships on the one hand increase the complexity of the construction procedure, but on the other hand allowed for a richer model and a consistent consolidation of model parts. I therefore suggest that the increased complexity for the model developer shouldn’t be the main focus, since the main goal is to provide mature reference models. Nevertheless, I suggest further research on methods of configurable reference modelling in terms of supporting model developers during the specification phase. This especially counts for more conceptual support for the identification of variation points. The main steps explained in section 3.3.1 can hereby serve as a basic framework. I conclude that the practical application of C-EPCs to a certain extent confirms an increase in the model complexity. However, it must be noted that this is only an assumption, as the perceived model complexity must be evaluated with the actual model users. The

[246] Compare Rosemann, van der Aalst (2007), p. 20.

presented system of configuration layers allows an abstraction from the actual models and thus helps to deal with the model complexity.

4.2 Internal perspective – configuration patterns

This section discusses the findings on the configuration patterns that can be defined in a C-EPC model. The previous section focussed on the general requirements that must be fulfilled by a configurable reference modelling language, thus it addressed the topic from an external perspective. As I now concentrate on specific elements of Configurable EPCs, this addresses the internal dimension of my investigation on the conceptual definition of C-EPCs.

The configuration patterns served as a basis for the development of the configurable modelling notation and were derived from an examination of a set of workflow patterns. They are closely related to the configurable elements of the C-EPC, thus specifying the configurability of a process model. Tab. 3 arranges the configuration patterns and the corresponding elements of a Configurable EPC. In the following I will use the findings of the practical application of C-EPCs to draw back conclusions on the supported configuration patterns. Moreover, I will particularly take into consideration the investigation on the theoretical foundations of configuration of VAN DER AALST et al.[247] They narrow down the choices of a configurable process model to the two basic principles *hiding* and *blocking*. Hiding hereby refers to simply skipping a step of the process which has no further influence on the path. A blocked step cannot be taken anymore. This potentially entails that a set of subsequent steps can't be reached anymore either. In the following, I reflect on the configuration patterns and the corresponding C-EPC elements as presented in Tab. 3.

Optionality – configurable function

The configuration pattern optionality is represented by configurable functions. N configurable functions show the relevance of optional tasks. This refers to the principle of hiding.[248] Excluded functions don't block a certain path but just skip one step of it. A path of a function that has been configured to OFF can still be taken, even if it is the only function of that partial graph. This is illustrated in Fig. 4.1.

247 Compare van der Aalst et al. (2006)
248 Compare Gottschalk, van der Aalst, Jansen-Vullers (2006), p. 13.

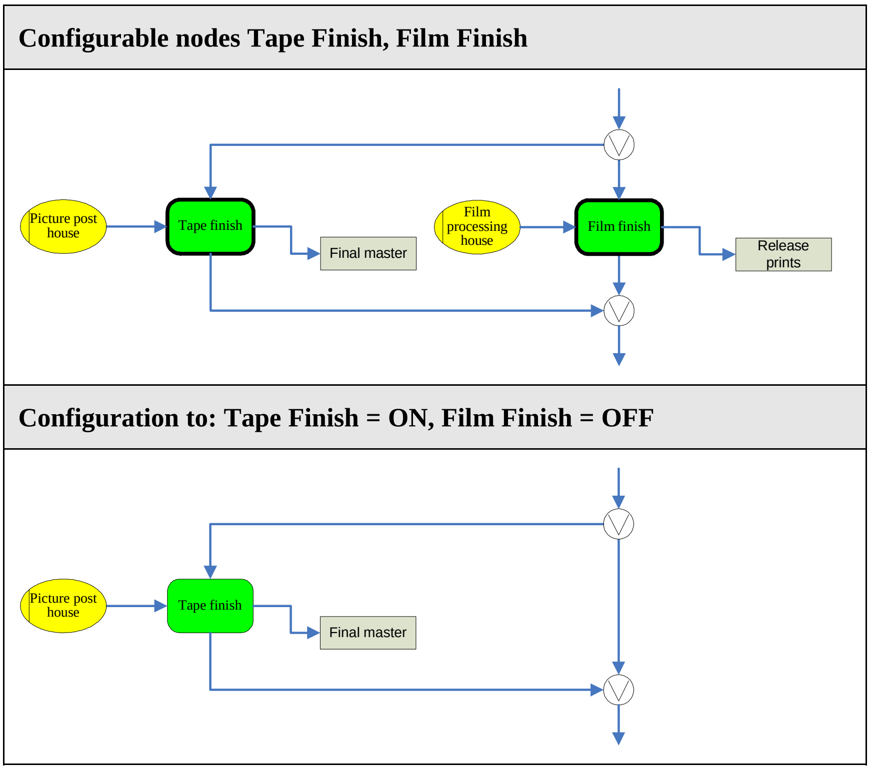

Fig. 4.1: Example of hiding by configuring functions

Parallel Split and Synchronisation – AND-connector

The configuration patterns involving a configurable AND-connector are parallel split and synchronisation. Both patterns do not appear in the post-production reference model. Therefore I cannot present any new findings on these configuration patterns. The minor relevance in the case study is assumed to be mainly due to the limited choices, a configurable connector of this type offers.

Exclusive Choice and Simple Merge – XOR-connector

The configuration patterns of exclusive choice and simple merge are more complex from the perspective of model configuration. This derives from a broader spectrum of choices, the configurable XOR-connector offers. These choices are the crucial element of configuration. Variation points hold choices that can be taken during configuration. The configurable nodes are means to highlight and define these variation points. Twelve configurable XOR-connectors show the high relevance of this particular configurable node for the presented reference model and led to the following conclusions:

It was found, that the representation of this configuration pattern in C-EPCs so far doesn’t allow for a clear specification of all choices that are potentially required at variation points. I want to explain this with the help of an example of the presented reference model. During the specification of the configurable nodes in the sub model *prepare film for edit,* I had to deal with the situation depicted in Fig. 4.2. It concentrates on the different options of a film grade. A film can be graded with one light grade, best light grade or can be skipped completely. A configurable model should allow for a restriction of the given alternatives. The goal essentially was to specify a configurable model that allows a configuration towards an exclusive choice of any combination of the three alternatives. This represents an example where the C-EPC definition lacks conceptual support for blocking and hence only manages to offer the demanded functionality in an unnecessarily complicated way. To explain this statement I first clarify the choices that a configurable XOR-connector offers and then draw conclusions on the missing configuration options and the resulting suggestions for the C-EPC definition.

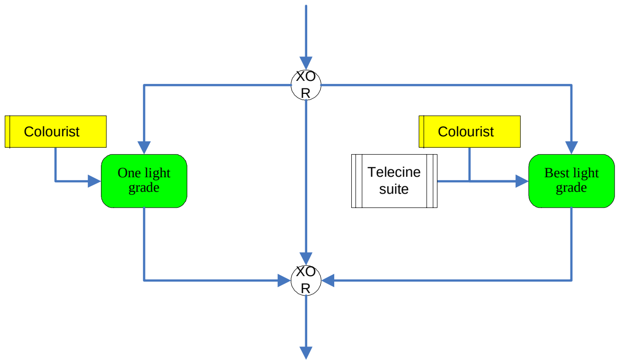

Fig. 4.2: Alternatives for film grading

It must first be noted, that the problem I address, only arises in the case of a choice between more than two alternatives. The relevance of this situation in practice was confirmed by the given example in Fig. 4.2. The definition of a configurable XOR-connector allows choosing one of the following configurations:[249] One-light grade, no grade, best light grade, and the run-time choice between all of these alternatives. This is depicted in Fig. 4.3 a)-d). As mentioned above, the goal was, to allow for a configuration of all lawful combinations. However, with the given definition of a configurable XOR-connector it is not possible to block only one of the paths, thus keep only two of the alternatives for a decision on run-time. Therefore, the configurations depicted in Fig. 4.3 e)-g) are not possible in the given situation. Since this may be required, as in the case of the presented context of my research, a single configurable connector is not sufficient for the specification of this variation point.

249 I refer to the definition of C-EPCs in Rosemann, van der Aalst (2007), pp. 12 f.

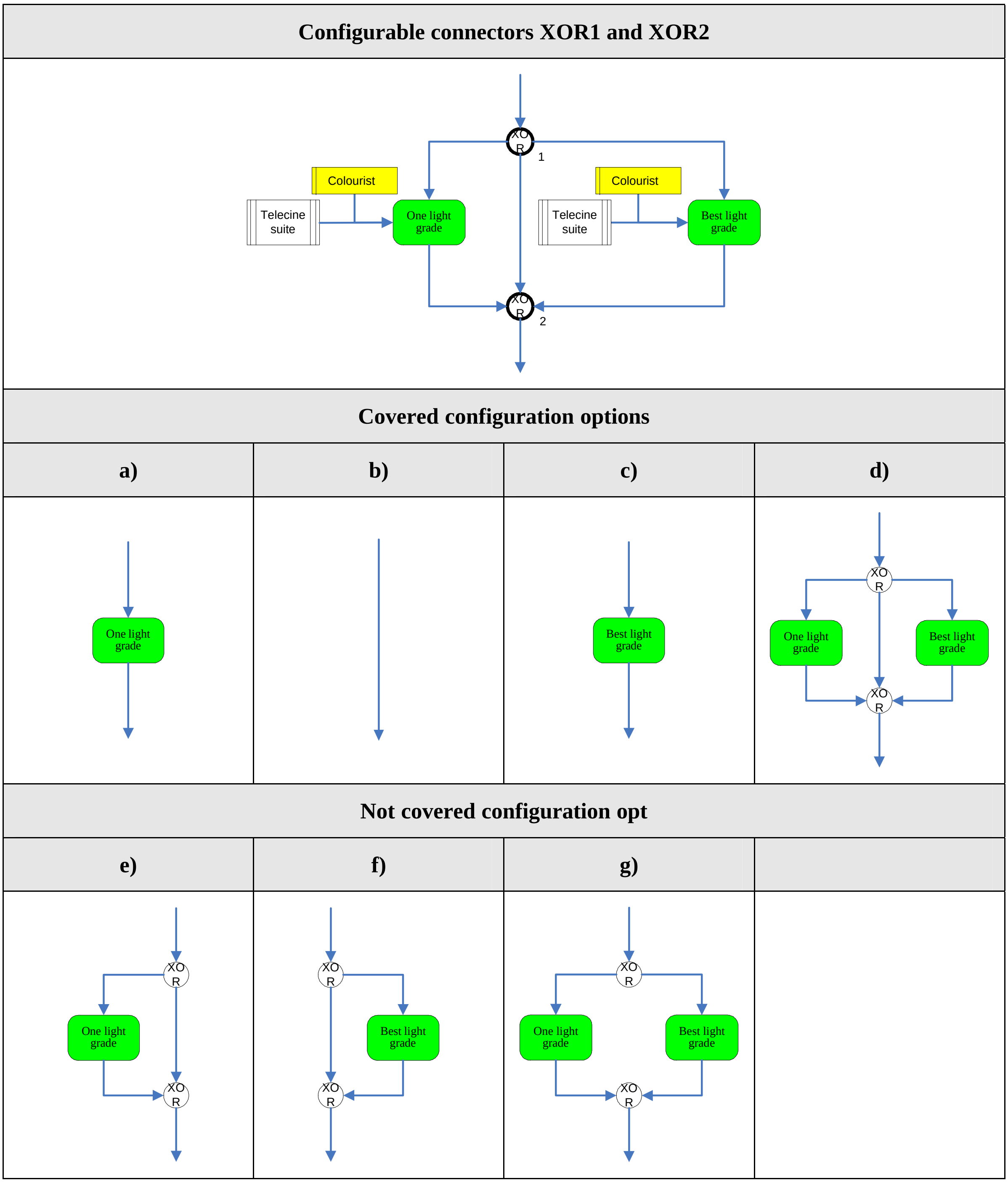

Fig. 4.3: Example of blocking by configuring connectors

There are two ways to handle this issue. The first solution is to use two consecutively arranged XOR-connectors. In a case of more than two alternatives, this implies one additional split connector and one additional join connector for each additional alternative. This increases the model complexity and is assumed to make the intended configuration options unclear. A sequence of connectors therefore is considered as a temporary solution only. This solution can be found in the model *sound design* in Fig. 3.13 for the configuration options regarding additional voice recordings.

A second solution to this problem, which has also been applied in the presented reference model, is to use configurable functions to specify the desired configurability. The model *prepare film for edit* in Fig. 3.6 shows this solution. The functions `one light grade` and `best light grade` are highlighted as configurable. Although this provides all mentioned choices for configuration, it must also be regarded as lacking a solution: The discussed problem represents a problem of *blocking*. Configurable functions are a means for *hiding*. Consequently it shouldn't be used in this situation. The inconsistent use brings along problems as soon as the partly graph consists of more than one function. Imagine, the one light grade would require some additional steps that follow the function `one light grade`. The configuration cases b), c) and d) of Fig. 4.3, where the one-light grade is configured OFF, thus hidden, the subsequent functions would still be part of the model, thus interfere with the intended configuration. This can only be avoided, if all functions of each alternative graph are specified as configurable and then linked with a configuration requirement. This apparently complicated solution illustrates that the inconsistent application of configurable function as means of blocking instead of hiding is inappropriate. A mature reference modelling language should provide consistent mechanism to support blocking and hiding.

The missing functionality of a configurable XOR-connector can be added fairly easy. So far, the configurable XOR-connector supports itself and one of the subsequent alternatives SEQn.[250] If a set of several given alternatives could be chosen, instead of only one alternative, this would allow for a blocking of the alternatives that are not chosen. This can be added to the formal definition of Configurable EPCs. The suggested functionality of excluding any alternative would solve the problems discussed earlier. Regarding the illustrated example, the two configurable XOR-connectors would allow for all desired combinations. I conclude that restricting a set of alternatives during configuration refers to the principle of blocking. Consequently, configurable connectors represent means of blocking while configurable functions refer to hiding. The definition of C-EPCs so far doesn't allow for a specification of all choices that were found to be relevant in practice. I suggest a minor alteration of the definition of configurable XOR-connectors to provide a full support of the principle of blocking.[251]

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250 Compare Dreiling et al. (2005a), p. 4; Recker et al. (2006b), p. 501; Recker et al. (forthcoming), p. 12; Rosemann, van der Aalst (2007), pp. 12 f.

251 GOTTSCHALK, VAN DER AALST and JANSEN-VULLERS state that the C-EPC notation lacks to block a function. This could be necessary in case of a partial process without any preceding connectors and would block the complete following process. Further research is necessary to find out if the complete blocking of a process is compatible with the semantics of an EPC. Until then this can be realised with an additional preceding XOR-connector that can be configured to lead to an extra ending event if the function needs to be blocked. This also ensures a checking of the consequences by the model developer.

Multi Choice and Synchronising Merge – OR-connector

The multi-choice and synchronising merge patterns refer to the configurable OR-connector. Nine occurrences in the post-production reference model demonstrate relevance in the presented practical context. Due to the rule, that configurable connectors support the configuration to connectors that restrict their behaviour, the configurable OR-connector also supports the configuration to XOR and the selection of one alternative SEQn (see Tab. 3). Consequently, the same findings on the topic of blocking that have been presented for the configurable XOR-connector apply.

Sequence Interrelationships

The sequence interrelationships are represented by configuration requirements and guidelines. The findings on the relevance of these constructs have been presented in section 4.1 in conjunction with the investigation on the requirements for configurable reference modelling languages. I repeat that the specification of interrelationships was found to be important for reference modelling. The importance becomes particularly apparent by considering its necessity for a sound model consolidation and for tasks, which exhibit optional positions of execution within the process model, but must not be done twice.

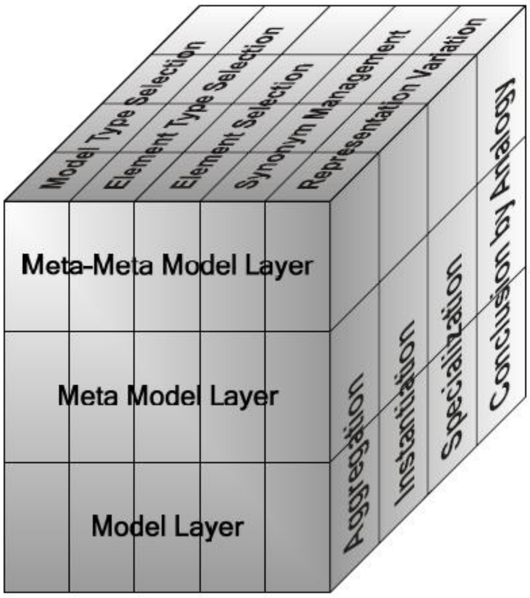
4.3 Further adaptation support

Both the configuration patterns and the requirements for configurable reference modelling languages are closely related to the development of C-EPCs. Thus my investigation so far represents reflections on the conceptual foundations of the modelling language, based on the findings of a first comprehensive practical application. However, the latter represents an application in a broader context of BPM and consequently raised (further) issues that go beyond the scope of the presented catalogue of configuration patterns and language requirements. In the following, I elaborate findings on the development of C-EPCs in a broader sense of configurable reference modelling.

Fig. 4.4 shows the framework for adaptation support for reference modelling by BECKER, DELFMANN, and KNACKSTEDT.[252] This framework represents a comprehensive classification of mechanisms for reference model adaptation in a broad context. In the following, it serves as a benchmark for completeness and helps categorising additional findings for further research. A thorough comparison of the C-EPC approach and the framework is out of the scope of this study. However, I will briefly discuss the classification of the mechanisms

252 Compare Becker, Delfmann, Knackstedt (2004), p. 252.

of C-EPCs within the framework and then refer to two additional adaptation mechanisms that were found to be of particular relevance in the context of my C-EPC application.[253]



Source: Becker, Delfmann, Knackstedt (2006), p. 6.

Fig. 4.4: Framework for adaptation support for reference models

The framework structures the adaptation mechanisms with the three dimensions *modelling layers*, *configuration adaptation* and *generic adaptation*. The *configurative adaptation mechanisms* hereby are defined as mechanisms that specify explicit adaptation points and corresponding rules to determine how a reference model can be modified.[254] *Model Type Selection* and *Element Type Selection* refer to a change or the modification of the modelling language, the reference model is designed with.[255] The other configurative mechanisms focus on a model-based modification. Hereby, they distinguish the modification of model parts in terms of selecting model elements (*Element selection*), perspective-specific exchange of model element naming (*Synonym Management*) and the change of representational aspects of modelling languages (*Representation Variation*).[256]

The second dimension comprises the *generic reference model adaptation mechanisms*. These mechanisms pose fewer restrictions to model adaptations and allow for creative freedom regarding the model modification.[257] They are partitioned in component-based combination of model parts (*Aggregation*), the insertion of feasible values for placeholders

253 For further information on the framework see Becker, Delfmann, Knackstedt (2006).
254 Compare Becker, Delfmann, Knackstedt (2006), pp. 6 ff.
255 Compare Delfmann (2006), p. 67.
256 Compare Becker, Delfmann, Knackstedt (2006), pp. 10 f.
257 Compare Becker, Delfmann, Knackstedt (2006), p. 7.

(*Instantiation*), a modification of model parts that restricts the level of detail (*Specification*), and the reuse of reference model content (C*onclusion by Analogy*).[258]

Interestingly, DELFMANN arranges the C-EPC approach under the category of generic adaptations as a mechanism of specialisation.[259] To some extent, Configurable EPCs indeed match the characteristics of specialisation. Model parts can be changed and removed during configuration to restrict the behaviour of the model and thereby, are subject to limitations that preserve the syntactical and semantic consistency of the model. On the other hand, the specialisation mechanisms – also called "free modification" – are defined to allow more freedom in terms of model alterations.[260] Yet, the similarity between the mentioned *adaptation points* of the mechanisms of configurative adaptation and the concept of *variation points* in C-EPCs raises the question, if a classification as a configurative adaptation mechanism was reasonable, too.[261] Hereby, the mechanisms of *Element Selection* must especially be considered, since the configurable nodes of C-EPCs offer the possibility to declare certain model elements as relevant or non-relevant in a situation of configuration.[262] It seems, the *individual character* of the choices provided by variation points, is the biggest difference, as the Element Selection particularly focuses on a rather *uniformly* parameter-specific adaptation that consistently applies for the complete reference model in a certain adaptation scenario.[263]

I conclude that Configurable EPCs provide configuration mechanisms that may be classified as somewhat between the category of specialisation mechanisms and mechanisms of Element selection. The presented system of configuration layers in section 3.4.1 may be considered as a shift towards the category of Element Selection mechanisms, because it aggregates the individual choices of variation points to configuration parameters and supports a consistent configuration with respect to overall objectives.

In terms of a further development of C-EPCs towards a more mature reference modelling language, the practical application raised the interest for two other categories of mechanisms within the framework for reference model adaptation. First, mechanisms of *Synonym Management* are considered to be useful within the presented reference model for post-production. This derives from the finding, that the Creative Industry exhibits a high

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258 Compare Becker, Delfmann, Knackstedt (2004), p. 252; Becker, Delfmann, Knackstedt (2006), p. 7.
259 Compare Delfmann (2006), p. 11.
260 Compare Delfmann (2006), p. 178.
261 GOTTSCHALK, VAN DER AALST and JANSEN-VULLERS. support this proposal, as they emphasize the characteristic of generic adaptation mechanisms to focus on *user-driven* configuration, while configurative adaptation mechanisms provides *clear rules*, how a reference model can be configured. Compare Gottschalk, van der Aalst, Jansen-Vullers (2006), p. 1.
262 Compare Rosemann, van der Aalst (2007), p. 10.
263 Compare Delfmann (2006), p. 111.

amount of technical terms and that these technical terms can differ, dependent on the geographical location. An example for this is the term “Timing” that is mainly used in the U.S. industry for “Grading”. Furthermore, the “colourist” can be called “timer” and “dailies” refers to the term “rushes”.[264] An additional configuration mechanism could allow for an adaptation to the respective established term within the given configuration situation.

A second category of mechanisms that appeared to be useful are mechanisms of *Representation Variation*. Hereby, I especially refer to the prospective models users within the Creative industries. It is assumed, that both the comprehensibility of the model and the user acceptance can be in increased, when the rather plain standard EPC elements can be exchanged on demand with suitable graphical elements or even established, company specific symbols for certain elements. This may simply be the exchange of the information carrier element with the graphic of a film roll or a tape respectively. I conclude that the practical application allowed identifying promising applications of additional mechanisms that should be topic in further research on C-EPCs and can be considered during refinement efforts regarding the presented post-production reference model.

[264] Compare Benedetti (2004), pp. 151-157.

5 Conclusion and outlook

This study addressed two research objectives. First, the construction of a reference model for the post-production of screen business productions and second, the evaluation of the reference modelling language of Configurable EPCs by reflecting on its concepts, based on the findings of the practical application.

The modelling efforts must be seen in a holistic Business Process Management approach. The reference model has strategic relevance for the Australian economy and holds importance for the local screen business industry in a global setting of increasing competition. Post-production hereby was found to be particularly interesting due to complex procedures, a high impact of new technologies, and the demanded high level of efficiency. After a clarification of the conceptual foundations, I approached the first research objective in three major phases, which comprised (1) the assessment of the portfolio of post-production processes, (2) the specification of a configurable reference model on the basis of these processes and (3) its systematic configuration combined with an evaluation of resulting examples. The reference model successfully consolidates various post-production paths, which are possible outcomes of a model configuration. Deducted configuration examples have been verified by industry practitioners. The configuration process is supported by a system of configuration layers that allow on the one hand, an easier selection of the desired post-production process, but on the other hand, still provide enough flexibility not to restrict the specified configurability of the model.

Regarding the first research objective I conclude that I successfully created a configurable reference model for post-production. First promising applications are the planned inclusion in the AFTRS teaching portfolio and the deployment to industry partners in the Creative Industries within the project of the CCI. The reference model is considered to be of enormous benefit because no comparable process-focussed management support was previously found and beyond this the reference model provides sophisticated ways, to align the models to the company's requirements. The constructed model supports the proposition that BPM is suitable for the Creative Industries. Still, a comprehensive application entails extensive further research. It must be noted that the sophisticated simulation of the processes as well as performance measurements need a satisfactory data basis. Simulation therefore requires case studies in conjunction with a model deployment with simulation tools like the ARIS toolset. In this context, the process models also induce further research towards a workflow automation of suitable process parts.

I am also aware of the fact, that within the scope of this work, I can't settle the claims for a mature and complete reference model for a whole industry sector. Rather, I deliver a starting point that serves as a basis for a continuously improved and maintained reference model and the accompanying BPM efforts. Further research must address the assessment of the VFX production processes, which have complex interactions with the editing processes presented here. This might raise the necessity for investigating more on the support of the highly creative parts and the simultaneous collaboration with other departments like the VFX house. In the long-term, it will be interesting to see the change of procedures due to new technologies or developed best-practices. A well managed model development can explicate the process change over time. This potentially allows for implications in terms of future industry development and helps to identify and estimate the impact of up-coming trends.

The elaborations concerning the second research objective rely on the principle, to derive new findings from the first practical application of C-EPCs in the presented case study. The analysis on the requirements for configurable reference modelling languages discussed the relevance of these requirements in practice with respect to the achieved coverage by C-EPC components and assessed the concept of configuration parameters in this context. It was found, that the system of configuration layers helps to comply with the requirements by serving as a basis for further language extensions, like the configuration in several iterations or the depiction of mandatory decisions at configuration time. The investigation on the supported configuration patterns focused on findings from a more internal perspective on C-EPCs. I examined both the relevance of the individual C-EPC elements in practice and the conformance with practical demands for a configurable reference model specification. Hereby, I came to the conclusion that the basic principles of hiding and blocking can be assigned to configurable functions and connectors respectively, but are not satisfactorily supported. I therefore suggest a simple extension of the C-EPC definition. In a third step I reflected on reference modelling from a broader perspective. This led to the conclusion that further research should stretch across several categories of adaptation mechanisms, including naming and representation variations.

I conclude that the reflections on Configurable EPCs contribute to a verification of practical relevance. They contain a more empirical foundation of the developed concepts and indicate promising fields of further research. Especially concepts that have been presented in the limited context of this study, for example the system of configuration layers need to be formalised and tested in other scenarios.

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Appendix

A Data view – term conversion

Definition ARIS terms:[265]	
Information carrier	The storage medium in which data is carried.
Technical term	Information from a business perspective (less formal).
Entity type	A real-world entity, described by data attributes, that is part of a formal data model.

Initially named term	**Information carrier**	**Technical term**	**Entity Type**
Tape dailies	Tape	Dailies	
Negative	Film	OCN (Original Camera Negative)	
Rushes paperwork		Rushes paperwork	
Processed negative	Film	Processed negative	
Low-res copy on HD	File	Low-res copy for edit	
Rushes tape (optional)	Tape	Dailies	
Tape-numbering protocol		Logging protocol	
DAT	Tape	Location Sound	
Low-res guide tape (optional)	Tape/File	Low-res guide picture	
Director notes		Director notes	
EDL			EDL
OMF		OMF	
Cutlist		Cutlist	
Final EDL		Final EDL	EDL
Final guide tape (optional)	Tape	Final guide picture	
Final credits	Tape	Final credits	
Final VFX	Tape	Final VFX	
Prints of VFX-shots + titles	Film Film	VFX scenes Credits	
Master tape	Tape	Master	
Workprints	Film	Positive workprint	
Guide tape	Tape	Guide picture	
Pos-conform	Film	Pos-conform	
Cut negative	Film	Cut negative	
Negmatching info		Negmatching notes	
Trial print	Film	Trial print	
Answerprint (pos)	Film	Answerprint	
Interpositive	Film	Interpositive	

265 Compare Davis (2001), pp. 150-157.

Internegative	Film	Internegative	
Music cues		Music cues	
Effect cues		Effect cues	
Temp score		Temp score	
Score		Score	
Recorded music			Audio track
Music premix			Music premix
Recorded ADR			Audio track
Recorded Voice Over			Audio track
Recorded Foley			Audio track
Recorded Atmos-phere tracks			Audio track
Dialogue tracks			Audio track
Sound FX tracks			Audio track
Atmosphere tracks			Audio track
Sound premix			Sound premix
Final mix			Final mix
M&E track		M&E track	
D&E track		D&E track	
Dolby license		Dolby license	
Optical sound nega-tive	Film	OSN	
Composite answer-print	Film	Composite answer-print	
Dupe negatives	Film	Dupe negative	
Release prints	Film	Release print	
Submaster ungraded tape	Tape	Ungraded submaster	
OAR/Broadcast submaster	Tape	OAR/Broadcast sub-master	
Final master tape	Tape	Final master	
Broadcast masters	Tape	Broadcast master	

B Data view – sample population

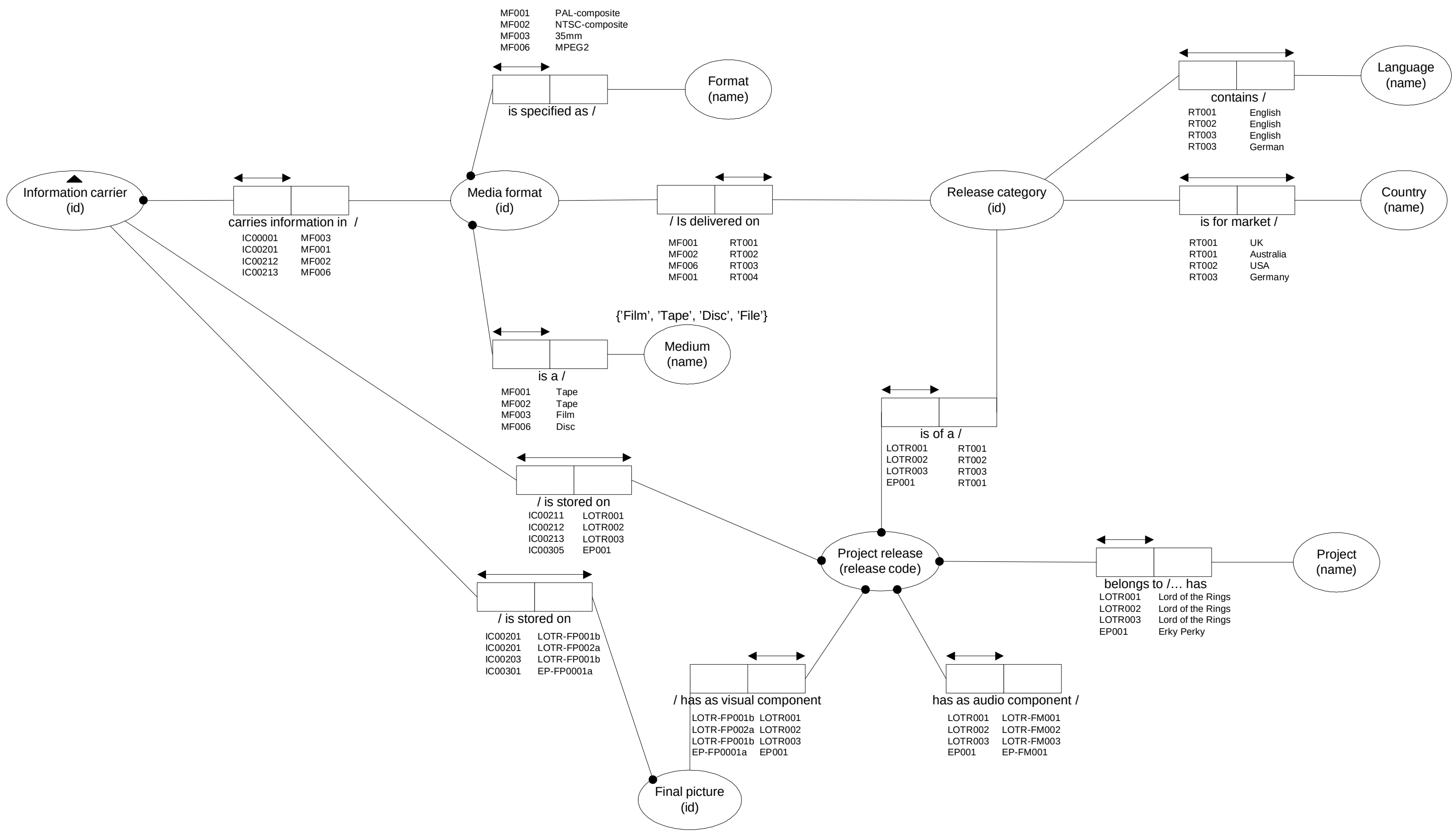


Fig. 5.1: Data view model with sample population (first part)

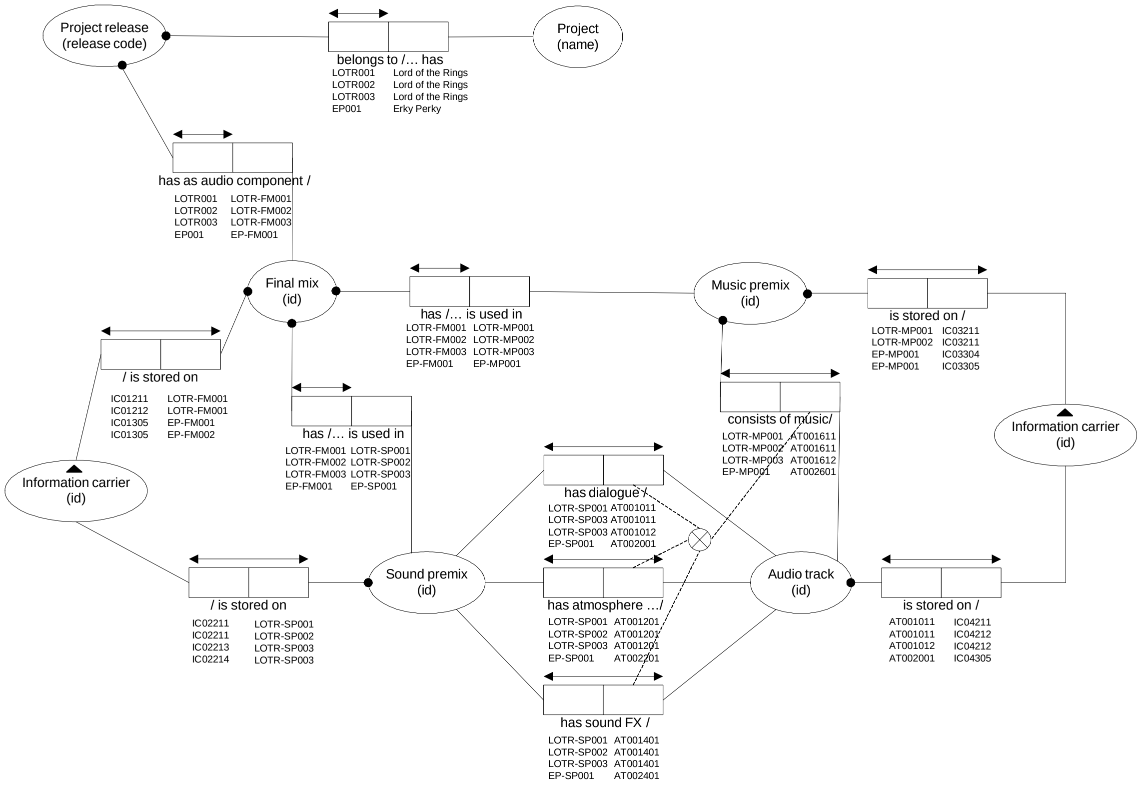


Fig. 5.2: Data view model with sample population (second part)

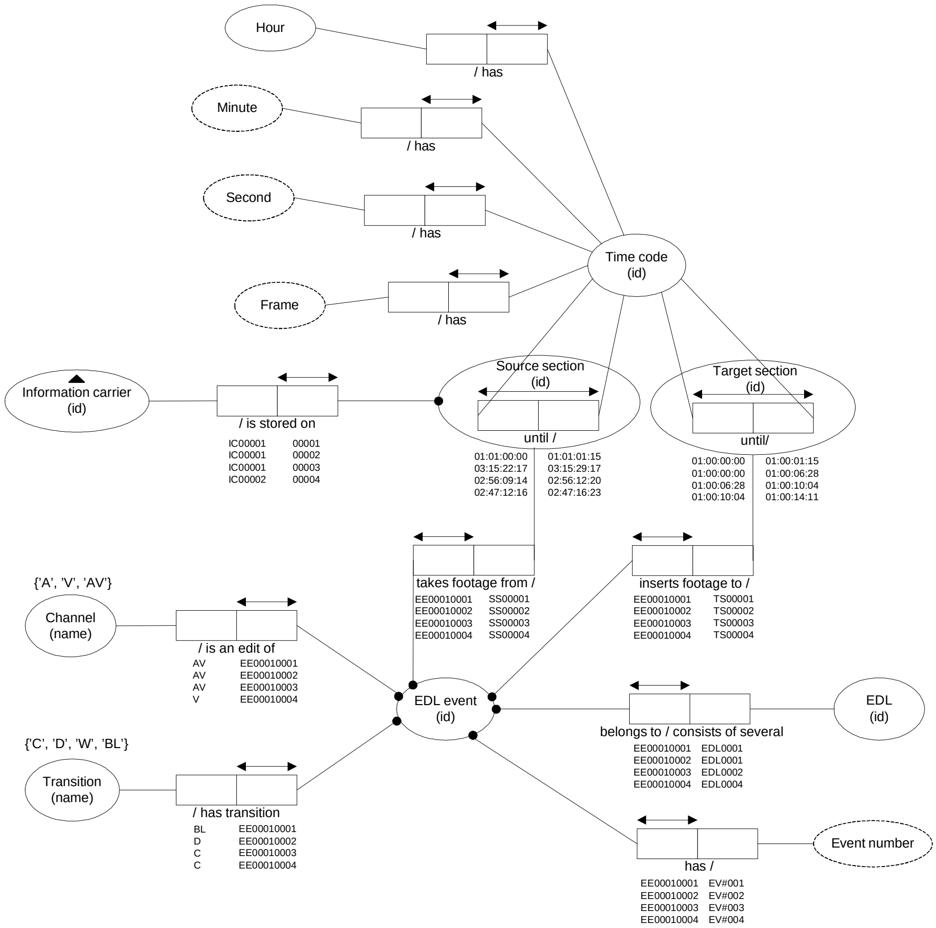


Fig. 5.3: Data view model with sample population (third part)

C Example configuration – variation points

Model name	Variation Point	Configuration example 1: “high-budget feature film”	Configuration example 2: ”low-budget documentary”
Main process	OR1	SEQ: Prepare film for edit	SEQ: Prepare tape for edit
	OR2 & OR3	SEQ: Negmatching	SEQ: Online
	OR4 & OR5	AND	SEQ: Tape finish
	Tape finish	ON	ON
	Film finish	ON	-
	Disk & file finish	ON	ON
Preparing film for edit	Digitise sound	ON	-
	Synch sound and picture in telecine	ON	-
	XOR6 & XOR7	XOR	-
	One light grade	ON	-
	Best light grade	OFF	-
	Play out to HD	ON	-
	Play out to tape	ON	-
	Synch sound and picture in editing suite	OFF	-
	Digitise to HD in editing suite	OFF	-
Offline	Hold test audience screening	ON	OFF
Online	XOR8 & XOR9	-	SEQ: XOR9
	XOR10 & XOR11	-	SEQ: Create titles
	Online grading	-	ON
Sound and music editing	XOR12 & XOR13	SEQ: Record music	SEQ: Create music arti
	Get Dolby approval	ON	OFF

	Sound mastering	ON	OFF
Sound design	XOR14 & XOR15	SEQ:OR16	SEQ:OR16
	OR16 & OR27	AND	OR
	Record Foley	ON	OPT
	Record atmosphere	ON	OPT
Film finish	Record digital film mas-ter	OFF	OFF
Tape finish	OR18 & OR19	SEQ:XOR20	SEQ: Tape grade
	Tape grade	-	OFF
	XOR20 & XOR21	SEQ: Transfer to tape with grade	-
Disk & file finish	Digitise finished project	OFF	OFF
	Import sound	OFF	OFF

Tab. 7: Configuration examples – variation point values

D Evaluation of example configurations

Date: 12.10.2006

Katie Shortland
Project Officer
Centre for Screen Business
Australian Film Television & Radio School (AFTRS)

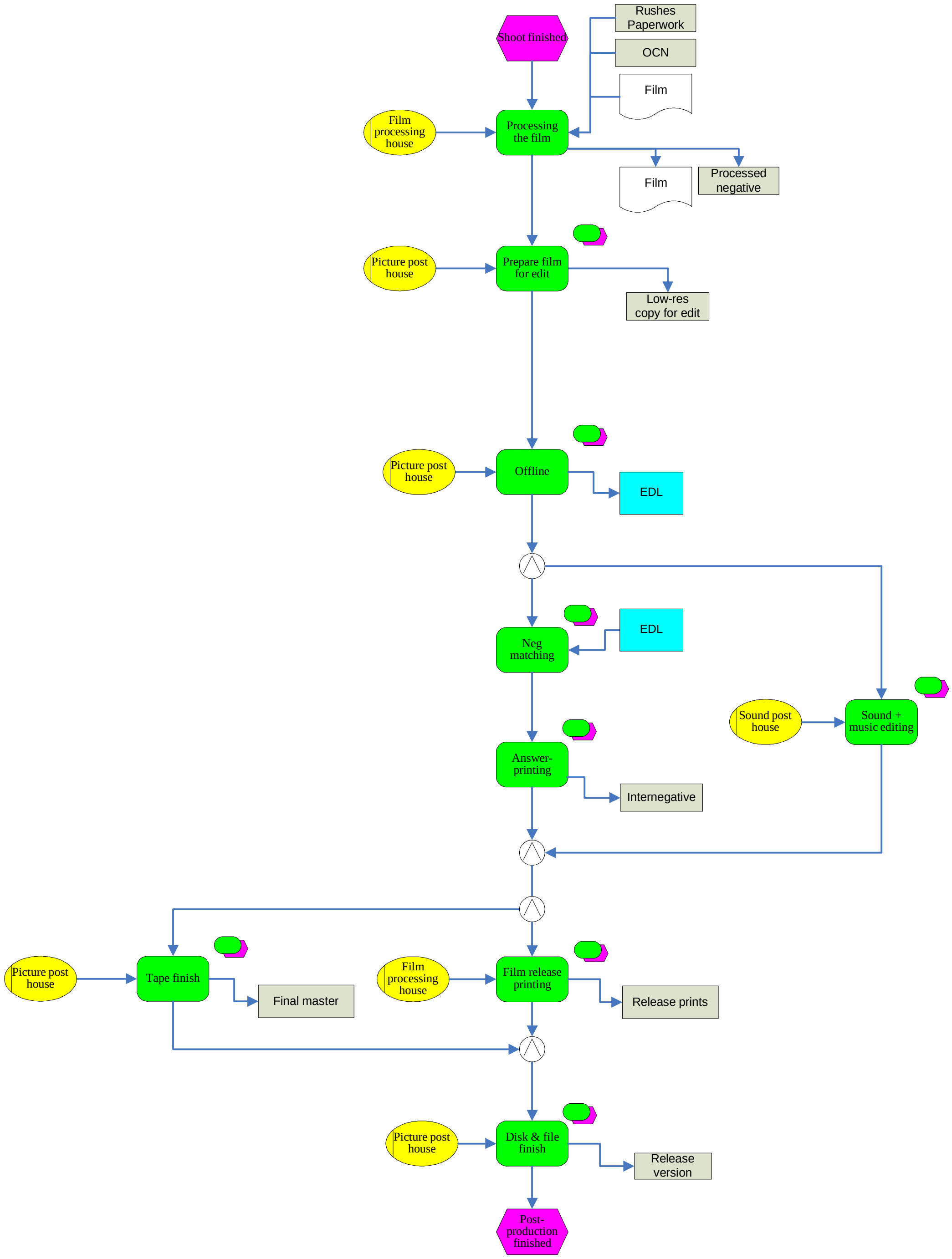
Question 1:
The configured models are valid post-production processes.

Question 2:
The configured models conform to the chosen configuration parameter values.

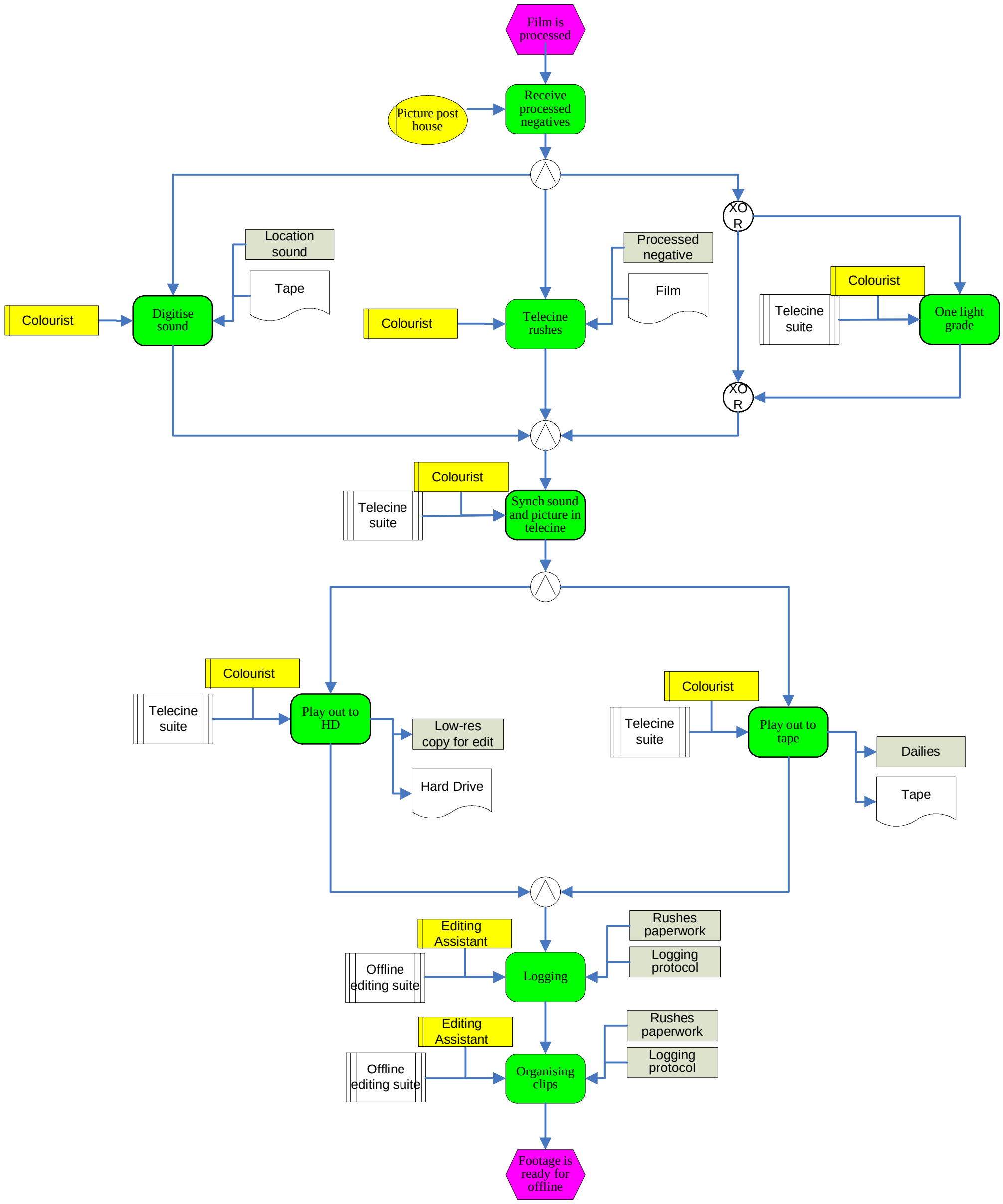
Configuration' Parameter	**Configuration example 1: "high-budget feature film"**	**Configuration example 2: "low-budget documentary"**
1. Shoot	Film	Tape
2. Completion	Film and tape and disc & file	Tape and disc & file
3. Cut	Film	Online
4. Telecine transfer	Record to tape and HD	-
5. Synchronisation sound & picture	In telecine	-
6. First grade	One light grade or no grade	-
7. Audience screening	Yes	No
8. External VFX & credits	Yes	No
10. Final tape grade	-	Online grade
11. Music	Record	Artificial
13. Dialogue recording	ADR and voice over	ADR or voice over
14. Foley	Record	Record or artificial
15. Atmosphere	Record	Record or artificial
16. Film-to-tape grade	Telecine	-

D.I Configuration Example 1

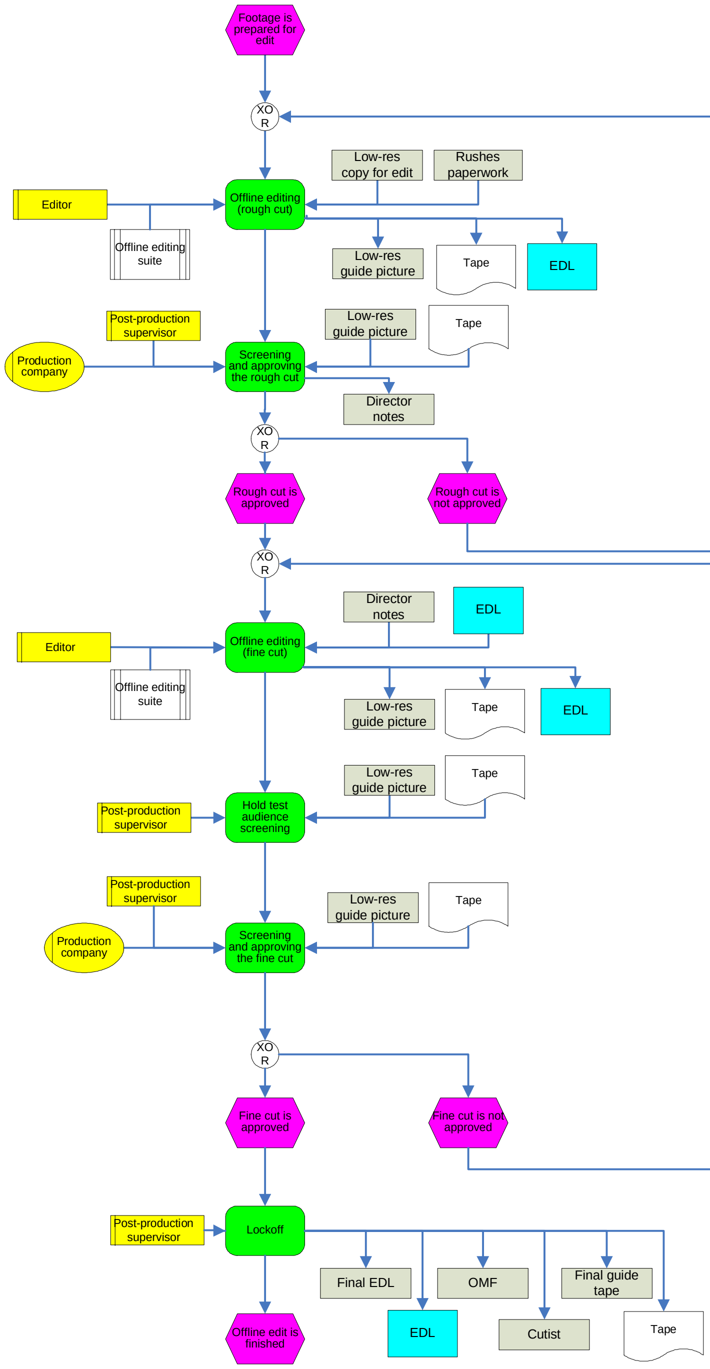
Main Process



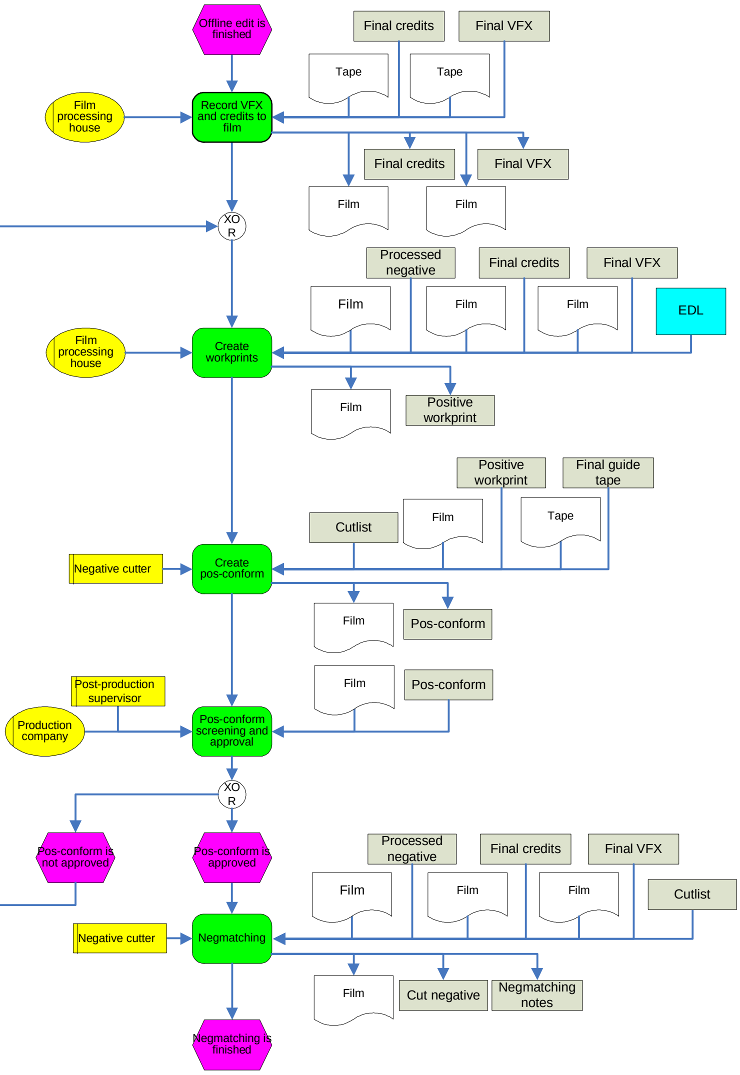
Prepare film for edit



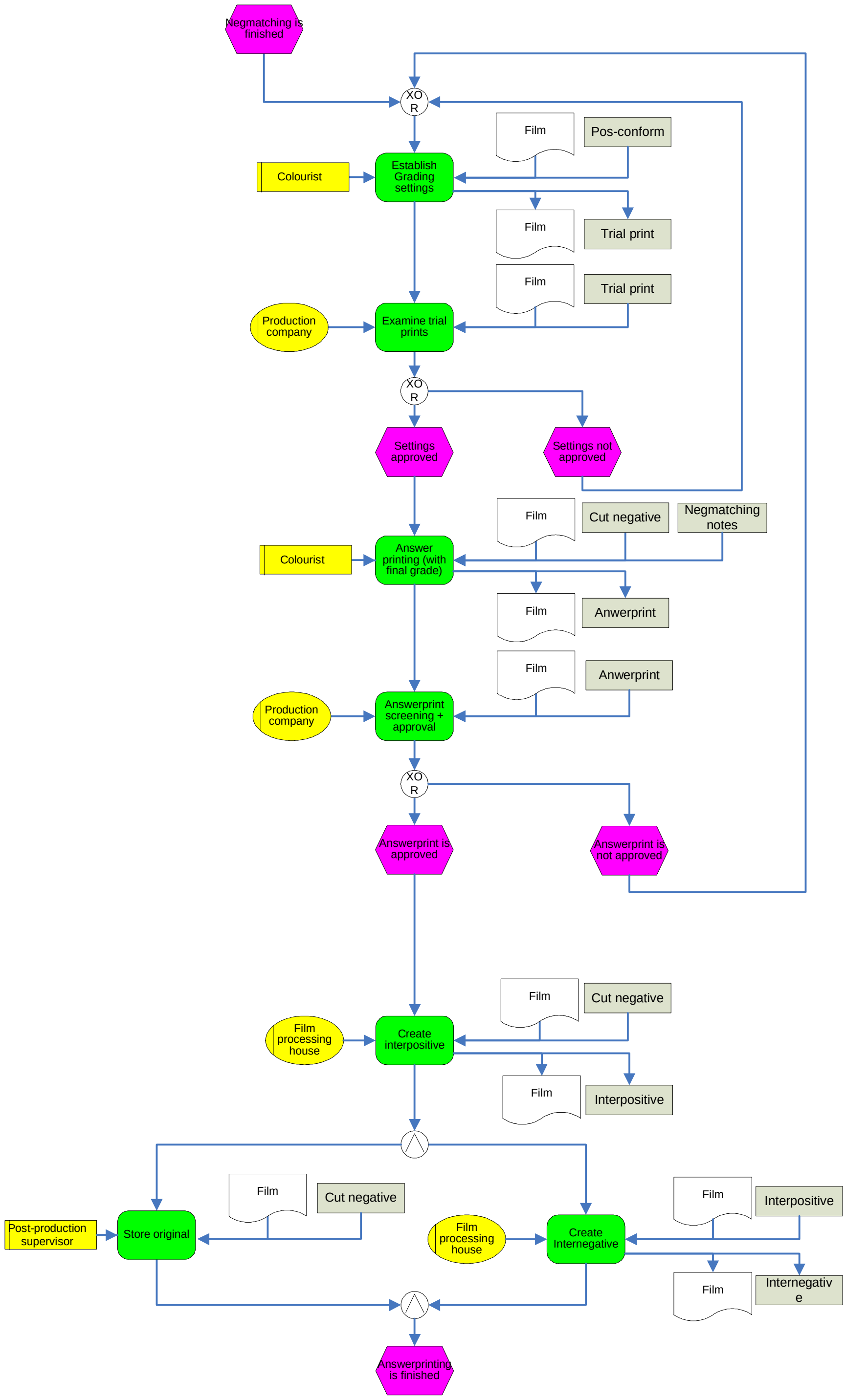
Offline


Footage is prepared for edit
XOR
Low-res copy for edit
Rushes paperwork
Editor
Offline editing (rough cut)
Offline editing suite
Low-res guide picture
Tape
EDL
Post-production supervisor
Low-res guide picture
Tape
Production company
Screening and approving the rough cut
Director notes
XOR
Rough cut is approved
Rough cut is not approved
XOR
Director notes
EDL
Editor
Offline editing (fine cut)
Offline editing suite
Low-res guide picture
Tape
EDL
Low-res guide picture
Tape
Post-production supervisor
Hold test audience screening
Post-production supervisor
Low-res guide picture
Tape
Production company
Screening and approving the fine cut
XOR
Fine cut is approved
Fine cut is not approved
Post-production supervisor
Lockoff
Final EDL
OMF
Final guide tape
Offline edit is finished
EDL
Cutist
Tape

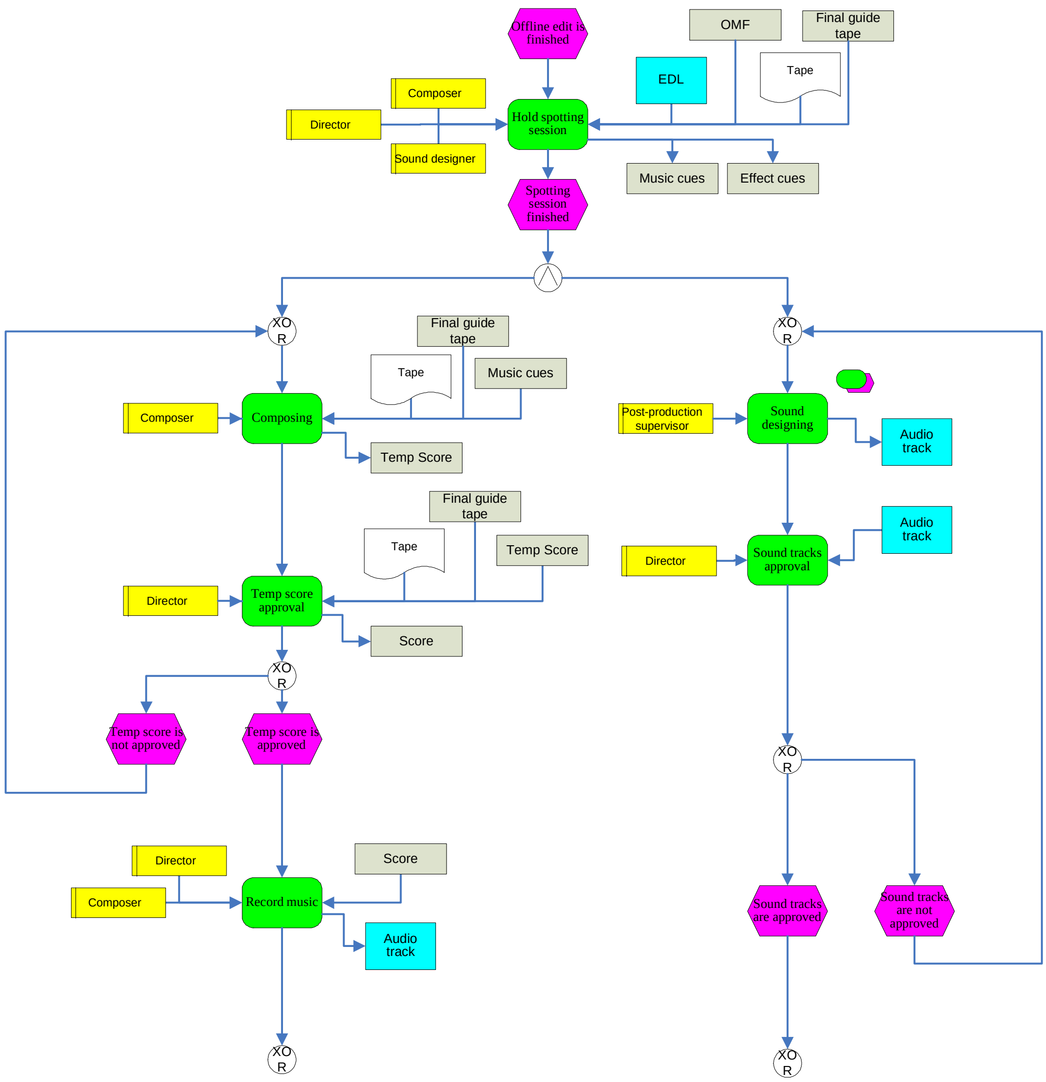
Negmatching



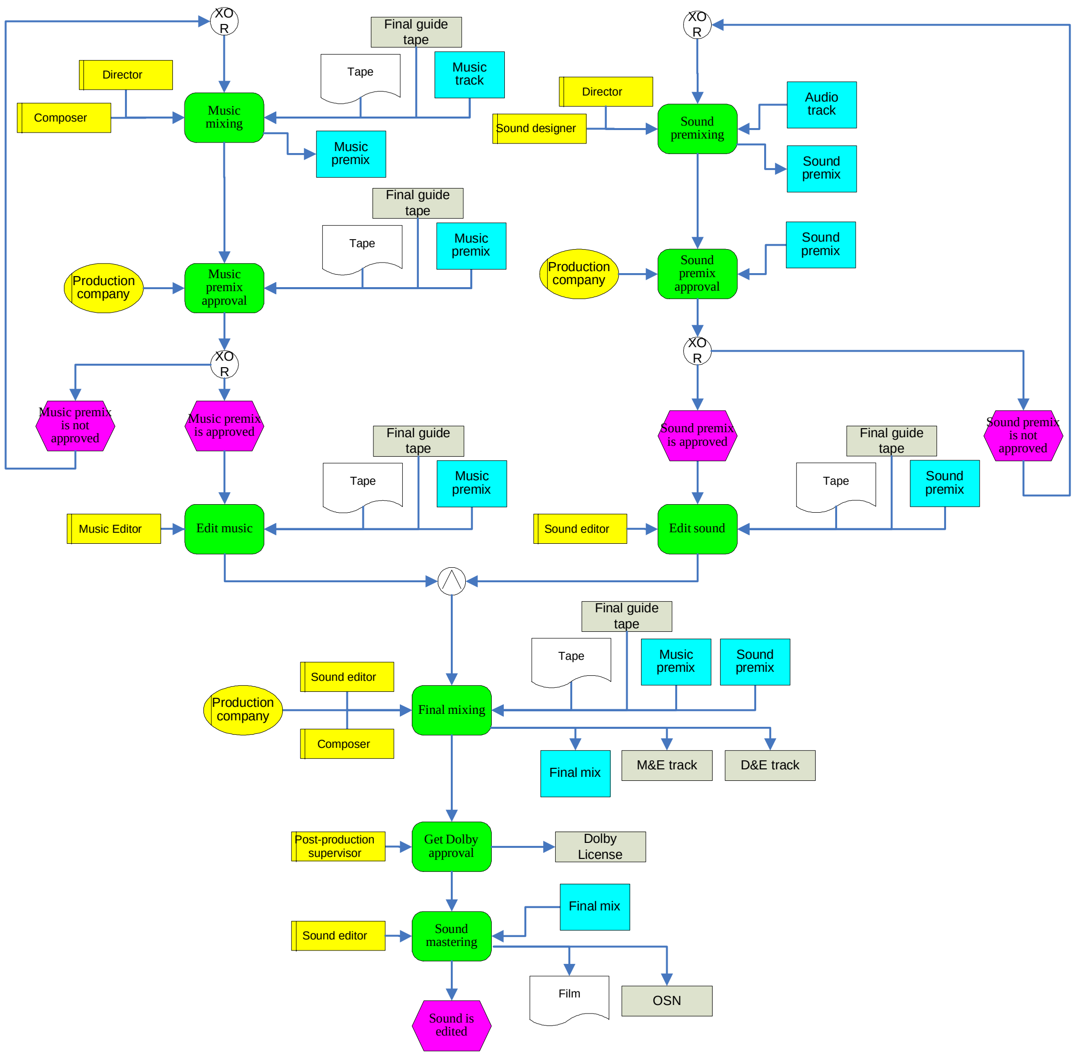
Answerprinting



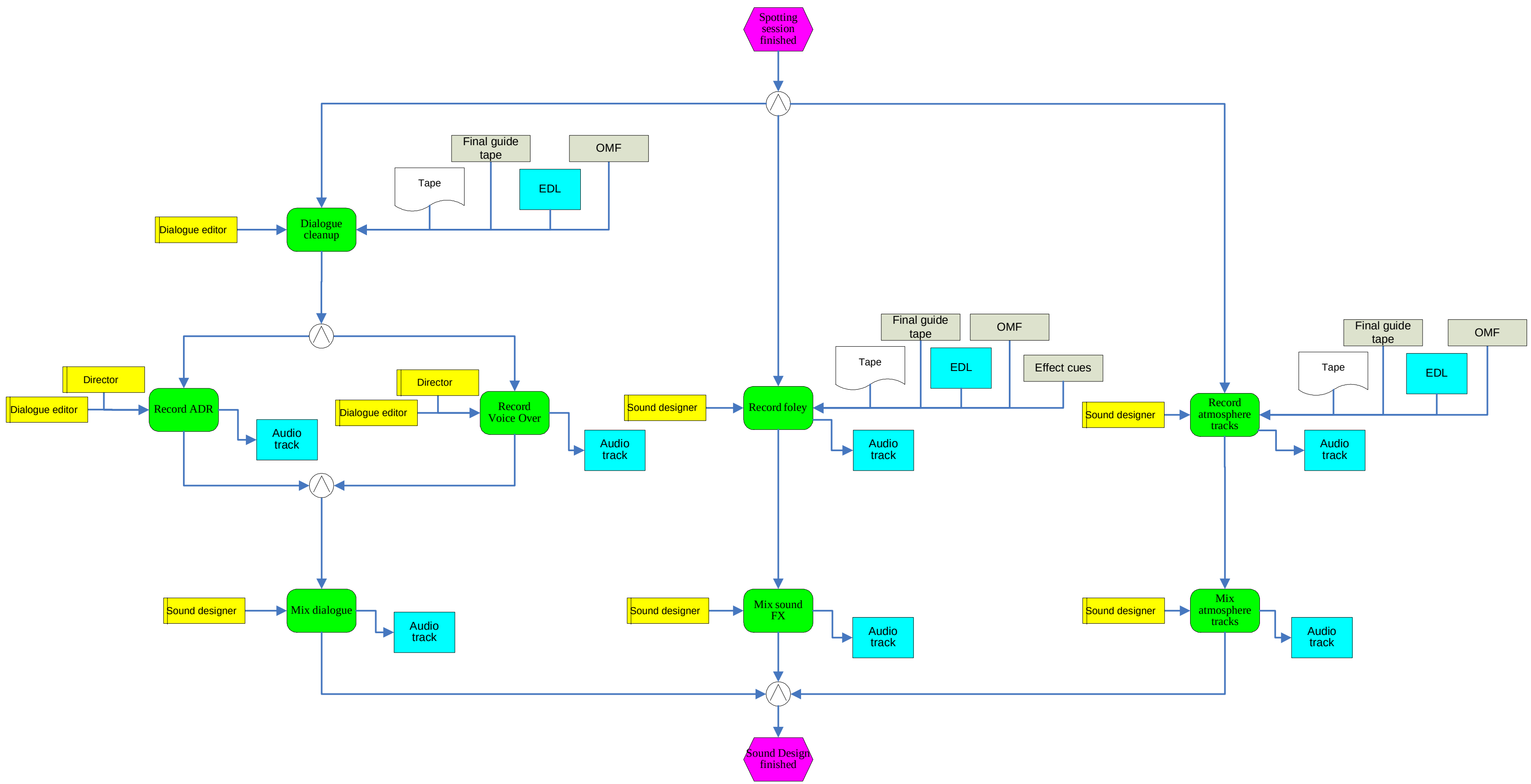
Sound and music editing (part1)



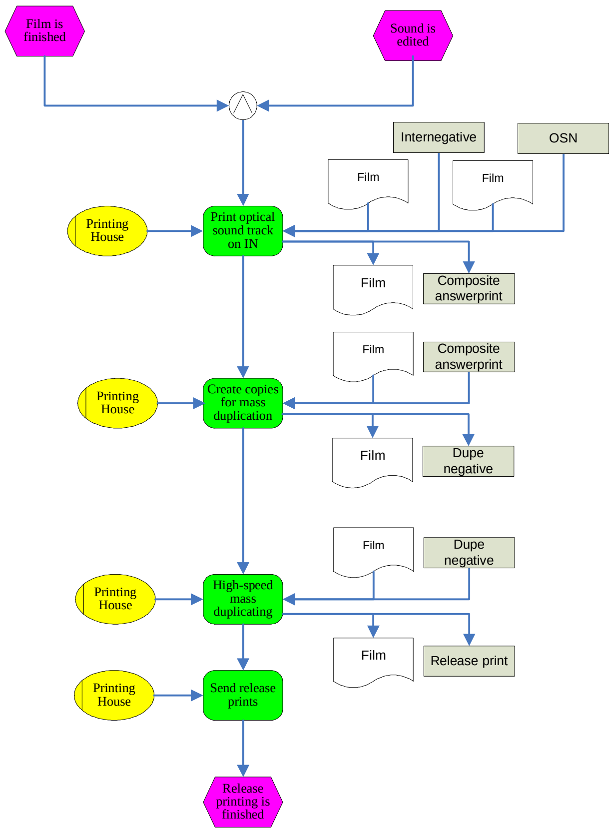
Sound and music editing part 2



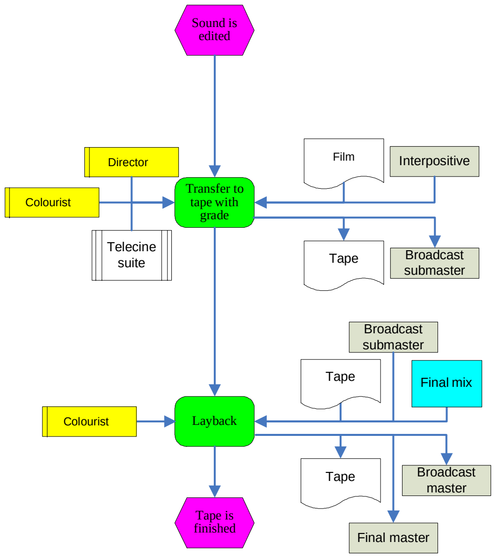
Sound Design



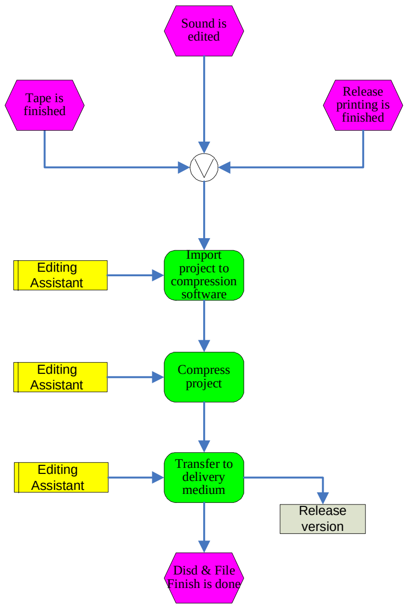
Film finish


Film is finished
Sound is edited
Internegative
OSN
Film
Film
Printing House
Print optical sound track on IN
Film
Composite answerprint
Film
Composite answerprint
Printing House
Create copies for mass duplication
Film
Dupe negative
Film
Dupe negative
Printing House
High-speed mass duplicating
Film
Release print
Printing House
Send release prints
Release printing is finished

Tape finish

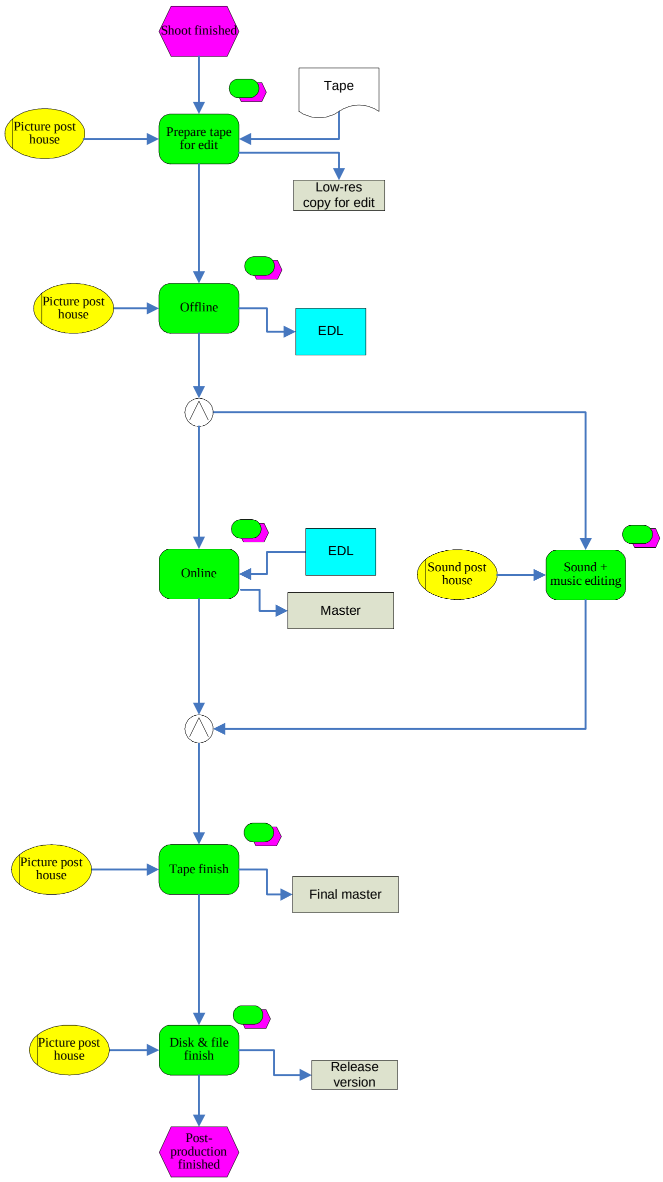


Disc and file finish

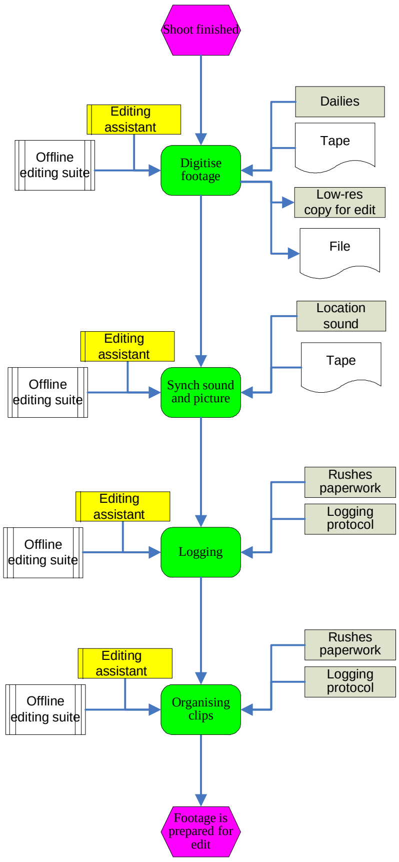


D.II Configuration example 2

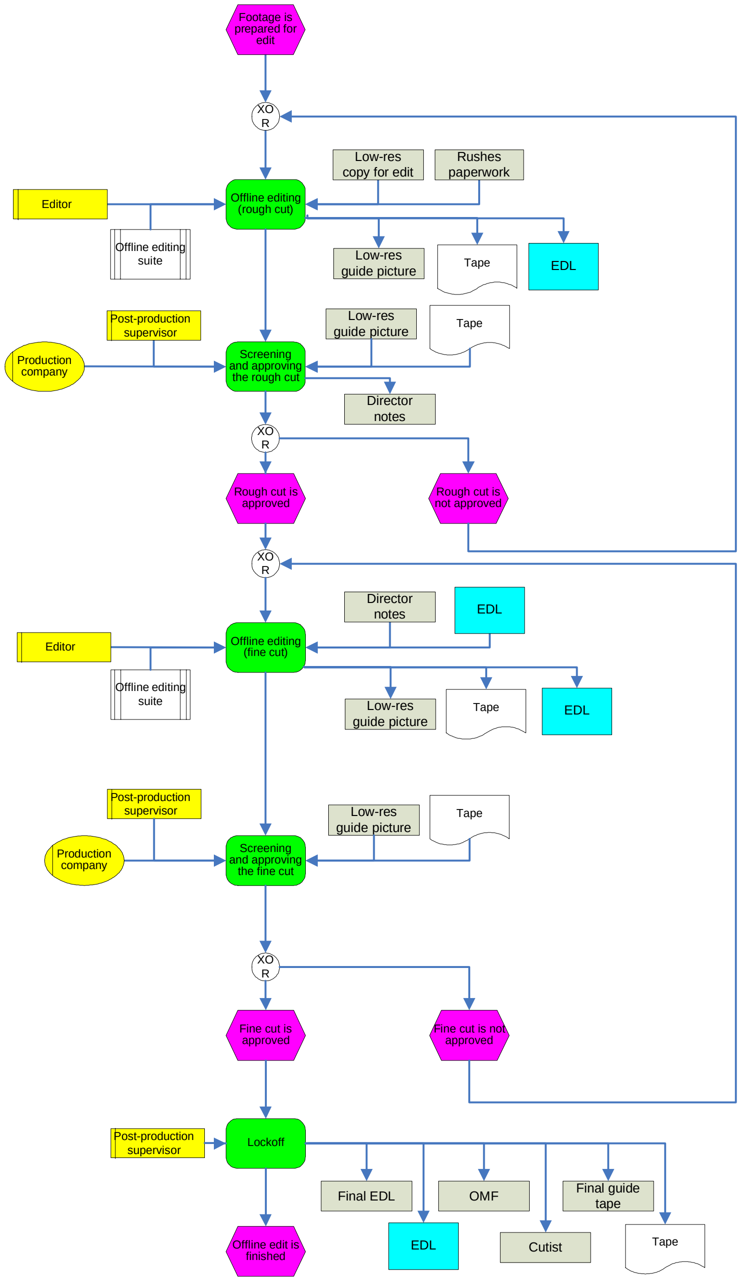
Main process



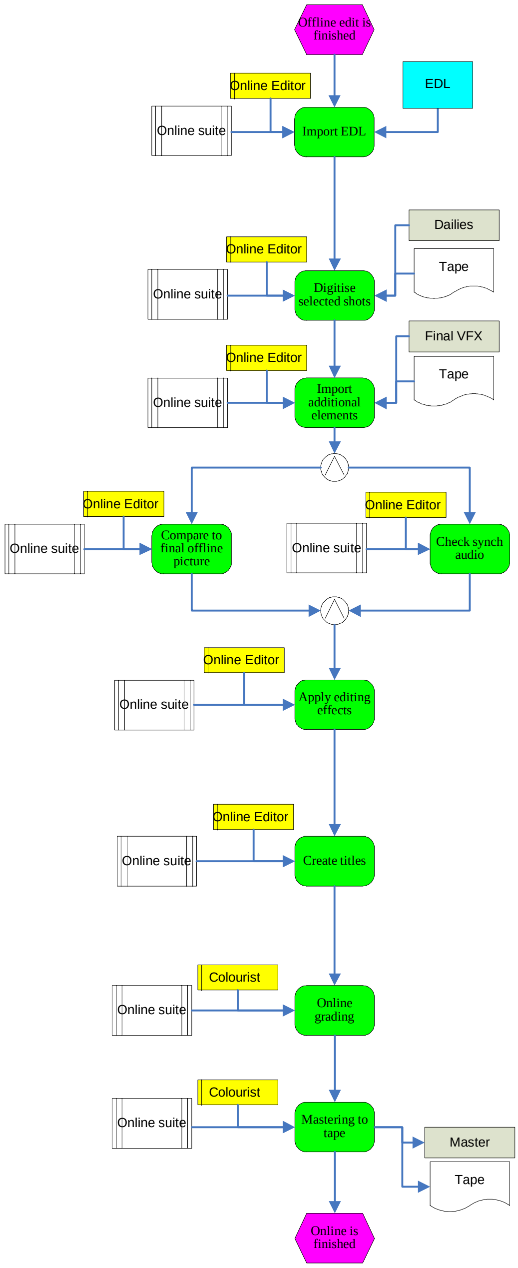
Prepare tape for edit



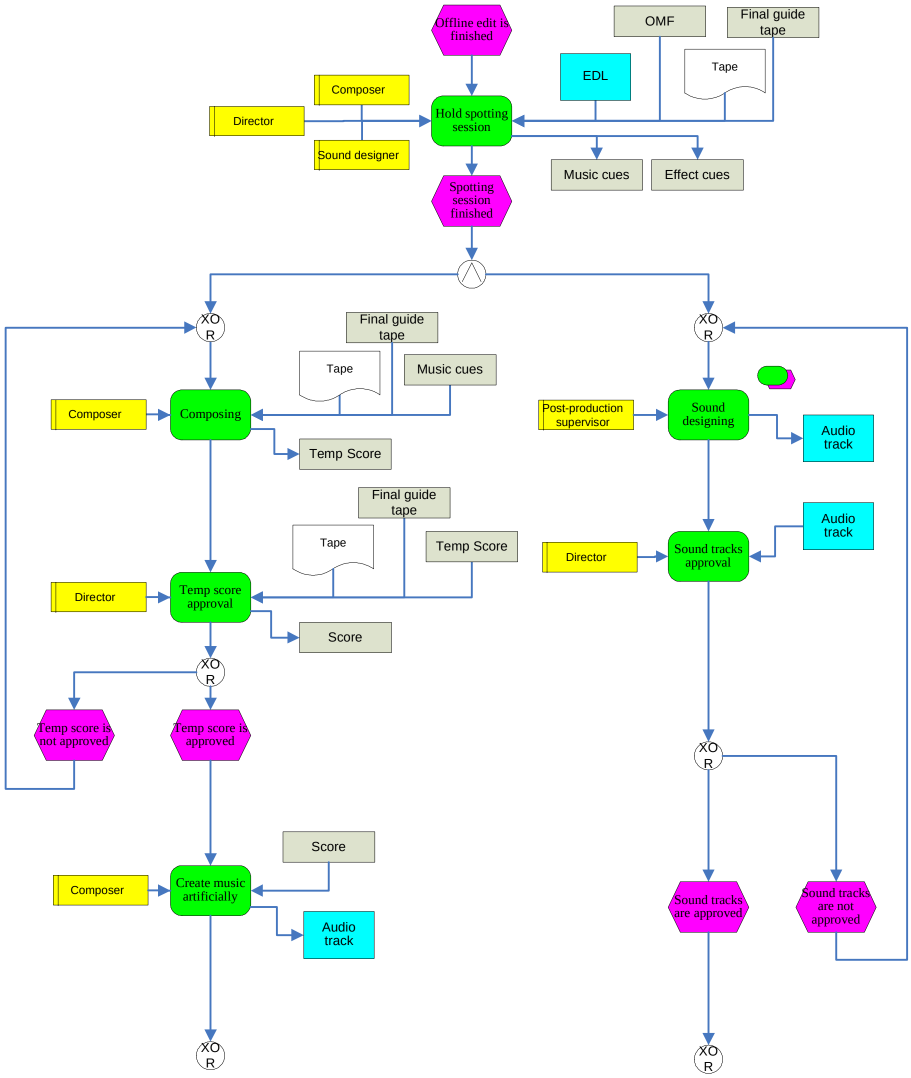
Offline


Footage is prepared for edit
XOR
Low-res copy for edit
Rushes paperwork
Editor
Offline editing (rough cut)
Offline editing suite
Low-res guide picture
Tape
EDL
Post-production supervisor
Low-res guide picture
Tape
Production company
Screening and approving the rough cut
Director notes
XOR
Rough cut is approved
Rough cut is not approved
XOR
Director notes
EDL
Editor
Offline editing (fine cut)
Offline editing suite
Low-res guide picture
Tape
EDL
Post-production supervisor
Low-res guide picture
Tape
Production company
Screening and approving the fine cut
XOR
Fine cut is approved
Fine cut is not approved
Post-production supervisor
Lockoff
Final EDL
OMF
Final guide tape
Offline edit is finished
EDL
Cutist
Tape

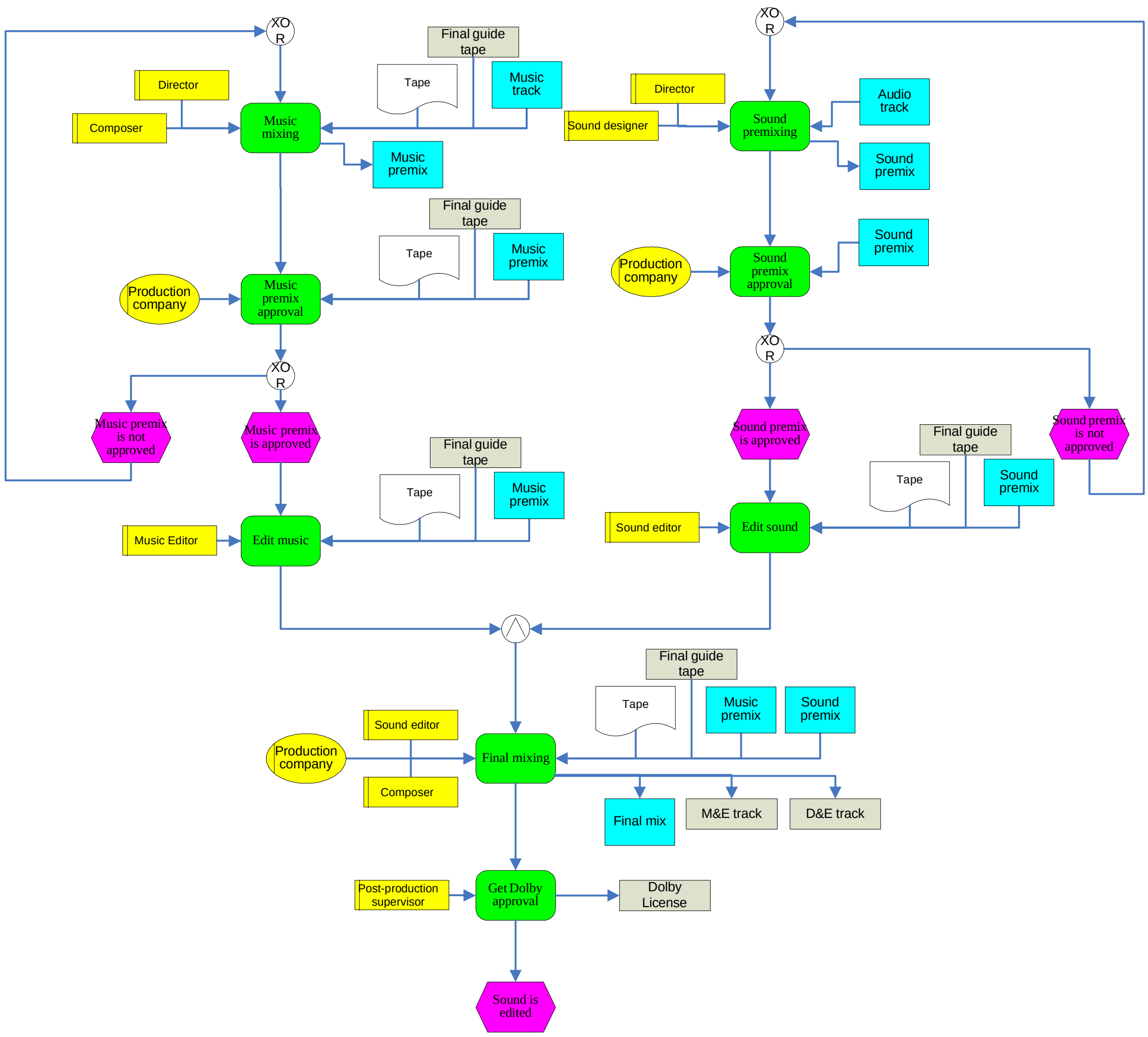
Online


Offline edit is finished
Online Editor
EDL
Online suite
Import EDL
Dailies
Tape
Online Editor
Online suite
Digitise selected shots
Final VFX
Tape
Online Editor
Online suite
Import additional elements
Online Editor
Online Editor
Online suite
Compare to final offline picture
Online suite
Check synch audio
Online Editor
Online suite
Apply editing effects
Online Editor
Online suite
Create titles
Colourist
Online suite
Online grading
Colourist
Online suite
Mastering to tape
Master
Tape
Online is finished

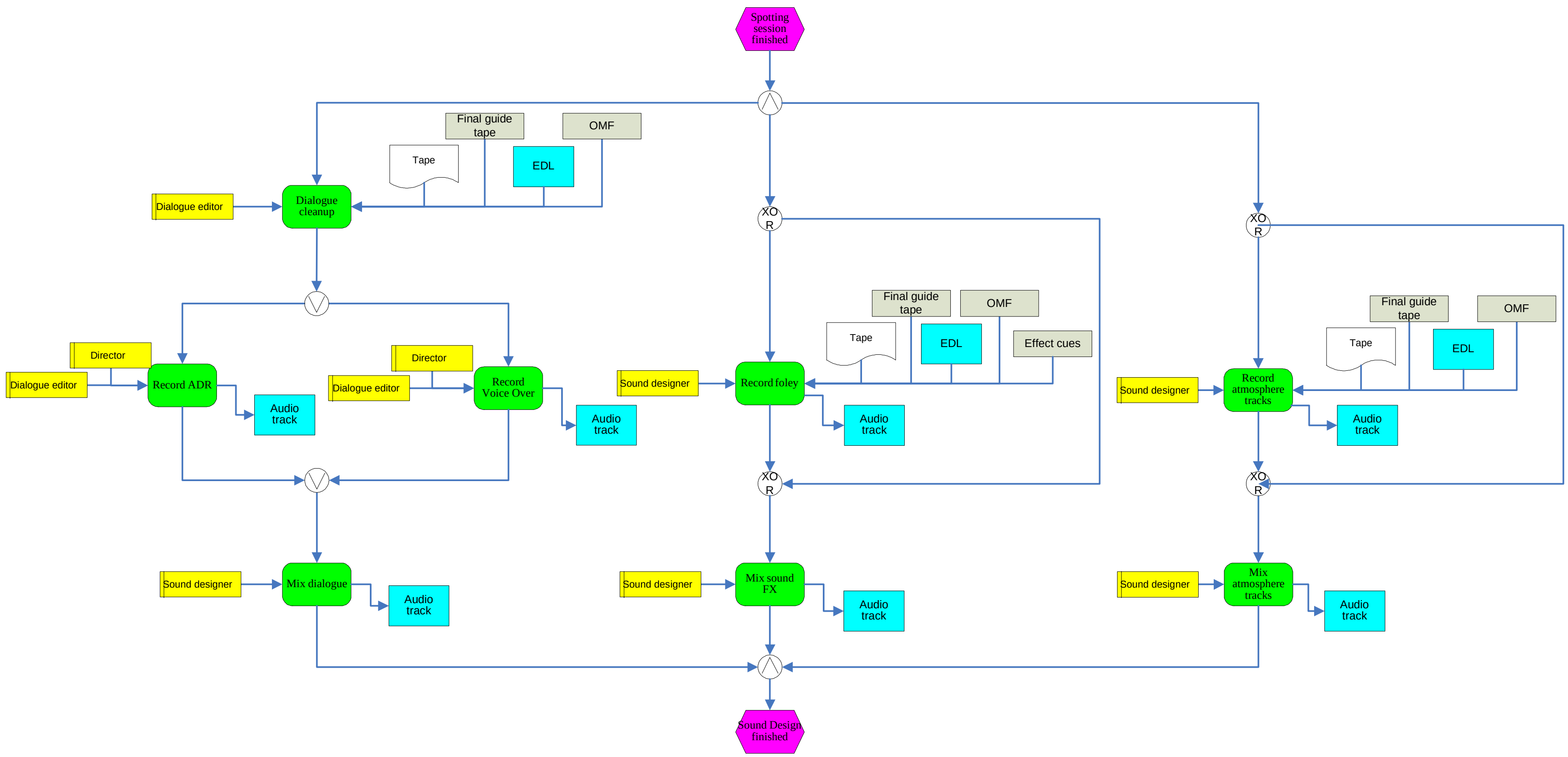
Sound and music editing (part1)



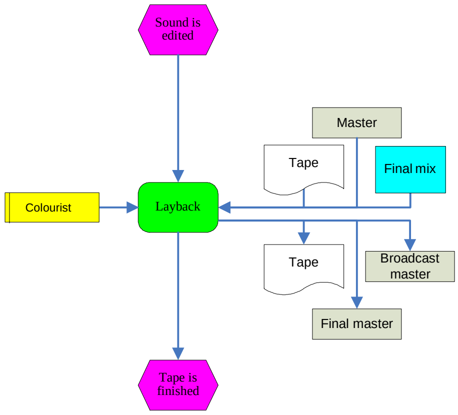
Sound and music editing (part2)



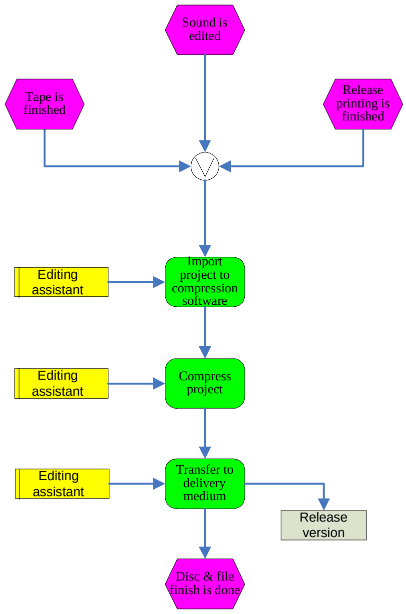
Sound design



Tape finish



Disc and file finish



E Specification of mandatory decisions

Configuration parameter	Possible values	Configuration objectives	Affected models	Mandatory?
1. Shoot	Film, tape, film and tape, film or tape, film xor tape	Content, budget	Main process	yes
3. Cut	Online, film, online and film, online or film, online xor film	Content, budget	Main process, disc & file finish, tape finish, film finish	yes
2. Finish	Film, tape, disk & file, film and tape, film and disk & file, tape and disk & file, film and tape and disc & file, film or tape, film or disc & file, tape or disc & file, film or tape or disc & file, film xor tape, film xor disc & file, tape xor disc & file, film xor tape xor disc & file	Content, budget	Main process, sound and music editing, disc & file finish	yes
4. Telecine transfer	Record to tape, record to HD, re-cord to tape and HD	Content, budget	Preparing film for edit	no
5. Synchronisation sound & picture	In telecine, in edit-ing suite	Content, budget	Preparing film for edit	yes
6. First grade	One light grade, best light grade, no grade, one light grade xor best light grade, one light grade xor no grade, best light grade xor no grade	Content, budget	Preparing film for edit	no
7. Audience screening	Yes, no	Budget	Offline	no
8. External VFX & credits	Yes, no	Content, budget	Negmatching, online	yes
9. Final tape grade	Telecine grade, online grade, tape-	Budget	Online, tape finish	no

	to-tape grade			
10. Music	Record, artificial	Budget	Sound & music editing	no
11. Dialogue re-cording	No dialogue re-cording, ADR, voice over, ADR and voice over, ADR or voice over, ADR xor voice over, no dialogue recording or ADR, no dialogue re-cording or voice over, no dialogue recording or ADR and voice over, no dialogue or ADR or voice over, no dialogue recording and ADR xor voice over	Content, budget	Sound design	yes
12. Foley	Record, artificial	Budget	Sound design	yes
13. Atmosphere	Record, artificial	Budget	Sound design	yes
14. Film-to-tape grade	Telecine, tape-to-tape	Budget	Tape finish	no

F Glossary

F.I Picture

Term	Explanation
Aaton Cameras	Record picture and sound with the same synchronised timecode (burned on film)
Anamorphic shooting	Shoot 16:9 (or other widescreen!) pictures with 4:3 cameras (16:9 equipment is expensive); anamorphic lens squeezes the picture; quality is not as good as real 16:9
Answer print	Printed film that is the result after neg matching and the final grade.
Aspect Ratios	- 2.35:1 ”Cinescope”/”Anamorphic Scope”: widest aspect ration in use today (rarely used). Needs anamorphic lens. - 1.85:1 ”Standard Academy Flat”: used for wide-screen feature films. Needs anamorphic lens (?) - 16:9 most digital video systems today use 16:9. HDTV and NTSC are in 16:9. Movies in a 4:3 format can be shown in a “pillar box” with black bars on the sides. - 14:9 ABC widescreen broadcast - 4:3 Movies in a 16:9 format can be shown in a “letterbox” with black bars on top and bottom
Continuity	Making sure that things in continuous scenes are consistent (e.g. briefcase in scene A → if scene b follows continuously: character also has the briefcase). Important with dramas.
Cutlist	Contains the exact cutting points for the negative matcher (“neg matcher”); can be created from an EDL
Digitizing (also: Capturing)	Transferring videotape rushes from a videotape recorder (VTR) to a hard drive
EDL	Contains video cutting points. It gives reel numbers and time codes for every shot needed as well as any transition information. Attention: Cutlist contains cut information for the negative. EDL contains just video/tape information (Can be created by editing suites like Avid).
Final Grading	Last grade, bringing colour to visual screening quality, done by laboratory/film processing house
Frame rate	Running speed of film or video in frames per second - 24 fps → film - 25 fps → video - 30 fps (29.97) → NTSC

Term	Explanation
Grade/Grading	- Grading = Timing (US) - Grading = Adjustments of colour balance and density (similar to contrast) - Happens at least after edit - Is done by Colourist (or timer) during telecine or during Final grade. - Tape-to-tape grade: needs EDL. Sometimes jumps back to online editing.
Interpositive/ Internegative	Positive (negative) film during the process in order to produce a negative (positive)
Kine	Transfer of tape to film with lower cost (and lower quality)
Lab Roll	The film rolls in the shoot; Numbered.
Lockoff (= “Fix up” (US))	The edit is locked off when the edit got its offline approval (the offline edit is ok)
Log/Logging	Database showing time codes, key codes, slate details, and descriptions of each shot in a roll; used to manage digitising, editing, and negative matching operations. Negative cutting logs and editing logs do not necessarily carry the same information though. Logging is done as defined in the “tape numbering protocol”.
Negative Matching	Only happens in productions on film. The neg matcher cuts the film (negative!) based on the information of the cutlist and the EDL. He needs the telecine rolls, the negatives of the VFX house (if external), the EDL, and the cutlist
Non-Linear	In a non-linear system you can jump forward and backwards like on a file (not like on film or tape)
Offline/Online Editing	Online Editing is on tape or hard drive, only in an abstract way on film → neg matching. It is the electronic equivalent of negative cutting. Online Editing means working on the high quality file, offline means working on a lower quality copy (easy processing → faster, cheaper)
Pre-Grading	Grading during the first telecine process
Processing the film	A chemical process to make the image on the exposed film both visible and permanent. Often done externally (e.g. Atlab) and then delivered as a negative.
Protected e.g. for 14:9	”Everything important” happens in a 14:9 window (also subtitles).
Record to film	Transfer of tape to film with high quality; laser printed
Rushes paperwork (also “pencil case”):	- Camera report - Comments on the material (good/no good ~ A-/B-negatives) - Marked-up script - Etc.
Rushes/Dailies	First copy mute prints from original negative
Synch point (”clapper-board”)	For synchronisation of sound and picture
Synchronizing the Rushes	Synchronising the sound recorded on location at the shoot (DAT) with the copy of the film by laying the sound elements to

Term	Explanation
	the pictures
Telecine	In general: Transferring film (positive or negative!) to tape (also to film possible?); very expensive; scanning the negative with a laser, thus converting light into electrical data. At the same time possible: Colour grading (= pre-grading; see “grading”) - One light grade: quick grade on the run without any manual work - Best light grade: stops and adjustments from time to time by the colourist
Time codes	Important for synchronizing - Key code: film frame numbers (on the negative) - Video time code: Code added on telecine on the video files to match it with film - Audio time code: The code of the audio track to each frame; two different timeframes can be used: o Drop timeframe: much more accurate, allows adjustments (to perfectly match the time codes) o Non-drop timeframe: cannot be adjusted (used for shorter productions like commercials) (Laramie (2004) S. 26) → While editing: drop timeframe - after lock: non-drop timeframe
VFX/Visual Effects	VFX supervisor participates in both production and post production - 3D animation Develop models, rig (put a skeleton in it) and then animate it. Adding to the shot with the compositing tools (Inferno). - 2D animation Hand drawn animations for every frame. Pass manipulated elements to the compositor to integrate it. - Matte painting Replace a background or complete a set extension to a live background. Pass manipulated elements to the compositor to integrate it. - Rotoscoping Cutting out segments of shots and replacing them by other elements. - Compositing o Putting together all created elements (animation, matte painting etc.) in the correct order and place. Then rendering it. o First offline then altogether online! o This is done by the compositors o Compositing suites: Inferno + Flame, Shake, Smoke, Combustion, After Effects) - Rendering Fusion of animation and texture (done after compositing)

Term	Explanation
Workprint	Mute print for editing

F.II Formats

Film Formats

- Only film can be negative. Projection of film is always on a frame rate of 24 fps

Term	Explanation
35mm	Most frequently used film for US feature films Film contains lots of information→ can be transferred to HD
16mm	Most frequently used film globally overall
65cm	IMAX format, can only be shot and projected with certain IMAX equipment
70mm	Not used anymore (last time 1996)

Tape Formats

- Video is always on Tape. Tape is always positive.
- HD (High Definition) formats have higher resolution than SD (Standard Definition) formats

Term	Explanation
"24pHD" (24 frames Progressive High Definition Video) or "24pHDTV" or "24p format"	- Digital Format for 24pHD cameras which shoot on video → complete digital workflow - Only for professional projects, expensive. - Progressive. (24p!) (lead to a sharper image than the interlaced scanning) - 24 frames, because cinema is on 24fps. Brain doesn't recognize the 24fps on the (25fps-) video Records digital picture in HD resolution on a ½-inch HD cassette.
Beta SX	Successor of DigiBeta; higher compression rate, backwards compatible
Digital Betacam – DigiBeta	- Broadcast quality, digital video format, digital successor of Beta SP - Four audio channels.
DV Cam (digital video)	- Digital, allows digital component picture and digital track to digitise into the edit system - For independent producers, DV cams are cheap equipment, record to film possible (Blair witch project) although lack of quality - Today's techniques also allow to give it a film look afterwards
DVC Pro	Digital, allows digital component picture and digital track to digitize into the edit system

Term	Explanation
HD Cam = High Definition Tape	Broadcast quality
SP Betacam or Beta SP	- Analogue format - Tape damage and dropouts possible - All Beta formats are released by Sony and use ½ inch tapes.

Broadcasting Formats

Term	Explanation
HDTV	- 1080 scan lines per frame - Screen ratio of 16:9 - More scan lines than analogue (1125) - Broadcast standard in Australia by 2010 - Different formats are possible for HDTV (see AFTRS brochure)
NTSC	American television standard; 525 scan lines per frame
PAL	British television standard, 625 scan lines per frame
SDTV	- ”Standard Definition Television” - Digital broadcast format - 576 scan lines - 16:9 ratio with improved picture quality and MPEG digital sound
SECAM	Other European television standard, 625 scan lines per frame (Eastern Europe)

F.III Animation Movie

Term	Explanation
Global Asset production	The production of assets that are used several times and in different scenes e.g. main characters
Leica	Matching Storyboard and Voice
Sequence Asset production	The production of assets that are just used in this sequence
Splitting scenes	Splitting up scenes of animation movies to organise production. Possible rules: - Split up by change of place - Change of day - Scenes longer than a minute
Storyboard	Drawings of key pictures of a scene illustrating the plot

F.IV Sound

Three main parts:

- Dialogue
- Sound (effects)

- Music

Term	Explanation
ADR	”Automatic Dialogue Replacement”, in sync to picture (also called “looping”)
Control track	60-Hz signal recorded with the soundtrack to verify original speed of sound recording. → used for synchronization.
D&E Track	Dialogue and Effects. For promos and trailers where the music track needs to be adapted to the mix of short sequences.
Double-System Sound	Procedure to record film and sound on two separate systems on the shoot → e.g. several cameras, one common soundtrack. Also better sound quality because of professional sound equipment can be used instead of camera-integrated sound. → needs synchronization
Final Mix	The final mix contains three separate channels for dialogue, sound effects, and music containing all the associated tracks of each part.
Foley	Reproduce and record sounds in a studio that could not be adequately controlled while on location.
Layback	Recording the final sound onto the audio tracks of the videotape master (thus only with tape finish)
Laying sound	Placing sound in the desired relationship to picture
M&E Track	Music and Effects Track. Audio (music and/or sound effects) but no dialogue. Allows for foreign language dialogue to be added.
OMF	(Open Media File Interchange) An audio-only file created in the offline edit for the sound department
Optical sound track	Printing the optical sound track negative (OSTN) on the negative print (usually the internegative) to join them. Result is an “optical track” (type of sound) on the print. Done with a CCP (Continuous Contact Printer)
Premix/Prelay	Consolidation of several tracks into a more manageable number of channels for easier handling in the following sound stages
Recording sound to camera	Only possible when shooting video. Most video formats offer either two or four uncompressed independent channels of digital audio
Sound formats	- DA88 Popular production recording choice with 8 audio tracks. Needs to be formatted before use. - DAT “Digital Audio Tape“. Should be superior to analogue formats (both ¼ + ½ inch) - ¼ inch Nagra Analogue tape, can record split tracks - ½ inch 4-track Straightforward method for recording production sound. Three analogue audio tracks + a time code track. Popular backup format for DA88
Synch point (”clapper-board”)	For synchronisation of sound and picture

Term	Explanation
Tracklay	Preparing or laying tracks in preparation for a mix.
Voice Over	Non-synchronous, explanatory speech like narration or commentary.

F.V Software and Computer Equipment

Term	Explanation
Avid	Common offline editing suite
Da Vinci 2k	colour grading tool for tape
Inferno	Powerful online editing suite

Plagiarism declaration

I hereby declare that, to the best of my knowledge and belief, this master thesis titled *Creating a Reference Model for the Creative Industries – Evaluation of Configurable Event Driven Process Chains in Practice* is my own work. I confirm that each significant contribution to, and quotation in this thesis from the work, or works of other people is indicated through the proper use of citations and references.

Münster, on the 23rd of October 2006.