Interdisciplinarity in the Age of the Triple Helix: a Film Practitioner's Perspective

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Abstract

This integrative chapter contextualises my research including articles I have published as well as one of the creative artefacts developed from it, the feature film *The Knife That Killed Me*. I review my work considering the ways in which technology, industry methods and academic practice have evolved as well as how attitudes to interdisciplinarity have changed, linking these to Etzkowitz and Leydesdorff's 'Triple Helix' model (1995). I explore my own experiences and observations of opportunities and challenges that have been posed by the intersection of different stakeholder needs and expectations, both from industry and academic perspectives, and argue that my work provides novel examples of the applicability of the 'Triple Helix' to the creative industries. The chapter concludes with a reflection on the evolution and direction of my work, the relevance of the 'Triple Helix' to creative practice, and ways in which this relationship could be investigated further.

Author’s Declaration

I declare that this integrative chapter is a presentation of original work and I am the sole author. This work has not previously been presented for a degree or other qualification at this University or elsewhere. All sources are acknowledged as references.

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List of Publications for Consideration

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1. Introduction

> *Each profession has its own toolkit. In the short run and for decisions unlikely to have broad impact, it may be more cost effective to use just one expert. But in the longer run and for wide-reaching issues, more creative solutions tend to come from imaginative interdisciplinary collaboration.* (Shiller in Nemko 2016)

The original context for this quote from Nobel Prize-winning economist Robert Shiller was within an exploration of irrational decision making. Yet, I feel it provides a rational insight that succinctly reflects my own experience as an industry practitioner working as a research-active academic over the past twenty years.

My research has evolved into two primary strands:

The first looks at the application and impact of new technologies on different aspects of commercial film and television production including the development of new tools, new production and postproduction workflows, new types of media product, and new methods of marketing and distribution.

The second involves the examination of the relationship between academia and the film and television industries in different commercial contexts such as models of formal academic-industry collaborations including their benefits and risks, and cultural issues surrounding the mixing of practice and academia including perceptions of media practitioners working in higher education.

The development of my body of work has been organic, derived from interests or needs I identified as being potentially novel areas for formal exploration. At first glance the outputs submitted with this chapter may seem rather disparate. However, reflecting on these as a whole, I have been struck by how the development of my work has both mirrored and been affected by the increasingly close interconnection between academia, industry and government in a manner consistent with the ‘Triple Helix’ model of innovation described by Etzkowitz and Leydesdorff (1995). This model originated from observation and analysis of the development of sea-change commercial products and services based on STEM[1]-related research enabled through government support. It has been used to contextualise the attributes of successful high-tech ventures as well as explain the development of Silicon Valley business practices as a new paradigm (Etzkowitz and Zhou 2018, p 9). However, to date there has been little discussion of the model's applicability to non-STEM domains, particularly the creative industries.

In this integrative chapter, I review my work considering the ways in which technology, industry methods and academic practice have evolved over the period of my research as well as how attitudes to interdisciplinarity have changed. I explore the opportunities and challenges – technically and interpersonally – that have been posed by the intersection of different stakeholder needs and expectations, from both industry and academy perspectives. I argue that the 'Triple Helix' model is not only theoretically relevant to the creative sector but that several elements of my work provide novel examples and evidence of its applicability to the film and television industry.

1.1 Relevant Personal Background

I joined the University of York in 2001 as a Lecturer in the Department of Electronics, which was my first academic appointment. I am not an engineer nor an electronics expert but was hired as the second member of a team to develop a new teaching and research initiative in Media Engineering based on my experience in the film and television industry (see the letter from Prof John Robinson in Appendix 1 for further details about my appointment).

My professional industry expertise lies in the development and supervision of projects involving computer-generated imagery as well as format and script development for both feature films and linear and interactive television programmes. I started my career working with Emmy award-winning Robert Greenwald Productions, part of MGM Studios, doing lighting for made-for-television movies for the ABC and NBC networks in the US. After completing my postgraduate degree at

[1] STEM in this context refers to the acronym of academic disciplines involving science, technology, engineering, and mathematics

the American Film Institute in 1989, I worked as a producer and director with numerous companies initially in short-form documentary, corporate and music video genres. I expanded into what was then called ‘new media’ including high-end interactive video and television, which is where my exposure to and involvement in academic research began. Notably among those projects, I worked with River City Productions where I produced and directed episodes for the award-winning Texas Learning Technology Group’s drama-based interactive video science series published by Glencoe/McGraw-Hill, which was officially adopted as a high school textbook alternative in several US states. I was also part of the First Cities consortium where I led development of over fifty high-definition interactive television programmes for a multimillion-dollar national US broadband network working with Ogilvy & Mather, IBM, Apple, LucasArts and others[2]. It was from these projects that I gained an appreciable grounding in user-centred design, human-computer interaction, and interactive storytelling.

Immediately prior to joining York, I worked for five years with a major Hollywood broadcast television company, Jonathan Goodson Productions, part of Paramount Domestic Television, developing a cutting-edge gameshow series I created that utilised virtual and augmented reality to put “ordinary people in extraordinary situations based on hit movies” (the logline for the project). The goal was to create a viscerally compelling experience for contestants whereby they would undertake stunts similar to those in action movies but do this safely using VR and AR technology. Viewers at home would see photorealistic rendered scenes that looked like clips from feature films but were actually game sequences created through motion capture and advanced visual effects (VFX).

A key aspect of my role during development was to translate and apply then state-of-the-art theory into viable production methods for commercial television production. I drew heavily on academic research that considered participant control (e.g., Witmer & Singer 1998), the importance of intuitive interaction (e.g., Slater & Usoh 1994), realistic feedback (e.g., Carlin, Hoffman et al. 1997) and audio cueing (e.g., Whitelock & Jelfs 1999) and then married this with industry-standard practice in VFX

[2] The Variety article by Rothman (1992) provides a good overview

production to create a viable workflow. This was my first exposure to truly multi-disciplinary research and development and was the basis for my job talk at York.

1.2 Chapter Structure

This integrative chapter is organised in four main sections that first provide a background context then consider different phases in the nature and development of my work, linking this to the 'Triple Helix' model. Publications are discussed roughly in chronological order based on when work was undertaken rather than publication date. In some instances, these have been grouped by common areas of research or themes to make overall development and context clearer.

The specific content of each main section is as follows:

1. The first describes the 'Triple Helix' model and discusses how it serves as a framework that can be used to contextualise my research.
2. The second considers my introduction to the academy and development of my approach to multi-disciplinary research, including a brief discussion of experiences in the application of my industrial expertise to help inform and develop novel tools in support of film and television postproduction that utilise computer vision. It illustrates how my early research efforts align with the 'Triple Helix' model albeit in a more traditional STEM-based context.
3. The third looks at different relationships between industry and the academy including changes in procedural paradigms with the advent of new technologies, the development of academic-industry collaboration models in the film and television sector, and the experiences of practitioners working in the academy. The relationship between these and the 'Triple Helix' is discussed in detail.
4. The final section presents a case study of a novel collaboration to create the commercial feature film, *The Knife That Killed Me*. It describes how new technologies were applied in innovative ways to push the creative boundaries of film production, which I argue was only possible through the unique academic-industry partnership developed, which involved government support through a knowledge transfer partnership. It provides a clear example of the 'Triple Helix' model's applicability to filmmaking practice.

The chapter then concludes with a discussion of key considerations in applying the ‘Triple Helix’ model to creative practice and the creative industries, and identifies areas for future research.

2. The 'Triple Helix' Model Defined

The 'Triple Helix' was first proposed by Henry Etzkowitz and Loet Leydesdorff as a theoretical framework through which the increasingly important and interdependent relationship between academia, industry and government could be explored at an academic workshop involving participants from all three sectors (Etzkowitz and Leydesdorff 1995). This subsequently led to it being developed into a formal model of innovation that describes how each institution can adopt and adapt practices from the others to enable the creation of novel and significant new offerings that would not be possible otherwise.

> *The Triple Helix thesis postulates that the interaction in university-industry-government is the key to improving the conditions for innovation in a knowledge-based society. Industry operates in the Triple Helix as the locus of production; government as the source of contractual relations that guarantees stable interactions and exchange; the university as a source of new knowledge and technology, the generative principle of knowledge-based economies. […] The Triple Helix denotes a transformation in the relationship among university, industry and government as well as within each of these spheres. As institutions increasingly "take the role of the other"* [3]*, the traditional match of institution to function is superseded. […] Arrangements in networks among the Triple Helix institutional spheres provide the source of innovation rather than any single driver. […] Innovation is a broader phenomenon than anything that takes place in a single institutional sphere.*
> (Etzkowitz 2003, pp 295-296)

For the purposes of this integrative chapter, I interpret the interrelationships of the institutions in a way similar to Farinha and Ferreira's (2013) expanded model, which places an emphasis on competitiveness and regional development. Figure 1 illustrates this.

[3] Etzkowitz later clarifies this stating while they "(assume) some of the capabilities of the other(s), each institution maintains its primary role and distinct identity" (ibid. p 309)

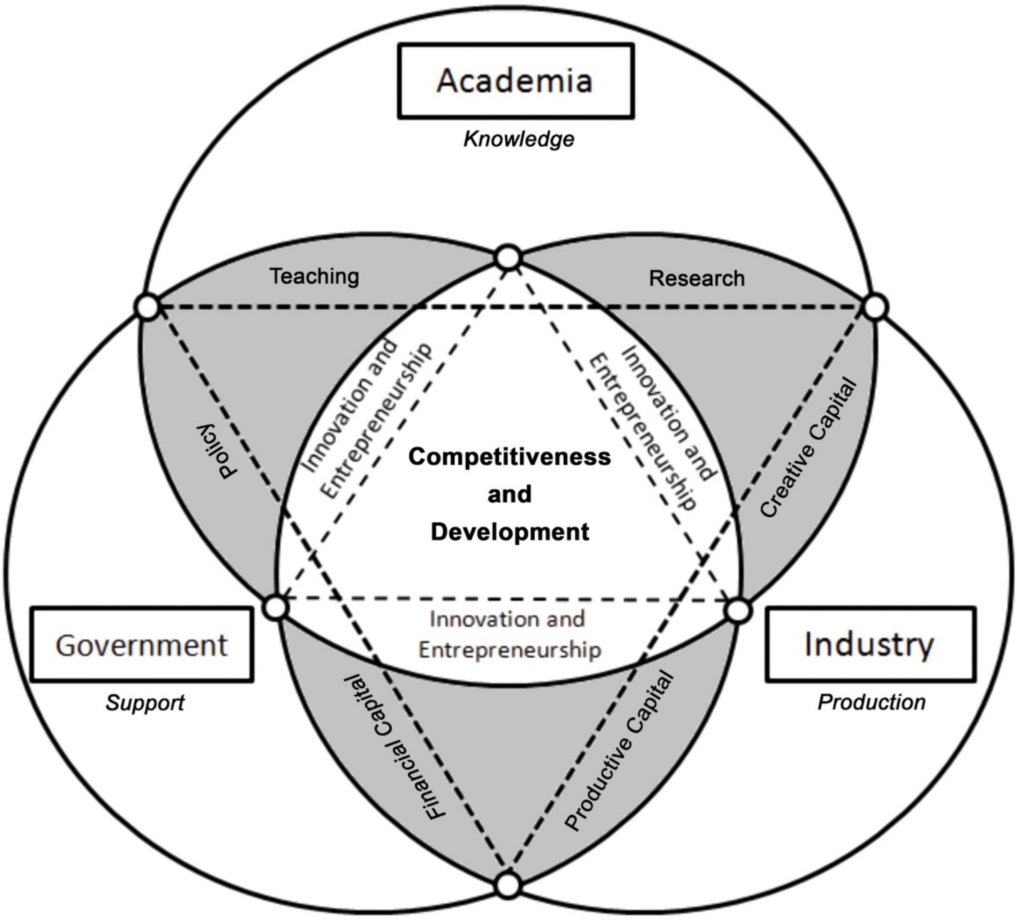


Figure 1: Triple Helix model adapted from Farinha and Ferreira (2013)

In the discussion of my publications that follows, I describe how different aspects of the work, and outputs from it, correspond to various relationships expressed by this model. I also highlight instances of my research involving commercial product development that have utilised resource from all three institutions and thus serve as direct examples of the Triple Helix applying to the creative sector. I consider the relevance and benefit of the model to the academy and industry from my perspective as both a researcher and a professional film and television practitioner.

3. Use of Industry Experience to Inform Research Design

I was hired by the department of Electronics to assist with establishing a new initiative in Media Engineering involving both teaching and research, drawing on my experience and expertise as a film and television industry practitioner. My responsibilities included contributing to the creation of an innovative BEng/MEng in Media Technology degree programme, which combined traditional electronic engineering studies with hands-on exploration of film and television production methods[4], as well as to the development of a novel programme of research into media-related technologies and systems. This led to the outputs described in this section, which I suggest are all examples of the intersection of academia and industry consistent with the Triple Helix, and in some instances also involve support by government initiatives thus demonstrating the full applicability of the model.

3.1 Research Context

Prof John Robinson, an expert in computer vision, was the leader of the Media Engineering initiative. When I joined the group, we discussed how we might combine his expertise in computer vision with mine in film and television. At that time, digital camera systems, such as Sony's Digital Betacam, were becoming standard in the television industry and postproduction systems were moving to the digital domain as well. With media assets in a digital form, it could be possible to apply computer vision techniques to their analysis and manipulation. Robinson and I agreed this emerging area was a prime candidate for research from both technical and procedural perspectives. Considering that image processing (a key component of computer vision technology) is essentially a postproduction process, we decided that developing tools that could enhance the editing process would be our objective.

[4] In hindsight this itself is arguably an example of innovation informed by the Triple Helix – an academic course was developed to address an overall decline in students studying electronics (noted by the government) through identifying an emerging sector of industry that was gaining increasing government support

3.2 Publication 1: *Developing Effective Test Sets and Metrics for Evaluating Automated Media Analysis Systems*

In my review of existing research into automated analysis of video attributes, an essential part of an advanced editing system, it became apparent that very little of it was adequately informed by industry end-user needs and did not consider common working practices. TRECVID, the Text REtrieval Conference – VIDeo retrieval evaluation, “devoted to research in automatic segmentation, indexing, and content-based retrieval of digital video” (TRECVID n.d.), is part of a long-running US government initiative specifically developed to encourage academic research into information retrieval that can ultimately lead to commercial innovation[5]. At that time, evaluation methods used by TRECVID and others were arguably flawed in that the experimental design used and test sets developed did not fully consider commercial requirements. In response to this I wrote a position paper (Publication 1) identifying the shortcomings of then-current approaches, which did not sufficiently consider technical attributes of footage[6] nor production methods used[7] that could affect analysis. I also proposed more robust testing methods to better assess the effectiveness of automatic footage analysis systems based on industry requirements. The experimental design aspect of this work subsequently underpinned all the research I undertook with the Media Engineering group. I suggest this work is an example of how industry knowledge can help inform academic research enabling innovation to the benefit of both, a key aspect of the Triple Helix.

3.2 Publication 2: *Robust Automated Footage Analysis for Professional Media Applications*

Concurrently with my work on Publication 1, Robinson and I started development of a tool known as ASAP – Automated Shot Analysis Program – that can automatically analyse raw film or television footage input in a digital form and identify individual shots as well as most common types of camera motion they might contain[8]. Using

[5] Interestingly while TREC serves as an example of government support as part of a Triple Helix, it is explicitly 'pre-commercial' in that results from TREC trials cannot be used in advertising
[6] Such as the aspect ratio, frame rate, transfer artefacts from conversion from film to video, colour depth, etc.
[7] Such as rack focus, swish pans, match cuts, jump cuts, fast montage, etc. Studiobinder (2020) provides a useful glossary of these and other film production terms
[8] Terms for camera motion from a fixed position include ‘Pan’ left or right, ‘Tilt’ up or down, ‘Zoom’ in or out. Terms for shots where the camera moves from one position to another include ‘Dolly’ in, out, left or right and ‘Crane’, which can refer to a move in any direction including up and down

Robinson’s Simplex Adapted Mesh (SAM) method (Robinson 2003), it generates output in the form of a text-based searchable database that contains information for each shot as well as keyframe images that serve as a visual representation of it – see Figure 2. ASAP was intended as a first step toward creating more ‘intelligent’ editing systems that could use automation to streamline parts of the editing process. Our emphasis was on applicability to industry, and we made it a priority to utilise test data sets and evaluation methods I proposed in Publication 1.

ASAP output

Shot	Start frame	End frame	Start time	End time	Duration	Description	Details	Key frame
159	20999	21049	13:59:23	14:01:23	0:02:01	Hold		
				CUT				
160	21050	21099	14:01:24	14:03:23	0:02:00	Hold		
				CUT				
161	21100	21101	14:03:24	14:04:00	0:00:02	Hold		
	21102	21185	14:04:01	14:07:09	0:03:09	Tilt up	0.996528 frame heights	
	21186	21208	14:07:10	14:08:07	0:00:23	Hold		
				CUT				

Figure 2: Output from ASAP

In our trials, ASAP significantly outperformed CutDet, the system that was seen to be the best at that time by the research community (Lienhart 1999), accurately identifying cuts in a wider range of footage types. ASAP’s identification of camera movement, functionality CutDet did not have, was also impressively accurate. This high level of performance suggested that, with further refinement, it could be possible to utilise the technology in a commercial application. Our efforts to achieve this are described in section 3.5.

3.3 Publications 3, 4 and 5: *Automated Reverse Storyboarding, Techniques for Automated Reverse Storyboarding* and *Iconic versus Naturalistic Motion Cues in Automated Reverse Storyboarding*

SAM, Robinson's system that underpins ASAP, was originally designed as a real-time process to generate image mosaics[9]. In addition to being suitable for image analysis, it can also generate images as well. Video summarisation in image form has long been an active area of research[10] but typically this has not considered film and television industry paradigms. I proposed to the Media Engineering group that we investigate whether storyboarding[11] could be applied in a reverse context through the analysis of image sequences. Since ASAP could identify and extract individual shots, it should be possible to summarise those through the creation of storyboard-like images and image mosaics.

To enable this work, I defined a set of standard visual attributes and conventions used in professional storyboards. These were then taken by Prof Bob Dony, a visiting researcher who specialised in mosaics[12], and used as a basis from which to adapt Robinson's SAM technique to create visual summaries in storyboard form. Several trials were conducted on different types of footage to assess the effectiveness of the system, and it became clear the approach could work. The methods used and our initial findings were then written up into two articles – a conference paper (Publication 3) and an expanded journal article (Publication 4).

We felt the first iteration was a good start – its output included many of the attributes of film and TV storyboards – but it was not complete. Secondary visual cues used by industry, such as arrows to suggest the direction and speed of any object motion within a shot, and external arrows to distinguish camera movement from subject motion, were missing. To address this, Dony and Robinson worked with PhD student Matt Day to develop ways to automatically generate these. Adding arrows outside of

[9] The creation of an image mosaic involves combining multiple individual images that have overlapping visual information into one larger image. Szeliski (2007) provides a seminal tutorial
[10] Ma et al. (2002) is one highly cited example
[11] 'Storyboarding' refers to the visualisation process used in the planning of film and television projects where each shot is represented by an image (or 'panel') and arranged next to others in time order to provide a summary of an editing sequence
[12] Vesilind's (2001) National Geographic article provides an excellent example of Dony's work

the storyboard panels between the frames[13] to represent camera positions at different points in time, was straightforward to implement, and the system could create summary images that were generally consistent with industry conventions. However, creating internal arrows, to indicate subject movement within the frame, proved to be much more difficult. From the trials it emerged that our methods could be useful in creating some attributes of professional storyboards but not all. These findings as well as the approaches used were reported in Publication 5.

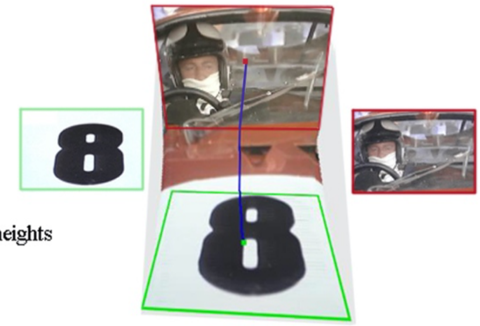
3.4 Publications 6, 7 and 8: *Semi-Automated Logging for Professional Media Applications*, *A Vision-Based Postproduction Tool for Footage Logging, Analysis and Annotation* and *Automated Description of Film and Video Shot Compositional Characteristics*

While Robinson and I were encouraged by the performance of ASAP in our limited experimental trials, I felt it did not yet have sufficient functionality to be beneficial in a professional editing setting – the logging of footage needs to have richer shot descriptions to be useful. At a base level, the tool would need to not only identify individual shots and classify any camera movement, but also to describe 'framings'[14] and 'groupings'[15]. This level of automated functionality could demonstrably streamline the logging and editing preparation process.

To advance our work, I proposed we use ASAP as the backbone for a hybrid semi-automated system, one that would make the logging process more efficient through automatic shot detection and camera movement classification but also enable framing and grouping detail, as well as additional text description, to be added manually. Robinson liked this and suggested we use image mosaics to provide succinct video summaries of shots with camera movement – Figure 3 shows an example of a 'tilt up' depicted using his method. The resulting system was named SALSA – Semi-Automated Logging with Semantic Annotation.

[13] These are known as 'Field Cuts' in storyboarding terminology
[14] This refers to size of the subject within a shot such as 'close up', 'medium shot', 'wide shot', etc.
[15] This refers to the number of people within a shot such as 'single', 'two shot', 'group shot', etc.

Shot	Start frame	End frame	Start time	End time	Duration	Description
161	25502	25503	17:00:01	17:00:02	0:00:02	Hold
	25504	25611	17:00:03	17:04:10	0:04:08	Tilt up 1.17949 frame heights
	25612	25631	17:04:11	17:05:05	0:00:20	Hold



Starts on tight close up of number 8 on car bonnet tilts to loose close-up of driver

---------------------------------------CUT------------------------------------

162	25632	25689	17:05:06	17:07:13	0:02:08	Hold

Tight close-up of driver

Figure 3: Output from SALSA with image mosaic upper right

To make manual input efficient, it made sense to consider existing keyboard interface paradigms used by professional postproduction systems to ensure operation felt familiar to users[16]. Because framing and grouping have standardised industry descriptions, and there is a limited number of these, 'hot keys' are ideally suited to inputting this information. Accordingly, I designed an operational interface using this approach. By having the ASAP engine output its results in text form, quick correction of any parsing errors could be readily completed through the keyboard interface while additional text description of shots was being added.

Results from our experiments indicated a time savings of approximately 50% in logging using SALSA compared to a standard manual logging approach, which was encouraging. From this, we developed Publication 6 for conference dissemination. After presentation of this work, Robinson undertook further development of SALSA's coding and I conducted an additional trial, which reinforced the findings of the first experiment. These outcomes, along with an expanded description of SALSA's development and testing, were developed into a journal article (Publication 7).

[16] Rubin (2000) provides a clear account of the evolution of modern editing systems

The SALSA project was progressing well, but we felt that it would be stronger and more attractive to industry if more of the tasks could be automated. I wondered whether face detection might be a viable way to automatically identify framings and groupings – if all people within a shot could be detected, with their size and position determined in relation to the shot frame boundaries, it should theoretically be possible to automatically capture this information. Such functionality could not only provide significant time-savings in preparation for professional editing but also could be valuable for automated archive analysis, another significant commercial market.

Robinson designed a framework to explore this, with Day leading development under his supervision. I drafted specifications for the types of information the system should extract, which Day incorporated. Results of the trials indicated that the approach could potentially work but that there were limitations, due in part to the detection system's inability to handle shots with complex camera and subject motion – this is reported in Publication 8. Because this automated functionality was not sufficiently mature, we decided not to integrate it into SALSA.

3.5 Considering the Viability of SALSA as a Commercial Product

Encouraged by our findings overall, Robinson and I showcased SALSA to the University's Enterprise and Innovation Office (E&I) to see if ultimately creating a spin-out company might be appropriate. They saw potential in the project and, in 2004, gave us a £24K 'Proof-of Principle' award from funding received by a UK government grant specifically designed to commercialise academic research. We used this money to hire a programmer, Dr Ed Tuke, who over the next year further developed and refined the system, porting it to the Windows platform which would be essential for commercial exploitation – Figure 4 shows the prototype.

First Frame	Last Frame	Move Type	Value	Units
727	778	Hold		
779	823	Pan right	0.57	frame widths
782	802	Tilt down	0.15	frame heights
805	965	Tilt down	5.09	frame heights
809	819	Zoom in	1.24	scaling (end/start)
875	888	Zoom in	1.16	scaling (end/start)
966	1004	Hold		

Figure 4: SALSA prototype running on Windows

By the beginning of 2006, appreciable progress had been made but development was slower than Robinson and I had hoped. The stability of the system was not sufficiently robust to undertake industrial trials and to get SALSA ready to be considered for commercial investment would require more time and programming resource. In the marketplace, there was a rapid drop in the price point of professional editing systems spurred by Apple becoming more aggressive in selling Final Cut Pro[17], which raised new questions about the market for SALSA and what a viable business model for a spin-out company might look like. Given these factors, and both my and Robinson's availability to work on it becoming much more limited[18], Robinson, E&I and I all agreed that the project should be suspended.

Looking back, the SALSA project is arguably a novel example of the Triple Helix applied to the creative sector – a film and television industry need was identified that informed the development of an academic research programme that drew heavily on

[17] Final Cut Pro is a non-linear editing system that competes with Avid Media Composer and Adobe Premiere
[18] I had been asked to become a founding member of a new department of Theatre, Film and Television (TFTV) and Robinson became the Head of the Department of Electronics, which greatly reduced our time for research

industry expertise, and exploration of commercial exploitation of the resulting system developed through the research was facilitated by government support. Although a company was not spun-out and the product did not go to market, the project was recognised as innovative and arguably would not have progressed as far as it had without the combination of input from the three institutions.

3.6 Reflections on my work with the Media Engineering Group

A key component of a workable Triple Helix relationship is an openness to interdisciplinarity. Without explicitly planning it, Robinson and I had developed an effective approach to research that ignored traditional barriers between science and art, and embraced the different skills and perspectives we each offered – we viewed each other as equals, something that is vital to effective interdisciplinary working but often lacking (discussed in Publication 10). Our relationship evolved organically, and in hindsight, remarkably mirrors the best practice principles described in Brown, Deletic & Wong's oft-cited 2015 article, *Interdisciplinarity: How to catalyse collaboration*:

1) Robinson and I had a "shared mission" with clear overall goals for our work
2) Our work was 'T-shaped' – we were able to "cultivate both (our) own discipline(s), and to look beyond (them)"
3) We "nurtured constructive dialogue" and were able to reconcile and learn from the "differing technical vocabularies and communication cultures" of our respective areas of expertise
4) We had strong "institutional support", starting with the department's vision to hire me as a non-engineer without an academic background, resourcing a new research group in Media Engineering, and, more broadly from the University, providing funding to explore commercialisation of SALSA
5) We were able to "bridge research […] and practice", as well as begin to influence policy as Robinson and I were both invited to be members of the Engineering and Physical Sciences Research Council (EPSRC) Steering Group on the Convergence of Graphics, Video and Vision, where we served from 2002 to 2004

Although my work with Robinson was ultimately suspended, our collaboration gave me valuable insight into the relationship between the academy, research and industry that has helped to inform my subsequent work. I will always be grateful for this experience.

4. Relationships between Industry and the Academy

In Autumn 2006, I joined the new department of Theatre, Film and Television (TFTV) full-time as one of its four founding members. I was given the responsibility of developing all aspects of film and television production provision, including the department's building and facilities, as well as designing new undergraduate and postgraduate programmes. Given the time required by these tasks, I was asked to put my research on 'hold'. However, the process of setting up TFTV involved forming and developing relationships between the academy and industry that were required by government funding and intended to fulfil government objectives, in alignment with the Triple Helix. Issues I encountered and observations made in undertaking this work shaped the direction of my inquiries when I resumed research, leading to the development of the publications discussed in this section.

TFTV was established in a different way to most academic departments. Part of the funding for its building came from the European Regional Development Fund (ERDF n.d.), the conditions of which required that we support local industry to add value to the regional economy. ERDF imposed specific targets for 'assists', which were formal collaborations we had to have with external organisations to benefit them in some way. This meant that rather than having general teaching facilities, TFTV had to have dedicated production and postproduction resources that would be attractive to industry professionals and could be used in support of commercial work. Part of my remit was to ensure that our building and equipment fit this requirement. Because of my background, I was also asked to lead on finding and engaging with film and television industry partners to meet ERDF targets, which was an unusual task for an academic.

I did not realise it at the time, but the requirements that dictated how TFTV was founded effectively represent a different type of novel example of the Triple Helix – TFTV was arguably the first department of its kind in the UK to be created based on the interdependent relationships described by the model – Etzkowitz notes this type of application explicitly:

> *The Triple Helix also becomes a platform for "institutional formation" […] new organisations arise from interaction among university, industry and government to promote innovation and are themselves a synthesis of elements of the Triple Helix.* (Etzkowitz 2003, p 308)

When I restarted research activities in 2010, I drew heavily on my experiences in establishing TFTV and questions they raised that in hindsight are relevant to understanding the applicability of the model in the creative sector.

4.1 Publication 9: *Digital Cinematography: Evolution of Craft or Revolution in Production?*

In the late 2000s, a shift began in industry moving away from analogue production technologies, such as film, to new digital equivalents. A key infrastructural decision TFTV had to make was whether we would support legacy formats or whether we should become an all-digital facility. In speaking with industry, particularly vendors, manufacturers, and others to develop workflows and equipment lists for the building, it became apparent to me that the latter made more sense.

I was interested in considering this from a research perspective as it seemed this shift potentially marked a watershed moment where film and television industry practice could be fundamentally changed. However, it was unclear how radically production and postproduction methods were being altered. This led me to develop Publication 9, which looks specifically at the impact of new digital technologies on the practice of cinematography, which is where the fastest technical development seemed to be happening[19].

The article represents an instance of research prompted by a need to make an academic department relevant to industry by understanding commercial trends. In other words, in terms of the Triple Helix, it is a small example of work that brings these two institutional spheres closer together.

[19] Ultimately, I concluded that the switch was evolutionary rather than revolutionary, but it is interesting to note that the debate continues nearly decade after the paper was published

4.2 Publication 10: *Perceptions of Broadcast and Film Media Practitioners in UK Higher Education*

In their discussion of “innovation from the knowledge base” (i.e., academia), Etzkowitz and Zhou note that “many academics believe that the university best fulfils its mission by limiting itself to education and research” (2018, p 8) hinting at potential resistance to the acceptance of different operational cultures that is required by the Triple Helix. I was not aware of this work at the time, but it is now evident Publication 10 represents a detailed investigation of this from the perspective of the film and television practitioner, which grew from my personal experience.

While I valued working as part of the Media Engineering Group, my time in the Department of Electronics was not always pleasant. There were numerous instances where my non-traditional background was highlighted, and I was described as ‘different’ in a pejorative way. To give one notable example, in my first week in post a senior Professor approached me and said he thought my appointment was a ‘mistake’, clearly stating that my background was inappropriate for the role of Lecturer and positing that I would add little to the department. Later, when I was asked by the Deputy Vice Chancellor to become involved in the development of TFTV, a member of the Electronics management team openly mocked this in department meetings, ultimately prompting me to make a complaint. Indeed, even when I moved to TFTV full-time, at various points I was told by a senior colleague, who had a traditional background, that I was unlikely to progress in my academic career unless I switched to a teaching-only contract.

These encounters made me wonder whether these experiences were unique to me or whether others who joined the academy from the media industry might have similar stories – and if the latter were the case, how widespread instances of bias were. To formally consider these questions, I developed a set of surveys that I sent to a substantial number of UK academics with professional backgrounds in film and television; the results are reported in Publication 10.

This work provides significant detail of cultural issues that exist between parts of the academy and industry in the creative sector, and how these represent barriers to enabling innovation. As such, it provides novel insight into considerations that must be addressed if projects modelled on the Triple Helix are to be viable and successful.

4.3 Publications 11 and 12: *A Fistful of Dollars or The Sting? Considering Academic-Industry Collaborations in the Production of Feature Films* and *Academic-Industry Collaboration for Commercial Film and Television Production: An Exploration of Case Studies*

As noted at the start of this section, conditions of TFTV's ERDF funding stipulated that the department provide 'assists' to media industry and arts organisations in our region. Given the professional standard required for our building and equipment as a result, support of commercial feature films and broadcast television projects seemed like a logical area to explore, particularly as there could be scope to enhance the student experience.

By chance, I had some experience of this type of collaboration previously when I enabled support of visual effects production for the feature film, *The Christmas Miracle of Jonathan Toomey* (2007), while I was in Electronics. For this, I arranged office space on the University Science Park for a team of students, who we trained in compositing[20], to undertake the work under the supervision of professionals[21]. The project was seen as a great success – the production company was happy with the finished work, students gained valuable paid experience (with a number subsequently getting jobs in the VFX industry) and the University gained significant publicity. Although the project was ad-hoc, it suggested to me that academic-industry collaborations had potential to be highly beneficial.

I first learned about formal models of academic-industry collaboration for commercial film production in 2008, when I met with Prof Tom Schatz of the University of Texas, Austin. I had arranged to meet with him to learn more about UT's film and television courses to help inform the design of those I was developing for TFTV. In that meeting, he mentioned Burnt Orange Productions, a commercial feature film production scheme he created to give students experience on real-world projects but

[20] This term refers to the process of combining different visual elements into one shot. Brinkmann (2008) provides a details discussion of the processes involved

[21] A full account of this collaboration is discussed in Publication 11 on page 151

with academic oversight[22]. The scheme was highly developed and seemed like a potential model for TFTV to use to both enhance teaching and meet ERDF requirements. I began to look at other universities involved in this type of collaboration and consider whether there were common models that had emerged.

Over time, this led to the development of Publication 11, which describes and assesses the efficacy of similar projects worldwide and contextualises related work undertaken in TFTV, including a basic overview of *The Knife That Killed Me* (*TKTKM*)[23]. The article describes several instances of "entrepreneurial university(ies) combining a 'third mission' of economic and social development, with teaching and research, (as a) growing contemporary phenomenon, in which academia takes a role […] in an emerging mode of production […] based on innovation" as Etzkowitz and Zhou describe in their chapter on the "entrepreneurial university in a triple helix" (2018, p 57)[24]. Although I was not fully aware of the Triple Helix when Publication 11 was written, in hindsight the work arguably provides novel analysis of different ways the model can be applied to commercial media production as well as identifies best (and worst) practice in developing and maintaining activities working within Triple Helix institutional relationships.

Publication 12 builds on the inquiries made in Publication 11, further refining my own proposed definitions of academic-industry collaboration models for film and television production, exploring additional initiatives, and updating case study information. In particular, it includes data from a series of surveys conducted during the creation of *TKTKM* that serve as a testbed to assess how different stakeholders viewed the project at different points within it, expanding discussion of the film as a case study.

[22] A detail account of Burnt Orange Productions, including interesting challenges it encountered, can be found in Publication 11 on pages 146-148

[23] In-depth discussion of my work on the creation of the film itself and its novelty as a commercial product that could not have been achieved without a Triple Helix collaboration in place, is in section 5

[24] The concept of the 'entrepreneurial university' was first described by Clark (1998)

4.4 Publications 13 and 14: *Enhancing the Competitiveness of An Independent Feature Film Production Company Through the Application of New Digital Technologies* and *The Impact of Digital Technology on the Distribution Business Models of Independent Film in the UK*

As discussed in Publications 11 and 12, TFTV had a close relationship with Green Screen Productions (GSP), the local feature film production company behind *TKTKM*. Originally the partnership was designed to involve support for different film projects as part of an 'umbrella agreement'[25], but as the relationship developed it became evident that there might be the possibility of increasing the scope to consider the operational workings of GSP and how they might be improved to enhance the company's competitiveness.

In 2013, Kit Monkman, Director of *TKTKM*, Alan Latham, Managing Director of GSP, and I, in my role as a senior academic, successfully applied to the Knowledge Transfer Partnership (KTP) scheme. KTPs are designed to connect "businesses that have an innovation idea with the expertise to help deliver it" (KTP n.d.) and provide direct financial support to accomplish this – essentially it provides a formal mechanism to create a Triple Helix collaboration.

Our award was for a two-year project designed to enable GSP, which had operated using increasingly antiquated traditional production and business methods, to better understand and exploit emerging digital technologies that were beginning to pervade all aspects of commercial filmmaking. Funding for our KTP came through the Technology Strategy Board (TSB)[26] and the Arts and Humanities Research Council (AHRC). It was the first KTP award to support commercial feature film production and, as such, represents a truly novel Triple Helix collaboration and arguably the first formal application of the model in the film and television industry in the UK.

All KTPs include an Associate, who is the person that serves as the Project Manager as well as a 'bridge' between the academic and industry partners. For our partnership, Keith Kehoe was hired to undertake this work, with Monkman as his

[25] This is an agreement I brokered between the University and GSP, which is discussed in section 5.2
[26] TSB is now known as Innovate UK

company line manager and me acting as his academic supervisor as well as academic project lead. One of the government's objectives for KTPs is to enhance the skillset and employability of the Associate from both commercial and academic perspectives; Kehoe was interested in undertaking formal research. This led to the creation of Publications 13 and 14, which he completed under my direction.

Publication 13 describes our KTP in detail at its half-way point, and provides a clear context based on a review of film industry practices at that time. It also considers perspectives and expectations of the different participants in the partnership and the rationale behind how the project evolved due to changing needs. Kehoe led development of the work and I edited and revised it to ensure it was appropriate for publication.

Publication 14 was substantially more involved. At the time of the KTP, it became apparent that the concept of 'digital disruption'[27] was proving to have a significant impact on independent feature film distribution and marketing, and the ability for smaller production companies like GSP to make money from their product. Previously established business models were being overhauled in response to new outlets such as Amazon and Netflix, whose payment terms differed radically from conventional theatrical distribution. Getting product noticed in a very crowded online-based marketplace required new ways of marketing. Indeed, we were experiencing the impact of this in our efforts to gain visibility for *TKTKM*[28], which was a driver in pursuing this research.

Under my guidance, Kehoe conducted the core research and developed the article using a framework we agreed. It was submitted for publication in 2014 but feedback indicated it needed substantial revision to be acceptable to the academic community. I led rewrites with Kehoe contributing additional research and the article was accepted in 2015 by the International Journal on Media Management[29].

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[27] 'Digital disruption' refers to the impact of the emergence of new technologies on existing processes or business models
[28] Section 5 discusses aspects of this more fully
[29] We are proud of this as it is a selective journal with a highly critical readership. The journal's homepage indicates that, to date, the article has been viewed over 38,500 times

I argue that our KTP demonstrates how the Triple Helix model can be applied successfully in economic contexts beyond STEM, including the creative sector. Indeed, this was only the second KTP to be supported by AHRC as the arts had previously not been seen as an area where worthwhile commercial benefit could be generated. However, there has been a marked shift since the project finished with the number of arts-focused KTPs rising significantly and the emergence of new UK government-backed initiatives to support the screen media sector, including the £80M Creative Industries Clusters Programme (n.d.) and AHRC's £63M CoStar network initiative (UKRI 2023), to support further Triple Helix collaborations.

4.5 Publication 15: *Digital disruption and its implications in generating 'impact' through film and television Practice-as-Research*

UK universities view the Research Excellence Framework (REF) as a critically important review process, not only due to the funding attached with a high rating but also for enhancing institutional reputations. Whereas the quality of scholarship and specific publication outlets were previously seen as key measures of excellence, the 'impact' of research has gained increasing importance in the exercise. For academics who involve practice in their research in some way, creating and demonstrating impact can be challenging, particularly for those involved in independent film production.

This article builds on the research I undertook with Kehoe for Publication 14. It considers how strategies described in that paper might be applied in an academic context by those involved in film practice as research. It originated as a conference presentation for the *2018 Media Education and Practice and Media, Communication and Cultural Studies Association Practice Symposium* that I developed to prompt discussion about the (then) upcoming REF 2021. Because of the innovative marketing activities he developed as an independent producer, I asked Samm Haillay (a Senior Lecturer at Teesside University at the time) to present with me to discuss his approaches rather than me relaying them second-hand. The session was very well received, and I was asked to write a full article based on it. I undertook most of the work, which involved conducting additional research and interviews, and asked Haillay to contribute details of his projects.

This work arguably shows a different aspect of the 'Triple Helix' relationship in a novel creative sector context. In my earlier publications, discussion included how industry needs could influence directions of research and help to define the specifications of systems being developed. There was also exploration of how collaborations could leverage the resources of academic, industry and government partners for mutual benefit with conventional institutional objectives being fulfilled. This article considers the transferability of processes from one operational institutional context to another with a different direction of flow. It argues that there are instances where specific industry practice can be adopted by the academy for institutional academic benefit. This is opposite to the more typical way the Triple Helix benefit is gained where academic research is facilitating organisational change in industry methods or government policy.

4.6 Publication 16: *Directing for Cinematic Virtual Reality: How Traditional Film Director's Craft Applies to Immersive Environments and Notions of Presence*

With the introduction of the Oculus Rift VR head-mounted display commercially in 2016 (Dingman 2021), including the significant hype surrounding the launch, it looked as though virtual reality might finally gain take-up and become the next-generation medium that has long been predicted by Jaron Lanier (1992) and others. Concurrently, a new form of linear content was emerging that allowed users, on any computer-driven screen device including VR headsets, to view films in 360º from online video platforms such as YouTube. This became known by the research community as 'Cinematic Virtual Reality' (CVR).

Given my background as a director and prior experience with VR, I was interested in analysing the CVR projects that were being created, particularly by Hollywood directors, to see if any standard forms of practice were emerging. I thought it could be useful to formally consider how western methods of screen directing might be adapted to creating CVR films, and whether approaches to 'suspending disbelief' could be applied to an immersive medium. I initially developed my inquiry as a conference presentation for the MeCCSA Post-Screen Cultures/Practices Symposium (Mateer 2016). The work was well received, and I was encouraged to expand it into the journal article; this became Publication 16.

The article itself is theoretical in its approach, proposing a set of production techniques to enhance user engagement based on industry-standard practice; the value of the set is argued speculatively, rather than through an analysis of its application in an experimental setting. However, it has been widely utilised both by academics and industry to help develop VR productions and practices[30].

One example is *Developing Production Methods and Visual Grammars for Combining Live-Action and Computer-Generated Imagery for Narrative Cinematic Virtual Reality Films,* a KTP-like project funded through XR Stories[31] (2023). This £300K project[32] brought together feature film director Kit Monkman, producer Thomas Mattinson, Visual Effects company Viridian FX and Virtual Reality experts Retinize, working with myself and academic colleague Guy Schofield, to undertake systematic testing of film techniques described in the article to inform the design of a cutting-edge CVR promo for the commercial feature film *At Home*. It represents another novel instance of the Triple Helix model being applied to the creative sector as it brings together academia and industry with government backing to apply cutting-edge research in support of the creation of a commercial product offering. The resulting work arguably could not have been developed without this relationship.

[30] To date, it is my most highly cited work and ranked in the top 25% of all outputs scored by Altmetric
[31] XR Stories is one of the nine clusters funded by the Creative Industries Clusters Programme (n.d.)
[32] The award from XR Stories was £63,850 with other support coming from the industry partners

5. Combining Research and Industry Practice through Academic-Industry Collaboration to create *The Knife That Killed Me*

This section provides an in-depth look at my work on the project as a practitioner in creating the film itself and considers how different aspects of my research informed its creation[33]. It provides unique insight into an effective Triple Helix relationship, demonstrating how collaboration between academia and industry can lead to innovation, technically and creatively, that would not be possible otherwise. Here, a government imperative (ERDF) prompted an academic institution (TFTV) to support an industry organisation (GSP) in the creation of a commercial product. But beyond that, the project partners sought to maximise the flexibility and potential of working in an academic environment, drawing on expertise informed by research, to make the product unique both in terms of production processes and in the creative design of the product itself. As such, *TKTKM* represents a truly innovative approach to commercial filmmaking that could only be accomplished through a Triple Helix structure.

5.1 Development

My work on the project started in February 2009. At this stage, GSP was still in the process of securing production funds and the project was highly speculative. However, core elements of the project were clear:

1) The film would be shot entirely in green screen with all set backgrounds created through VFX composited with live action – example in Figure 5
2) All VFX work would be undertaken by recent graduates with relevant degrees who would be overseen by industry professionals
3) The VFX team would be situated within a university and utilise university resources wherever possible
4) Kit Monkman would have overall responsibility for directing visual elements working closely with VFX Supervisor Tom Wexler, and Marcus Romer would have overall responsibility for directing the actors

[33] Publication 12 provides further information about the development of the film and my research involving formal evaluation of the project in terms of shareholder expectations and their fulfilment

5) Thomas Mattinson and Alan Latham would produce, with Mattinson mainly responsible for creative and day-to-day producing tasks and Latham mainly responsible for financing, distribution, and legal aspects of the project
6) The management structure would be highly collaborative and inclusive, with all crew members encouraged to provide ideas
7) The film would be intended for commercial theatrical release internationally

Figure 5: Example scene as shot (top) and as in the finished film (bottom)

My main contributions in this phase were developing preliminary technical specifications and determining the cost of the hardware and software needed to create a VFX department for the film (see Figure 6). Other work was put on 'hold' until funding and a completion bond were finalised.

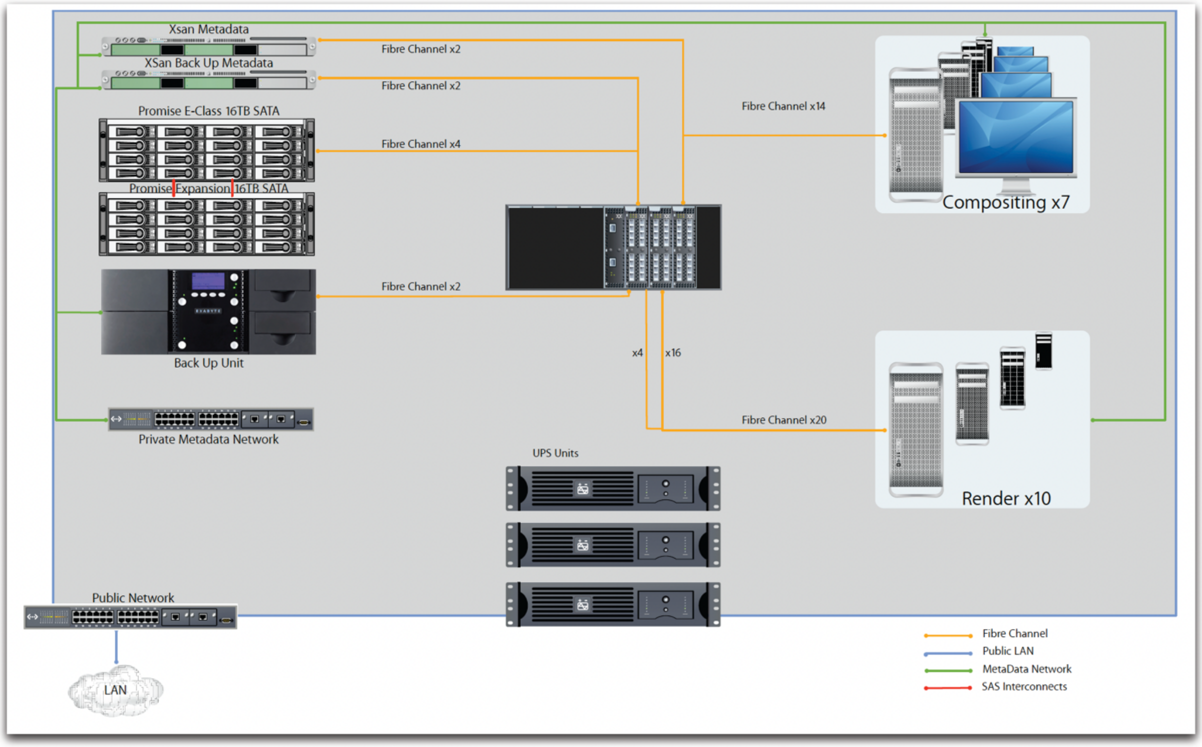

Figure 6: Preliminary VFX department infrastructure, developed with Apple

5.2 Pre-production

My work on the project started in earnest in mid-2011 once the completion bond was secured and most of the funding in place. By this time TFTV had created Heslington Studios Ltd. (HS), a corporate vehicle owned by the University of York that would enable direct engagement with commercial organisations. GSP had acquired the site of the former Advanced Residential Theatre & Television Skillcentre (ARTTS) at Bubwith[34] with a view toward building a green screen production studio, where *TKTKM* could be filmed. Latham and I discussed how TFTV might collaborate on a slate of projects beyond *TKTKM*. Working with Philip Morris of the Enterprise & Innovation Office and Matthew Just of the Legal Department, I developed an ‘umbrella agreement’ between HS and GSP to formalise the relationship. Crucially, I was able to ensure that teaching and core department activities would always have priority access to TFTV facilities. GSP would need to be flexible about their working patterns and Latham was happy to agree to this.

[34] Near Selby, North Yorkshire

By brokering the ‘umbrella agreement’, I was able to secure in-kind contribution from TFTV that lowered the ‘hard cash’ requirements of *TKTKM*. Relatedly, I struck a deal with The Foundry[35] whereby they provided free licenses to our VFX team for their industry-leading VFX compositing package Nuke (Foundry n.d.) in exchange for receiving production assets from the film that could be used for training purposes[36]. Both deals were effectively equivalent to securing funding, so my work here was that of an ‘Executive Producer’. As a note, because of this and other contributions I made, I ultimately received a credit for that role[37] in addition to my credit for ‘VFX Producer’. It signifies that the film could not have been made without my involvement (at that time at least).

One of my key responsibilities was to establish and manage the VFX department. This included sourcing staff as well as specifying and creating a working space that had sufficient resources to undertake the work required. I identified six recent graduates of TFTV’s *MA in Postproduction with VFX* or *Sound Design* course, who I thought could work effectively in the VFX team. Monkman and Wexler interviewed them, and all were hired. TFTV’s building had a dedicated Knowledge Transfer room (TFTV/015) that was specifically earmarked to support commercial activity in accordance with ERDF requirements, so this was a logical place to house the VFX department.

Because this was a VFX-heavy film with a limited budget and small crew, developing a viable workflow, covering production and postproduction, was vital and one of my most important responsibilities. With input from Wexler, Ben Louden, the lead 2D artist, and Mattinson, I created the workflow that was ultimately used (outlined in Figure 7).

[35] The company is now known only as ‘Foundry’

[36] This represented a significant savings as each license cost approximately £3,000 per year at that time, meaning the deal was worth nearly £50K by the time the film was fully completed

[37] This can be seen on all posters and commercial packaging for the film as well as in the end credits

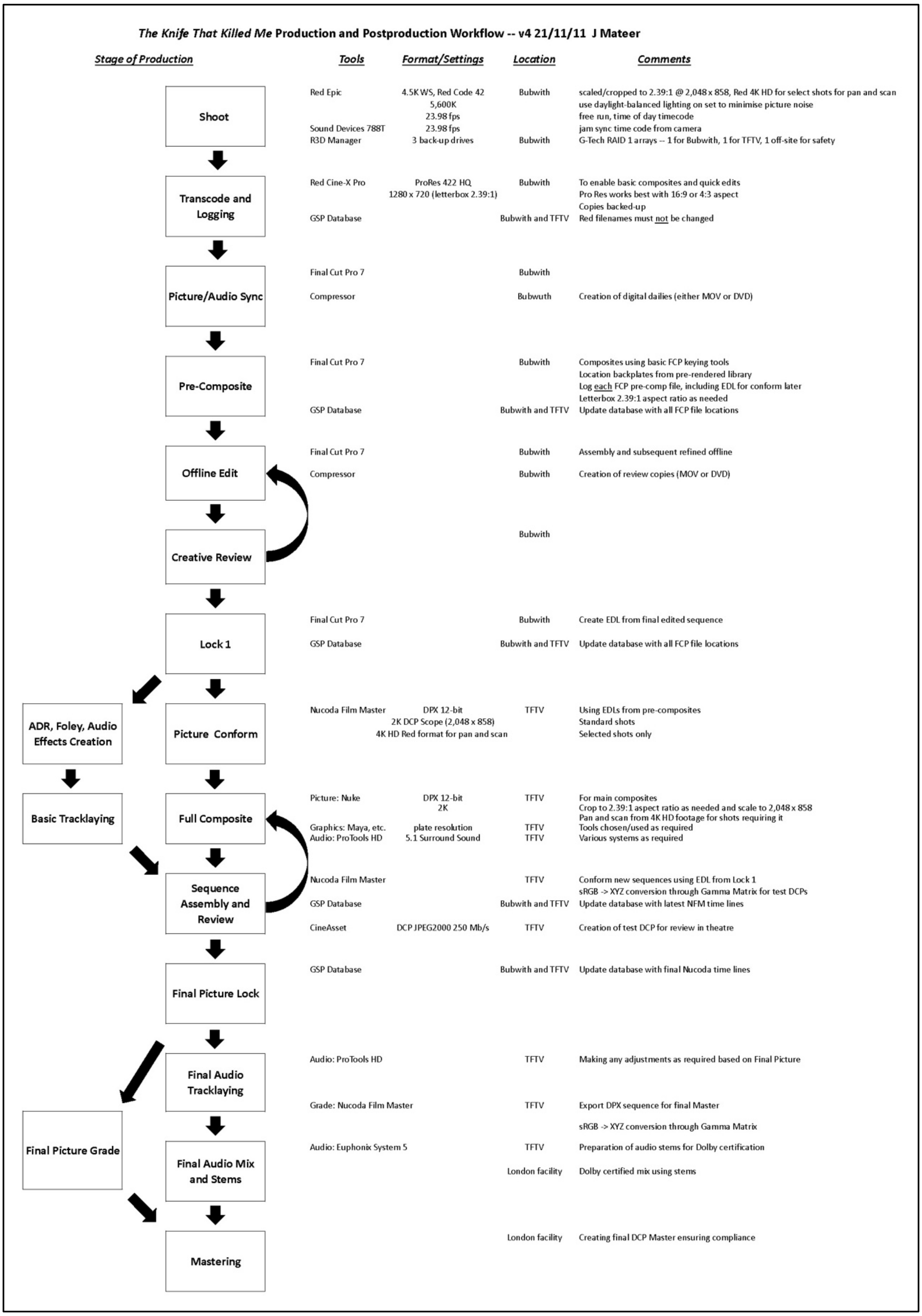

Figure 7: Production and Postproduction Workflow for *TKTKM*

The backbone of this workflow was a bespoke database that was essential to enabling the team to ensure all elements were shot and readily available for compositing. The complex visual design included transitions into and out of different graphic elements, which meant we would need to combine multiple live-action shots with multiple computer-generated image assets. In some instances, shots would require more than 20 passes[38] to create the finished shot. Working with Mattinson, Wexler and the VFX team, I developed specifications for the database, which were then given to a programmer to create – these are listed in Figure 8.

Scene Number

Shot Number

Red Magazine Name -- XNNN_ddmmHH.RDM (<camera letter><reel number>_<day><month>.RDM
　　(*this is the folder that contains the Red clips for the shot)*
　　Format (e.g., 4K 16:9, 4.5K WS, etc.)
　　Codec (e.g., RedCode 42) ** only if different
　　Frame Rate (e.g., 23.98 fps) ** only if different
　　Colour Temp (e.g., 5,600K) ** only if different

Audio Reel Name
　　(*this is the folder that contains the audio clips for the shot)*

Source Materials
　　Red Clip Name -- XNNN_CTTT_ddmmHH.RDC (<camera letter><reel number>_C<clip number>_<day><month><hash code>.RDC
　　　　Comment
　　Audio Clip Name
　　　　Comment

Shot EDL Filename
　　(*this is the EDL for assembling all of the passes within the shot)*

VFX Asset Folder
　　(*this is the folder that contains the CG assets for the shot)*

Live Action Passes
　　Offline Quicktime Clip Name
　　　　Comment
　　Transcode Clip Name
　　　　Comment

2D Passes
　　2D File Name

3D Passes
　　3D File Name

Audio Passes
　　Audio Film Name

Comments

Figure 8: Database specifications for our bespoke asset management system

[38] Each element that is part of a composited shot, irrespective of whether it is live-action or computer-generated, is known as a 'pass'

Because of the high number of passes required by many shots, we needed to create a new nomenclature for identifying what was being filmed[39]. The team and I developed a novel numbering system that would ensure we could quickly log all the information required. This included the scene number, the pass type (abbreviated as LAP: live-action to be composited without effects; ALAP: altered live-action that would be manipulated with VFX; and BLAP: live-action that would be used in the background) the pass number, the shot number and the take number. For example, 021LAP01S45T1 on the clapperboard corresponds to scene 21, live-action pass number 1, shot 45, take 1.

To give a sense of the complexity of some shots and the importance of having a bespoke approach to slating and asset management, it is useful to see an example as it evolved from testing to the finished shot. To achieve the sparse visual style of the film, actors would be filmed either individually or in small groups and then composited into one shot to appear together. Figure 9 includes a list of all passes used to create a test composite of scene 21 shot 45[40].

Shot Number	Red Mag Code	Red Shot Code	Lens Hight Start	Lens Hight End	Subject Distance Start	Subject Distance End	Lens	Action	Cast	Extras	Props	Notes
021LAP01S45T1	A003	C009	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		3 Chavs		Far Group Left Frame
021LAP02S45T1	A003	C010	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		4 Chavs		2nd Group Left Frame
021LAP03S45T1	A003	C011	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		3 Chavs		1st Group Left Frame
021LAP04S45T1	A003	C012	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		6 Chavs		Centre Group
021LAP05S45T1	A003	C013	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		4 Chavs		1st Group Right Frame
021LAP06S45T1	A003	C014	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		3 Chavs		2nd Group Right Frame
021LAP07S45T1	A003	C015	1.2	1.2	10.2	10.2	50	Playground laughing, POV Freaks		4 Chavs		Far Group Right Frame
021ALAP01S45T1	A003	C016	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		3 Chavs		Far Group Left Frame
021ALAP02S45T1	A003	C017	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		4 Chavs		2nd Group Left Frame
021ALAP03S45T1	A003	C018	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		3 Chavs		1st Group Left Frame
021ALAP04S45T1	A003	C019	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		6 Chavs		Centre Group
021ALAP05S45T1	A003	C020	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		4 Chavs		1st Group Right Frame
021ALAP06S45T1	A003	C021	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		3 Chavs		2nd Group Right Frame
021ALAP07S45T1	A003	C022	1.2	1.2	10.2	10.2	25	Playground laughing, POV Freaks		4 Chavs		Far Group Right Frame
021BLAP01S45T1	A003	C023	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		3 Chavs		Far Group Left Frame
021BLAP02S45T1	A003	C024	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		4 Chavs		2nd Group Left Frame
021BLAP03S45T1	A003	C025	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		3 Chavs		1st Group Left Frame
021BLAP04S45T1	A003	C026	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		6 Chavs		Centre Group
021BLAP05S45T1	A003	C027	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		4 Chavs		1st Group Right Frame
021BLAP06S45T1	A003	C028	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		3 Chavs		2nd Group Right Frame
021BLAP07S45T1	A003	C029	1.28	1.28	4.7	4.7	25	Playground laughing, POV Freaks		4 Chavs		Far Group Right Frame

Figure 9: Table showing all passes needed to create the scene 21 shot 45 test

Figure 10 shows a test shot for the first pass, which used crew members as actors. Note that because this was a test, the clapperboard uses our bespoke

[39] Luzi (n.d.) provides a detailed account of how clapperboards are used and common information they contain

[40] This shot is meant to show several students laughing at a girl who has just been hit by a ball. For the test, seven groups of 'chavs' (the character name) were shot in three different ways for the three different types of passes – LAP, ALAP and BLAP – resulting in 21 passes for the composite

numbering system, but some information was omitted that would normally be recorded in production.

Figure 10: Pass 1 of the scene 21 shot 45 test

Figure 11 shows the composited test shot. Note that the colour chart and the image of the woman with flowers were included to enable measurement of colour shifts and other forms of image degradation in the compositing process. Also, the mattes[41] used were rough as we were interested in general placement and control of the groups rather than creating a production-level shot for the test.

[41] 'Matte' refers to an image that enables isolation of part of a shot to create a visual element, which can then be superimposed on a background with other elements to create a composite. Wright (2013) provides an excellent discussion of this

Figure 11: Composite of the scene 21 shot 45 test

In the full test composite shot, groups appeared and disappeared over time as they laughed, with the camera remaining static. We decided that it would be more interesting if the camera moved past each member of the group so we could see their reactions more clearly. All passes would be shot with a fixed camera, with a dolly move right created by animating a virtual camera move in Nuke. Figure 12 shows the finished version of scene 21 shot 45 as it appears in the film.

Figure 12: The finished shot for scene 21 shot 45 at approximately 12:14

I organised additional test shoots to trial the workflows and to determine the most efficient way to create what was needed. Drawing on image analysis methods I learned working with John Robinson, I undertook the formal technical assessment of images and video streams from these tests to confirm quality was being maintained throughout the production and postproduction processes. This was not only important aesthetically, but also to ensure compliance with Universal's delivery specifications.

To help with creative development, I organised a full audio recording of the script, which was then used by Wexler and the team to create an animatic[42] of the entire film using MovieStorm (n.d.). This work helped to inform the visual design and editorial flow, and was used heavily by Monkman, Romer and Mattinson in planning production.

5.3 Production

Physical production started in April 2012 and was originally scheduled to last 25 days. All shooting was conducted in GSP's studio in Bubwith using a mix of equipment, some of which was provided by TFTV with the remainder hired from specialist film equipment houses. Because our testing had been thorough and there had been extensive pre-production planning, Monkman and Mattinson agreed that there was no need for me to be on set every day once we ensured our processes were running smoothly. The live-action elements being filmed represented only a part of the overall look of the film and the bulk of my work would come during postproduction, when the computer-generated assets would be created, and the film assembled.

During production, I regularly reviewed footage to ensure the technical quality of what had been filmed each day, another of my compliance responsibilities, and kept in regular contact with the VFX team to address any issues that arose. I provided advice and proposed solutions for numerous issues including ways to reduce visual

[42] Animatics are computer-generated scenes that are related to storyboards except that they enable the testing of different camera moves, lens choices and editing styles by showing these in real-time

camera noise, correcting focus issues digitally, and methods to create better mattes. It is interesting to note that all of these required me to draw on image processing concepts I learned while in Electronics. Overall, the team functioned very well during production, and it was clear they understood what was needed. It was particularly gratifying to see how they were growing from recent graduates to knowledgeable professionals.

5.4 Postproduction

Principal photography was completed near the end of May 2012. The first VFX work involved creating the opening sequence[43], which was needed to demonstrate the visual style and 'tone' to stakeholders. This was done by August, but completion of other shots took substantially longer.

Making the most of the freedom allowed by working in an academic environment, Monkman's working style relied heavily on experimentation and seeing examples of different designs to then refine them. Here, although many stylistic cues had been decided before production, suggestions of new ideas were encouraged. This meant that in the first stage of postproduction, the VFX team spent significant time mocking up and revising different versions of shots and sequences where the design hadn't already been finalised; in several instances ideas were abandoned. While this iterative approach can ultimately yield great results because it allows for experimentation, from my perspective as the VFX Producer it was inefficient and I needed to adjust to this style of working, which was different to industry norms. Given the complexity of the project, charting progress on shots and scenes was essential so we developed a spreadsheet that tracked this – see Figure 13.

[43] From approximately 1:02 to 2:58 in the finished film

Scene Number	Shot Number	Pass	Time Required (L, M, H)	Week	Camera Type	Camera Move	Location	Maya Rough (mdl,tex,cam,light)	Proxies Made	Rough Comp	mov with alpha created (for LAPs)	100 Frame DPX KEY	Progress Notes	Shot Comments
1	001a			F	none	none	void						surroundings only	white line
2	002a			F	virtual	tilt up	Ext. Gypsy Field Hill						surroundings only	
2	002b			F	real	rotate around goddo	Ext. Gypsy Field Hill						surroundings only	cam static, turntable – into 003a (same as 138a)
3	003a	001aLAP3		F	mix	push in	Ext. Gypsy Field Track Side						complete for shots facing Paul, not others	real dolly in, virtual push to CU Paul
4	003a	001aLAP4		F	mix	push in	Ext. Gypsy Field Track Side						complete for shots facing Paul, not others	real dolly in, virtual push to CU Paul
118	118a			1	none	none	Ext. Cinema							rain effect
13	001a	001aLAP6	L	1	none	none	Ext. Street (CINEMA)						library of street assets started	
120	120a-b			F	none	none	Ext. Cinema							rain effect, motion blur
121	121a-d			1	none	none	Ext. Cinema					121d left		rain effect
122	122a			F	none	none	Ext. Cinema							
119	119a		L	1	none	none	Ext. Florist						very rough	rain effect
119	119b-e			1	none	none	Int. Florist						very rough	rain effect outside
67	067a			F	none	none	Ext. Crossfields Playground						3D done, cam extension done, need info on BG	truck wipes in front revealing Paul
67	067b-s			1	none	none	Ext. Crossfields Playground					067c d e h i g m s q done	3D done, 1st half of rough comps done - need to look at cam angles for rest	
11	067n			1	none	none	Ext. Crossfields Playground							as scene 071d, dog placed on Paul's face
71	071a-d		L	1	none	none	Ext. Crossfields Playground							071d as scene 11, was this shot?
84	071c			1	none	none	Ext. Crossfields Playground							from scene 71
17	017a			1	mix	pull out	Truck Cab						in good shape	Pull out, pan left in shot 18
17	017b			1	mix	pull out	Truck Cab						in good shape	Pull out, pan left in shot 18
17	017c		<L	1	mix	pull out	Truck Cab						in good shape	Pull out, pan left in shot 18
17	017d			1	mix	pull out	Truck Cab						in good shape	Pull out, pan left in shot 18
18	018a			1	mix	pan left, track	Ext. Paul's House						in good shape	From 17
91	156a		L	1	real	push in	Ext. Paul's House						assets pretty complete	???
156	156a			1			Ext. Paul's House						assets pretty complete	past police woman
69	069a-c			1	none	none	Ext. Shane's House						in progress	last part is partially in Shane's house hallway
70	70b-f			1	none	none	Int. Shane's House Hallway							
73	073a-f		L	1	none	none	Int. Shane's House Hallway							check orientation of hallway to ensure continuity
72	072a-g			1	none	none	Int. Shane's House Basement							need to add phone image in CU of phone (072f) - build mattress
107	107a-f			1	none	none	Int. Shane's House Basement							build mattress
108	108a-b			1	none	none	Ext./Int. Shane's Bedroom							Paul sees Shane burn himself (BASEMENT FROM OUTSIDE)
42	042a		L	1/2	virtual	tracking dolly back	Int. School Corridor						fully modelled	Paul on treadmill, track back
48	048b		M	1/2	real	push in	Int. School Corridor						fully modelled	past maddy
48	048c-j		L	1/2	none	none	Int. School Corridor						fully modelled	outside Mrs. Botham's Office, Boyle comes and gets Paul
82	082a		L/M	1/2	virtual	dolly back	Int. School Corridor						fully modelled	walking down corridor before getting mobbed by bates and miller
82	082b-c			1/2	none	none	Int. School Corridor						fully modelled	gets mobbed by bates and miller outside toilets
95	095a-e		<L	1/2	none	none	Int. School Corridor						fully modelled	maddy and paul chat in corridor w/lockers
45	045a			2	none	none	Int. School Toilets							virtual mirror
46	045a		L/M	2	none	none	Int. School Toilets							virtual mirror

Figure 13: Shot Status Spreadsheet

I met with Louden and Andy Jones, the 3D Lead, each day to review shots, give feedback and discuss solutions to problems. I helped to resolve many technical queries that were common to VFX projects but also helped solve some new issues posed by the postproduction workflow, one of which ultimately led to advancing industry knowledge.

TKTKM was designed to be delivered in the (then) emerging format of Digital Cinema Package (DCP), which has become the standard for digital distribution of commercial feature films[44]. DCP uses the colour space[45] XYZ, which differs to those used by VFX software packages such as Nuke. This means that composite shots created in Nuke would look incorrect without mathematical translation. At that time no function existed in Nuke to do this directly but, after some experimentation, I was able to create a code script that could perform this function – Figure 14 provides a breakdown of the process used. The approach was verified by The Foundry and added as a new function to Nuke in later versions.

[44] Donnelly (2022) provides a useful DCP primer
[45] 'Colour space' in this context refers to a model of representing colours in numeric form

Converting Nuke Output to XYZ Color Space for DCP
----

1) Read in Source footage ensuring that colorspace is same as the footage was encoded with (Nuke will usually sense this and note it as 'default')

2) Manipulate footage as required

3) Prior to output use two Colorspace conversion nodes:

First, conversion to P3
in: Linear / D65 / sRGB
out: Linear / D65 / DCI-P3

Second, conversion to XYZ
in: Linear / D65 / DCI-P3
out: CIE-XYZ / D65 / DCI-P3

4) Write out to DPX with the following settings:

colorspace: default (sRGB)
file type dpx
datatype: 12 bit, big endian
transfer: (auto detect)

The rendered DPX sequence should now be in the correct color space for conversion to DCP using CineAsset using the following settings:

codec: JP2K for DCinema
Max bitrate: 250Mbs
MXF packaging format: Interop

DO NOT convert to XYZ' in CineAsset

Figure 14: Colour Space Conversion Process developed for *TKTKM*

By March 2013, appreciable progress had been made and the majority of shots had been finalised, but we determined that one pick-up day was needed to shoot additional passes for the final sequence. Once these were obtained, there was a push to get the film finished for the Cannes Film Market. Time was tight so I undertook some of the rotoscoping and matte work myself, mainly for elements needed for the fight[46] and stabbing[47] sequences, which Louden then used in the final composites. My most important contribution was quality control,

[46] At approximately 1:29:00 to 1:30:13 in the finished film
[47] At approximately 1:32:25 to 1:32:52

which included reviewing the entire film frame-by-frame to check for technical errors.

The film was finished by the beginning of April and delivered to Universal for review. It was conditionally approved so the final sound design and mix were then completed, with all deliverables[48] being created. The film was formally accepted for distribution in July 2013.

5.5 Reception of the Film and Reflections

The film received mixed reviews from the press, ranging from "Easily one of the best films of the year" in the Huffington Post (Crow 2014) to an "Ambitious but flawed teen drama" in the List (Northmore 2014)[49]. But even the most critical article acknowledged the effectiveness of the unique visual design. This would seem to not only validate Monkman's inclusive collaborative working style but also the model of using recent graduates for the VFX team, both of which would not have been possible without a Triple Helix relationship structure. I argue that it is remarkable that a VFX team of eight could complete a film this complex in under two years. To put the significance of this in perspective, according to IMDB (n.d.) *Sin City* (2005) had over 300 credited members of its VFX team and took a year to produce. This isn't to claim that the technical quality of *TKTKM* is directly on par with *Sin City*, but I argue it is far closer than its budget – approximately $1.8M[50] compared to $40M for *Sin City* – would ever suggest. It is unfortunate that Universal Pictures UK did not embrace the film and put little effort into marketing it. This has been the most disappointing aspect of the project[51].

[48] Distribution companies require many different versions of a film so it can be exhibited through different outlets (e.g., cinemas, TV, airplanes, etc.) and in different countries (i.e., with provision for different language tracks or subtitles). Together, these constitute the 'deliverables.'
[49] Appendix 4 has a significant sample of reviews
[50] The budget of TKTKM was approximately £1.2M. The film industry uses the US dollar as base currency for ease of comparison
[51] The film is available on Amazon Prime Video for streaming and DVDs are still available for purchase

5.6 ***TKTKM* and the Triple Helix**

Considering the project as a whole, it is evident that *TKTKM* could not have been made without an academic partner as this enabled a high level of experimentation both in the design of the film and in the processes involved in its creation. And despite the film not gaining the visibility (or profitability) that all stakeholders had hoped[52], there has been significant benefit and impact generated through the Triple Helix collaboration:

- From the academic institutional perspective, the film served as a formal research testbed that resulted in REF-eligible outputs as well as a vehicle to gain insight into new marketing and distribution strategies through a Knowledge Transfer Partnership (not to mention providing research-related income to the university). Students were involved in various parts of the project, enhancing their skills and employability, and the value to the graduates involved has been particularly extensive, launching their careers with the core group ultimately forming the successful VFX company Viridian FX (n.d.) and others joining major VFX houses in the UK and China. The collaboration also provided an example of how full-time academics in the creative sector can engage with industry at a meaningful level to the benefit of both institutional spheres, demonstrating the viability of “entrepreneurial university” activities in this domain.

- From the industry institutional perspective, the collaboration facilitated the creation of a commercial product that was lauded for its inventiveness, which in turn enabled funding to be secured for new projects[53]. It led to a spin-out company, Viridian FX, which enhanced GSP’s market presence, and also helped to establish Monkman as a feature film director in the eyes of the industry, further enhancing his career.

[52] As reported in Publication 12

[53] This included the 2018 version of *Macbeth*, which features a more refined visual design developed from the workflows created for *TKTKM*. I was formally involved as its Visual Effects Producer

- From the government institutional perspective, the project fulfilled ERDF requirements for ‘assists’ as well as added value to the local economy by creating jobs as part of the films production and the eventual formation of a new company in Viridian FX, bolstering film and television industry provision in the Northeast UK.

From my own perspective, both as a professional practitioner and as an academic, the film has allowed me to learn new methods of working and develop cutting-edge techniques through collaboration with the team. It demonstrated how traditional research, including image processing and testing methods I learned working with John Robinson, can be successfully applied in a commercial setting, and also be used to create truly innovative work.

6. Conclusions

In this integrative chapter I have sought to demonstrate how, in retrospect, my research has involved areas of inquiry, collaborative relationships, working methods and other facets directly related to the Triple Helix model.

When I first entered the academy, the relevance of Triple Helix-like institutional interdisciplinarity to the creative sector was seen as limited. However, over the period since, the creative industries have emerged as a central driver of the UK economy[54]. Government policy has shifted from a reliance on market-driven economics that discounted the importance of the sector[55], to providing directly targeted support to develop it[56]. Relatedly, UK universities have been increasingly called upon by the government to help develop the workforce both generally[57] and specifically within the creative industries, as typified by the creation of Creative Skillset (now called ScreenSkills)[58]. This has created a growing imperative on academic institutions to alter their priorities and change practices to become more entrepreneurial, thus significantly changing their role in keeping with Etzkowitz and Zhou's discussion (2018 pp 55-78).

In light of this and points made in previous sections, I suggest that this PhD by Publication is novel and contributes new knowledge in two main ways:

1. The chapter illustrates that the body of work itself represents a case study of one academic's journey in developing a research portfolio in the age of the Triple Helix. From this contextualisation it is now apparent that choices I made with regard to the topics explored, the modes of inquiry, the application of findings and the creation of artefacts have all been

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[54] As noted in Waitzman (2021), "the GVA of creative industries had increased (...) by 43.6% between 2010 and 2019 (...) faster than the UK economy. (...) The (second) biggest contributor to growth in the sector was 'film, television, video, radio and photography'"

[55] Most notably in the 1980s. The House of Lords' Communications Committee - First Report (2010) provides a useful summary of the history of UK government support of the film industry

[56] This is epitomised by the introduction of corporate tax incentives in 2007. A breakdown of current tax incentives for media production can be found in Film London (n.d.)

[57] The Universities UK and the UK Commission for Employment and Skills report (2014) is a prime example

[58] ScreenSkills (n.d.) describes this remit in detail

influenced and shaped by the evolution of the increasingly close interrelationship between the three institutional spheres that the model describes. As such it gives a unique individual account of the impact of the model on shaping academic activity. While there are some instances of Triple Helix-related case studies in the creative sector, such as Etzkowitz and Zhou (2018 pp 275-297), Colapinto and Porelezza (2012), Comunian, Taylor and Smith (2014), and Van Bueren and Goh (2016), none of these considers the specific experience of a key participant within them. I also suggest that the corpus represents a unique and highly consistent example of the applicability of the Triple Helix to the film and television industry domain, providing additional novel evidence of the model's applicability beyond STEM.

2. Analysing each of my publications individually in light of the Triple Helix, and demonstrating their relevance to it, has revealed a level of inquiry that differs from prior work, providing more rounded exploration in several instances as a result. Likewise, considering the way in which my works builds upon aspects of my prior ones, this has developed a unique viewpoint of the different topics covered that has not been widely articulated.

   For example, media education is a widely studied topic that typically considers the academic institutional sphere in a traditional light, particularly with regard to pedagogy and the student experience. Works such as Petrie and Stoneman's (2014) and Banks' (2019) explorations of film schools, teaching-focused inquiries such as Bachmann and Zahn (2018) and Aidelman and Colell (2018), and Morley's et al (2021) investigation of work experience as a driver in screen production education, all frame their discussions through a conventional interpretation of the role and function of the university. Because several of my inquiries have been driven by a need to develop a new academic department oriented towards and informed by the needs of industry, they have intrinsically considered the "entrepreneurial university" model from the outset, which is markedly distinct[59].

Similarly, unlike considerations of the theory/practice divide from Bell (2004, 2006), those in Myers (2011) or more recent explorations such as Sanders et al (2018), Morris (2019) and Crespin-Mazet and Ingemansson-Havenvid (2021), I have considered the involvement of practitioners in the academy predominantly in terms of the innovation they can bring to it because of their industry experience, which I argue can further support an entrepreneurial vision[60].

Finally, while there are many examples of film, television and video projects being undertaken as creative practice research, as described in the various discussions of screen production in Batty and Kerrigan (2018) and others, this is rarely from an explicitly industry perspective as mine is[61] and does not consider value or benefit outside of the academy.

6.1 Building on the Triple Helix – A New Continuum of Impact

Based on my experience with the Triple Helix throughout my research, I suggest there is a continuum between academic and industrial activities that is distinct from the technology transfer models Etzkowitz and Zhou describe (2018 p 64).

The terms 'impact', 'benefit' and 'value', while slightly different in meaning across different institutional spheres, can generally be considered synonymously within the Triple Helix model and suggest levels of fulfilment of an institutional or corporate objective. From an academic perspective, the shift of emphasis to success measures based on 'impact' would arguably be seen as a deviation from the Frascati (OECD 2015) definition of research. However, as the Helix model continues to evolve[62], I argue it would be beneficial to reconsider what 'research' really means. In my continuum model, each of the categories can generate impact – see Figure 15.

[59] As detailed in Publications 11 and 12 in section 4.3

[60] An important aspect of Publication 10.

[61] *The Knife That Killed Me* is the explicit example in this integrative chapter but I feel similarly about my other work including *Macbeth* (2018)

[62] There are now several variants of the Triple Helix model that retain the same core idea but have different numbers of strands to consider different types of relationships. The Triple Helix is still seen as the main model

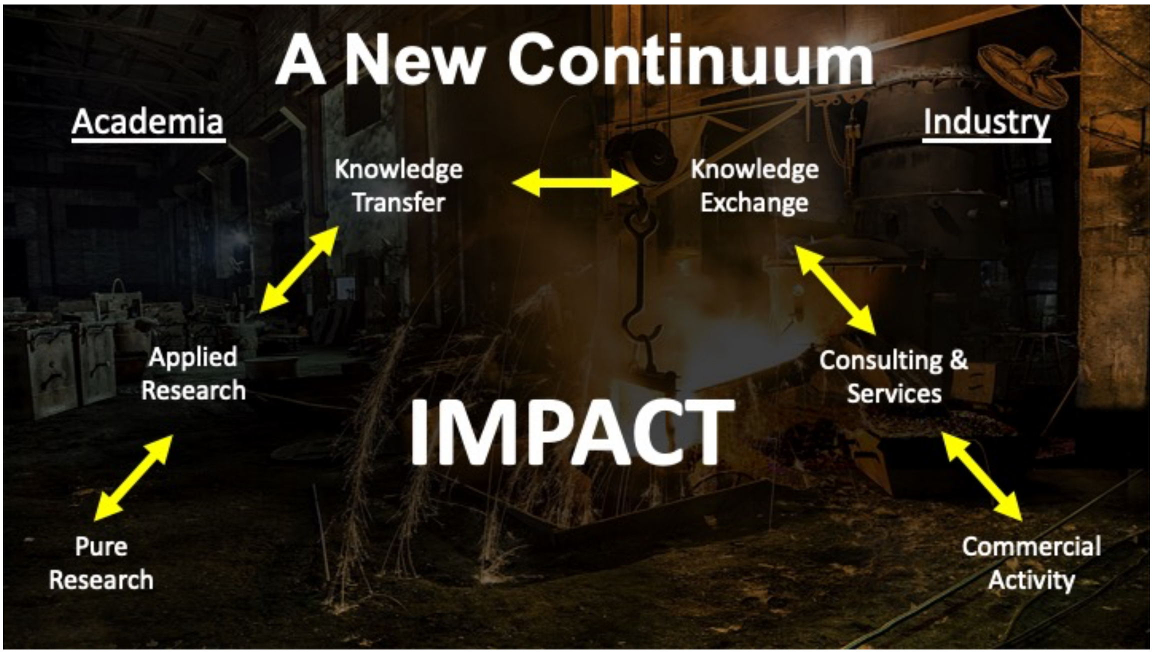

Figure 15: Proposed Academia-Industry Continuum

I also argue that practice activities can take place in any of these categories, although at the extreme ends of the continuum the direct benefit is usually limited to one institutional sphere.

I suggest that just as research evolves and expands knowledge, so should our view of what constitutes research-relevant activity. Given the evidence of the Triple Helix's existence, this would be consistent with Etkzowitz's assertion that the model "denotes a transformation in the relationship among university, industry and government (where institutional spheres) 'increasingly take the role of the other'" (2003 p 295). If the nature of the academy is changing based on the increasingly close relationships with industry and government, surely so should the view of what academic activities include and how they are defined.

6.2 Areas for Future Exploration

As my work describes, there can be synergistic collaborations between industry and academia but there needs to be clear communication between stakeholders, as well as an understanding of differences in organisational cultures, for Triple Helix collaborations to be successful. There are fundamental differences in the way the academy, industry and government are structured, particularly with regard to working practices and worker expectations within them.

Traditionally, academics advance in their careers based on individual accomplishments that are seen institutionally as evidence of effective performance within specific areas. Many academics undertake teaching and research activities in relative isolation, either by themselves or in small groups, specific to their domain of expertise. By contrast, members of industrial organisations typically work together to fulfil common corporate objectives irrespective of their individual role or discipline. Teamwork across a company as a whole is valued with accomplishment measured by contributions to fulfilling direct corporate needs more broadly (e.g., sales, profit, etc.) Government is comprised of several different types of staff – some permanent, some not – with success measures mainly based on political and policy objectives that may or may not be consistent with the other spheres. The nature of politics is such that metrics of success can vary widely depending on the type of objective being fulfilled, and also can involve external factors that are less common to the other two.

On a direct level these differences mean that participants in Triple Helix collaborations can have significantly different expectations, which can affect their performance within the collaboration. More broadly, working practices, reporting protocols and management structures – particularly time scale expectations – can also vary significantly between the spheres, which can compromise the ability of the collaboration to succeed.

An important area of future work (as it relates to mine) would be to analyse these working practices and expectations within the creative sector across the three institutional spheres to enable better understanding across them that would facilitate stronger and more effective Triple Helix collaborations.

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Appendix 1 –

Letters from co-authors papers confirming my involvement

THE UNIVERSITY *of York*

Professor John A Robinson PhD, PEng, CEng

Department of Electronic Engineering
Heslington, York YO10 5DD
Direct line +44 (0)1904 322353
Email : john.robinson@york.ac.uk

18 December 2020

John W Mateer

Statement regarding publications submitted towards a PhD by publication

I write this letter at the request of John Mateer, my collaborator and co-author on research publications as follows:

Journal Articles

1. Mateer, J.W. and Robinson, J.A. A Vision-Based Postproduction Tool for Footage Logging, Analysis and Annotation, Journal of Graphical Models, 2005, Vol 67, No 6, 565–583.

2. Dony, R.D., Mateer, J.W. and Robinson, J.A. Techniques for Automated Reverse Storyboarding, IEE Journal of Vision, Image & Signal Processing, 2005, Vol 152, No 4, 425–436.

Fully Refereed Conference Proceedings

3. Day, M.G., Mateer, J.W., Robinson, J.A., Automated Description of Shot Compositional Characteristics. Proceedings of the 2nd IEE European Conference on Visual Media Production (CVMP), London: IEE, 172-180, 2005.

4. Dony, R.D., Mateer, J.W., Robinson, J.A., Day, M.G., Iconic versus Naturalistic Motion Cues in Automated Reverse Storyboarding. Proceedings of the 2nd IEE European Conference on Visual Media Production (CVMP), London: IEE, 17-24, 2005.

5. Dony, R.D., Mateer, J.W., Robinson, J.A., Automated Reverse Storyboarding. Proceedings of the 1st IEE European Conference on Visual Media Production, London: IEE, 193-202, 2004.

6. Mateer, J.W. and Robinson, J.A., Robust Automated Footage Analysis for Professional Media Applications. Proceedings of Visual Information Engineering, Guildford: IEE, 85-88, 2003.

7. Mateer, J.W. and Robinson, J.A., Semi-Automated Logging for Professional Media Applications. Proceedings of Video, Vision and Graphics, Bath: IMA, 25-31, 2003.

The work of which the above contributions were a part also informed John's sole-authored conference paper,

8. Mateer, J.W., Developing Effective Test Sets and Metrics for Evaluating Automated Media Analysis Systems. Proceedings of IEEE International Conference on Multimedia & Expo, Baltimore: IEEE, volume 2, 201-204, 2003

Co-authors with John and me on the above papers were Matthew (Matt) Day, at that time my PhD student, and Robert (Bob) Dony, a professor of the University of Guelph, who spent a sabbatical year in my lab at York.

All the work was done in the Department of Electronics at the University of York. Initially John and I were two of three members of a new group establishing Media Engineering in the Department, which I led. This group subsequently merged with a longer-standing Music Technology research group, and the leader of the combined group was Professor David Howard.

The publications break down into two projects. Papers 1, 6, 7 and 8 result from initial Mateer-Robinson collaboration on the semi-automated parsing of video, while papers 2, 3, 4 and 5 are about our subsequent collaboration with Bob Dony and Matt Day on automated reverse storyboarding. The figures at the end of paper 2 give perhaps the best visual summary of the results of both projects.

John and I brought complementary backgrounds and skills to these projects. John was recruited to the Department specifically for his experience and expertise in film and television production. He combined a strong understanding of the theory and craft of film-making with knowledge of the practicalities of working in mass-market TV (for example, in game show development), and, in particular, a clear view of what industry users --- such as directors, editors, and others involved in production --- would expect from multimedia tools. I was a professor having previously worked in the communications industry and been both a regular faculty member and an Industrial Research Chair in Canadian universities. My research contributions have been in image and video analysis and so the perspective I brought to the collaboration was an engineering one. Specifically I developed, implemented and tested the software that would parse footage into units of meaning (such as shots and camera moves) that John identified and specified.

A reasonable summary of our respective contributions to the publications would be that John wrote the material dealing with film language, the needs and expectations of production, and the user interface and interaction expectations of industry users, and I (and later Matt Day and Bob Dony) wrote sections dealing with the scientific and technical design of the automated tools. We would all comment on all parts of the text and of course the final papers were agreed by all authors.

Our collaboration was an excellent and unusual interdisciplinary fit. None of the work would have been undertaken without John's identification of the needs and opportunities in the industry. The features of our automated tools were developed equally. John provided the demand-pull perspective, and I drew on the techniques I had developed and used in other contexts to supply new ways of visualising and summarising footage. John provided test sequences that challenged the algorithms and ensured our system was robust. When we were joined by Matt and Bob, we enjoyed a very rich collaboration, to the extent that all four of us made design contributions, and I could not now identify which ideas in representing motion cues originated with which of us. However in all these discussions, John was the person who anchored ideas back in the tradition of storyboarding and the practical world of filmmaking.

In the mid-2000s John and I discussed going further with the tools we had invented. We had successful demonstrations and the publications showed that our work was judged worthwhile. I recall a discussion with a member of the Enterprise and Innovation Office at York where I demonstrated three working prototypes of different aspects of research and we agreed that a different area was one to concentrate on. This decision was influenced by John's move to TFTV and my imminent appointment as HoD in Electronics. I have sometimes wondered whether it would have been better to push harder and further for productization and marketing of the work with John, because it still offer benefits to film production and there remain technical challenges that a further fifteen years of development in computer vision and image analysis could address. However, we did not take the work further, and at least this provided the time and opportunity for John to contribute in still other unusual and interdisciplinary directions.

I would be happy to provide any further information or comment that may be useful to the examiners and the SCA.

Sincerely,

John Robinson

John Robinson

KEITH KEHOE
7b Florence Road, London, N4 4BU
kehoeke2@gmail.com

John W Mateer
Statement regarding publications submitted towards a PhD by publication

I am writing this letter at the request of John Mateer, my collaborator and co-author on the following publications:

Journal Articles

1. Kehoe, K and Mateer, J.W. The Impact of Digital Technology on the Distribution Business Models of Independent Film in the UK, International Journal on Media Management, 2015, Vol 17, No 2, 93-108

2. Kehoe, K and Mateer, J.W., Enhancing the Competitiveness of an Independent Feature Film Production Company through the Application of New Digital Technologies, InImpact: The Journal of Innovation Impact, 2014, Vol 7, No 1, 244-256

These works were created as part of the Knowledge Transfer Partnership KTP008947 between Green Screen Productions Ltd. and The University of York, which was funded by the Technology Strategy Board (now known as Innovate UK) and the Arts and Humanities Research Council (AHRC). I was the KTP Associate on the project and John Mateer was the Knowledge Base Supervisor and Lead Academic/Researcher.

The objective of this project was to use existing expertise at the University of York to develop capacity within the company partner (Green Screen Productions) to enable them to apply new digital systems and workflows to enhance the production and distribution of independent commercial feature films, with the emphasis ultimately on new forms of marketing and distribution strategies. My role was effectively to serve as a conduit between the University and the company partner to identify and translate research in ways that could benefit their commercial objectives. Part of this included identifying, proposing and developing academic research outputs under John's supervision and guidance.

Article 1 above I proposed to John in November 2013 and we subsequently developed a structure for the paper together. I developed numerous drafts, which John then edited and further refined, but I had the majority of input for the initial version, which was submitted in July 2014. This version was rejected but we were provided with helpful feedback and asked to resubmit. A key criticism was that the presentation of the work was too journalistic and insufficiently academic in tone. As a result, while I conducted some additional work to feed into a revised version, John took the lead to reorganise and recontextualise the research to address the concerns raised. A resubmission was made in March 2015 and was successful. Overall, across the two versions our contributions were about equal.

Article 2 above originated based on the recommendation of the University's Knowledge Transfer Manager, Rukmal Abeysekera, in February 2014 when she received an announcement for InnovationKT, the International Conference on Innovation through Knowledge Transfer. John and I jointly developed the paper, which was submitted in April 2014. The work was not only judged to be appropriate for conference acceptance but was also seen as significant and was included in both the conference proceedings (in the journal noted above) and in the book "Innovation through Knowledge Transfer" published in the KES Transactions series. As with article 1, the contributions of John and myself were about equal.

If you need any further information about these publications, please feel free to contact me.

Sincerely,

Keith Kehoe

Professor Chrisina Jayne
Dean
School of Computing, Engineering & Digital Technologies
Teesside University Middlesbrough
Tees Valley TS1 3BX UK
T: +44 (0)1642 342631
tees.ac.uk

Teesside University

John W Mateer

Statement regarding publications submitted towards a PhD by publication

I am writing this letter at the request of John Mateer to describe my involvement and contribution to the following publication:

Journal Article

1. Mateer, J.W. and Haillay, S. Digital disruption and its implications in generating 'impact' through film and television Practice-as-Research, Media Practice and Education, 2019, Vol 20, No 2, 166-178

In early 2018, John contacted me about a talk he was developing for the Media Education and Practice and Media, Communication and Cultural Studies Association (MeCCSA) Practice Symposium, hosted by the University of Lincoln on 15 June 2018. He asked to interview me to learn more about my experiences as an independent feature film producer, particularly with regard to novel ways I have developed to market and distribute my films. He found them very useful to such a degree that he asked me to present part of the symposium talk to convey my experiences directly. The talk was well received, and John was asked to submit a journal article (listed above) based on the success of it. Given we had done the symposium presentation together, he asked me to be a co-author of the paper.

For the article John undertook the majority of the work, including the development, research and writing of most sections. For my part, in addition to providing information about projects I was aware of and giving feedback on drafts, my main contribution was developing the section about 'The Myth of Self-distribution', which I drafted and John edited.

If you need any further information about these publications, please feel free to contact me.

Sincerely,

Samm Haillay,
Senior Lecturer
Course Leader MA Producing for Film and TV
Department of Transmedia, Digital Art & Animation

Appendix 2 –

Copy of contract for *The Knife That Killed Me*

DATED 28 MARCH 2012

THE KNIFE THAT KILLED ME LIMITED

AND

JOHN MATEER

VFX Producer's Agreement

"THE KNIFE THAT KILLED ME"

<u>THIS AGREEMENT</u> is made the 28 day of MARCH 2012

<u>BETWEEN</u>

1. **THE KNIFE THAT KILLED ME LIMITED** of Laurel House, West Lilling, York YO60 6PR (**TKTKM**)

2. **JOHN MATEER** (**"the VFX Producer"**) of Hollyberries, 1b The Orchards, Westow, York, YO60 7NF

RECITALS

A) TKTKM is entitled to the non-exclusive services of the VFX Producer (as hereinafter defined) for a period not in excess of the term of this Agreement and the entire copyright and all other rights in and to the products of the VFX Producer's services throughout the universe together with the right to make such services available to others as required to ensure the completion and distribution of the Film.

B) TKTKM wishes to engage the services of the VFX Producer as an individual VFX Producer of the Film and the VFX Producer has agreed to be engaged on the terms set out below.

<u>IT IS AGREED</u> as follows:-

1. DEFINITIONS

In this Agreement:-

"the Act"	means the Copyright, Designs and Patents Act 1988 as amended.
"the Completion Guarantor"	means Entertainment Guarantors.
"TKTKM"	shall include its successors in title licensees and assigns.
"the Engagement Period"	means the period from the date hereof until the completion of the first exhibition positive print of the final cut version of the Film in all respects in accordance with this Agreement and delivery of the Film to its principal distributors.
"the Film"	means the feature length film with a running time between 90 and 110 minutes and an intended certificate not more restrictive than "R" which TKTKM intends but does not undertake to make provisionally entitled "THE KNIFE THAT KILLED ME"
"the VFX Producer"	means JOHN MATEER.

2. ENGAGEMENT

TKTKM hereby engages the VFX Producer to provide services to TKTKM upon the terms of this Agreement as an individual VFX Producer of the Film.

3. NON-EXCLUSIVITY

TKTKM shall be entitled to the non-exclusive services of the VFX Producer from the date hereof and in particular from the commencement of principal photography of the Film, which is intended to be 20 February 2012 ("the Date of Principal Photography"), until delivery of the Film to the principal distributors.

TKTKM acknowledges and accepts that, owing to other commitments, the VFX Producer can only guarantee 10 hours of work per week on the Film but that the VFX Producer will use his best endeavours to commit as much additional time as required whenever circumstances allow it.

4. VFX PRODUCER'S SERVICES

The VFX Producer undertakes, to the best of the VFX Producer's creative skill and technical ability, as may be requested in writing by TKTKM to:-

(1) Do all things that may reasonably be required to ensure that the photography and recording of the Film shall be of the highest quality and made in an efficient and economic manner in accordance with the delivery requirements of the principal distributors.

(2) Comply with all rules and regulations made or approved from time to time in connection with the production of the Film and all rules and regulations in force at the studios in which it is made and use the VFX Producer's best endeavours to ensure that such rules and regulations are complied with by other personnel engaged in the making of the Film.

(3) View the rushes and assembled sequences and the rough and final cut versions of the Film.

(4) Do all things that may from time to time be required in order to make due and proper delivery of the Film to the principal distributors in a first class condition so that the Film as delivered conforms to the approved screenplay and is of the duration and will qualify for the certificate set out in Clause 1.

(5) If and when required by TKTKM deliver to TKTKM all manuscripts documents and papers in the possession or under the control of the VFX Producer relating to the Film.

(6) At all times until the completion of all the VFX Producer's services hereunder diligently and conscientiously carry out and implement the instructions of TKTKM and the Completion Guarantor regarding the production of the Film and render all those services usually rendered by a first class individual VFX Producer of feature length films.

(7) Render promotional and publicity services where and when required by TKTKM (both during and after production of the Film) subject to the VFX Producer's prior professional commitments notified to TKTKM **PROVIDED** that in any event the VFX Producer shall use his best endeavours to ensure that he will be available around the time of the release

of the Film in connection with the publicity of the Film. The remuneration set out in Clause 6 shall be deemed to include payment for such services.

5. VFX PRODUCER'S UNDERTAKINGS

The VFX Producer warrants and undertakes with TKTKM that:-

(1) Such contributions as the VFX Producer shall make to the treatments scripts and story material hereinbefore mentioned and the production of the Film insofar as the VFX Producer is responsible therefore, and to the best of his knowledge and belief, shall be original in the VFX Producer and shall not infringe upon the copyright, right of privacy or any other right of any third party or be defamatory.

(2) The VFX Producer will comply with and perform all undertakings and agreements entered into herein by the VFX Producer relating to his services and the VFX Producer is absolutely the sole owner, free from encumbrances, of the existing and future copyright and all other like rights throughout the world in all the products of such services for the full term of copyright and all renewals and extensions thereof and is entitled to lend, assign, license or otherwise deal with all such services copyright and other rights and in particular in every way in accordance with the terms of this Agreement. The VFX Producer further warrants and undertakes with TKTKM that he has not previously assigned or granted or in any way encumbered such copyright so as to derogate from the rights granted hereunder and that it shall not hereafter do so.

(3) The VFX Producer will not without the prior written consent of TKTKM now or at any time hereafter directly or indirectly authorise or provide any statement or disclosure or supply any information or photographs to any person (except the VFX Producer's professional advisors where such information is necessary for such advisors promptly to perform their obligations to the VFX Producer) or to the public relating to the Film or to any matter arising hereunder or to the general affairs of TKTKM coming within his knowledge by reason of the rendering of the VFX Producer's services hereunder or to the VFX Producer's services to be rendered hereunder. The foregoing shall not be deemed to prohibit the VFX Producer from issuing personal publicity concerning the VFX Producer which incidentally mentions the Film provided that the same is of a non-confidential nature and does not mention the Film or any personnel engaged in connection therewith or TKTKM in an unfavourable or derogatory manner nor from discussing any of such matters with their professional advisors

(4) The VFX Producer is a "qualifying person" within the meaning of the Act and for the purposes of United States copyright law the products shall be considered a work made for hire

(5) The VFX Producer will not at any time hereafter knowingly do, or omit to do, or authorise anything in relation to the Film, whereby any right of copyright or other protection afforded to the Film in any part of the universe would be lost, destroyed, or otherwise impaired, or be incapable of being obtained

(6) The VFX Producer shall apply for and assist TKTKM in applying for and do all things as may reasonably be required by TKTKM in order to secure any work permits, visas, passports, licences, permissions, consents or other matters necessary to carry out the VFX

Producer's services in any country or country of the world in which the Film may be produced

(7) The VFX Producer will indemnify TKTKM against any and all direct and indirect losses costs expenses and damages suffered or incurred by TKTKM or any compensation paid by TKTKM in connection with or arising out of any proven breach by the VFX Producer of any of his obligations agreements warranties and representations contained in this Agreement. This indemnity shall survive the completion of the VFX Producer's services hereunder. On its part TKTKM agrees to indemnify the VFX Producer in respect of any claims made against the VFX Producer arising out of the production, distribution or other exploitation of the Film itself and the material contained therein and forming part thereof.

6. REMUNERATION

(1) Subject to the provisions of this Agreement relating to suspension and termination and to the due compliance by the VFX Producer with the obligations undertaken by the VFX Producer hereunder TKTKM shall as inclusive remuneration and as full consideration for all services rendered up to the date of such payment and for all rights granted to TKTKM hereunder pay to the VFX Producer the sum of £[redacted] ("the Fee") payable in accordance with the agreed cash flow but in any event not later than the First Day of Principal Photography.

(2) Sums payable to the VFX Producer are exclusive of value added tax, which TKTKM agrees to remit to the VFX Producer on the presentation of valid VAT invoices.

(3) The VFX Producer agrees that all the consideration payable to him in accordance with the provisions of this Agreement take into account and includes a payment in respect of all rights of communication to the public by satellite, cable retransmission rights and any and all rental and lending rights and that (to the extent permitted by law) the said payment constitutes full equitable and adequate consideration for the assignment of satellite, cable and rental and lending rights, and constitutes and satisfies in full any and all rights which the VFX Producer has or may, at any time have, to receive equitable, adequate or other remuneration for the exploitation by satellite and cable and the rental or lending of the products of the VFX Producer's services and/or the Film and/or copies thereof and/or any part or version of adaptation of any of the foregoing **PROVIDED** that nothing in this Agreement shall prevent the VFX Producer from being entitled to receive monies due to him from bona fide collection societies in any jurisdiction

7. EXPENSES

TKTKM shall reimburse the VFX Producer any expenses, agreed in writing in advance, incurred by the VFX Producer properly wholly and necessarily in connection with the Film against presented vouchers..

8. CREDIT

(1) Subject to the VFX Producer duly rendering the material services required of the VFX Producer and to the compliance by the VFX Producer with all material undertakings warranties and agreements hereunder and to the provisions of sub-clauses (2) and (3) of this Clause TKTKM shall accord the VFX Producer on the negative and all positive

copies of the Film made by or to the order of TKTKM credit as the VFX Producer thereof (on a favoured nations basis with the other Producers) to be upon a separate panel with the other Producers (any such credit to be subject to the standard and usual exceptions as are in writer's contracts in the industry) and shall also accord the VFX Producer like credit in the billing block and major paid publicity and advertising.

(2) The provisions of this Clause 8 shall not apply to exploitation or advertising falling within the following categories:-

(a) group list or teaser advertising publicity or exploitation

(b) special advertising publicity or exploitation of the Film relating to any member or members of the cast the author director or other personnel concerned in its production or similar matters

(c) any exploitation publication or fictionalisation of the story screenplay or other literary or musical material upon which the Film is based or of by products of any kind (including but not limited to sheet music and records videograms) or commercial tie-ups

(d) trailer or other advertising on the screen or radio or television

(e) institutional or other advertising or publicity not relating primarily to the Film

(f) so-called "Award Ads" (including consideration nominations or congratulations for an award) relating to any other person involved with the Film

(g) advertising of eight column inches in size or less

(h) commercial tie-ups designed to promote a product or thing other than the Film itself

(i) billboards

(j) advertising for film festivals, film markets (unless the principal distributors shall agree otherwise or unless the other VFX Producer of the Film is accorded credit in this excluded category)

(k) any customary exclusion required by the principal distributors

(3) The inadvertent failure by TKTKM to comply with the provisions of this Clause and the failure of persons other than TKTKM to comply with their contracts with TKTKM shall not constitute a material or fundamental breach of this Agreement by TKTKM. However within fourteen (14) days of receiving written notice from the VFX Producer with particulars of such failure TKTKM shall take all practical steps on a prospective basis (but without incurring any legal costs or other financial liability whatsoever) to endeavour to procure the observance by the distributors of the Film of the undertaking respecting the giving of credit. The rights and remedies of the VFX Producer in the event of a breach of this Clause by TKTKM shall be limited to the VFX Producer's right (if any) to recover damages in an action at law and in no event shall the VFX Producer be

entitled by reason of any such breach to enjoin or restrain the distribution or exhibition of the Film.

9. VFX PRODUCER'S CONSENTS

(1) The VFX Producer hereby irrevocably and unconditionally grants to TKTKM all consents, which it may require under the Act or any modification or re-enactment thereof to make the fullest use and widest possible exploitation of the products of the VFX Producer's services in perpetuity.

(2) The VFX Producer gives every consent and undertakes that the VFX Producer will not at any time hereafter object to TKTKM using and authorising others to use the VFX Producer's name, photographs and other reproductions of the VFX Producer's physical likeness and recordings of the VFX Producer's voice and the VFX Producer's autograph and biography either in whole or in part in connection with the advertisement publicity and exhibition of the Film and the commercial exploitation thereof.

10. PRODUCT OF SERVICES

(1) The VFX Producer with full title guarantee hereby irrevocably assigns unto TKTKM (and insofar as necessary by way of present assignment of future copyright) the entire copyright and all other rights of whatsoever kind or nature (including without limitation all ancillary and subsidiary, serial, remake and merchandising rights) in and to the products of the VFX Producer's services hereunder and all of the VFX Producer's rights in the Film (including but not by way of limitation the right to add to take from alter adapt and change the same and the Film in any manner TKTKM shall think fit to translate the same into any and all languages and to combine the same with any literary dramatic or musical work) TO HOLD the same unto TKTKM absolutely throughout the world for the full period of copyright and all possible renewals revivals and extensions thereof and thereafter (so far as may be or become possible) in perpetuity free from any so-called "moral rights" of authors or other similar rights whatsoever.

(2) The VFX Producer hereby irrevocably and unconditionally waives (without prejudice to the VFX Producer's rights under Clause 8) in perpetuity in respect of the Film and the products of the VFX Producer's services hereunder the benefits of any provision of law known as moral rights, whether arising under the Act or otherwise, and the benefits of any provision of law known as "droit moral", or any similar law in any country of the universe.

(3) Without prejudice to the generality of the assignment of rights in Clause 10(1) hereof, the VFX Producer hereby confirms and agrees that the assignment of rights hereby made to TKTKM includes any and all rights of communication to the public including but not limited by satellite, cable retransmission rights and any and all rental and lending rights, whether now or hereafter known or existing in any country of the world, and irrevocably and unconditionally grants to TKTKM any consents which may be required under Part II of the Act to enable TKTKM to make fullest use of the products of the VFX Producer's services hereunder and/or the Film and/or copies thereof any/or any part or version or adaptation of any of the foregoing.

11. COMPANY NOT LIABLE

(1) TKTKM shall not be liable to the VFX Producer in respect of:-

(a) any loss or damage to any clothing or other property owned by or in the possession of the VFX Producer howsoever such loss or damage may be caused except to the extent that TKTKM recovers compensation therefor from any insurance company or third party;

(b) the death disability or injury of the VFX Producer caused in any way during the VFX Producer's engagement hereunder (insofar as TKTKM is entitled to exclude such liability by law) except to the extent that TKTKM recovers compensation therefore from any insurance company or third party;

(c) any delay or failure to make the Film or if the Film is made any failure to distribute it or otherwise exploit it.

(2) TKTKM shall not be bound to waive any breach by the VFX Producer of any of the terms of this Agreement because TKTKM has waived a preceding or succeeding breach

12. ASSIGNMENT COMPLIANCE

If TKTKM in its sole discretion thinks it desirable it may assign the benefit of this Agreement or any part thereof or lend the VFX Producer's services hereunder to any third party. The VFX Producer may not assign this agreement, in whole or in part, or any of his obligations and warranties provided for hereunder.

13. COMPLETION GUARANTOR

Notwithstanding anything to the contrary contained herein, this Agreement is subject to the approval rights of the Completion Guarantor and this Agreement and all of the VFX Producer's rights hereunder are subject to the rights of the Completion Guarantor pursuant to the documents comprising or ancillary to the completion bond for the Film including without limitation the Completion Guarantor's rights to take over the production of the Film and to issue any instructions it personally deems necessary to prevent or reduce the risk of the actual production costs exceeding the approved budget. The VFX Producer will co-operate fully with the Completion Guarantor to the best of the VFX Producer's ability. The VFX Producer shall be furnished with a copy of the form of said completion bond agreement and the VFX Producer agrees that he shall be bound by all provisions thereof which may affect the rendition of his services hereunder and that the VFX Producer will sign any documents customarily and reasonably required by the Completion Guarantor in connection therewith.

14. FURTHER ASSURANCE

The VFX Producer hereby undertakes and covenants to do all such further acts and execute all such further documents and instruments as TKTKM may from time to time require to vest in or further assure to TKTKM the copyright and all other rights expressed to be granted to TKTKM and for the protection and enforcement of the same and in the event of the VFX Producer failing to do so within seven (7) days of receiving written notification from TKTKM requesting the same, TKTKM shall be entitled to execute such documents and instruments in the name and on behalf of the VFX Producer or the VFX Producer's duly authorised representatives.

15. NO INJUNCTIVE RELIEF

The VFX Producer's sole and exclusive remedy for TKTKM's breach of this Agreement or any term hereof shall be an action for damages and the VFX Producer irrevocably waives in perpetuity any right to seek or obtain equitable or injunctive relief.

16. NOTICES

Any notices required to be given under the provisions of this Agreement shall be in writing and shall be deemed to have been duly served if hand delivered or sent by facsimile or other print-out communication mechanisms or, within the United Kingdom, by prepaid first-class registered or recorded delivery post, or, outside the United Kingdom, by prepaid registered airmail post, correctly addressed to the relevant party's address as specified in this Agreement or at such other address as either party may hereafter designate from time to time in accordance with this Clause, and any notice so given shall be deemed to have been served:-

(1) if hand delivered, at the time of delivery;

(2) if sent by facsimile or other print-out communication mechanisms, within 8 (eight) hours of transmission if during business hours at its destination, or within 24 (twenty-four) hours if not within business hours (and for this purpose "business hours" means between 09.30 and 17.30 Monday to Friday, excluding bank and public holidays in the country of the addressee)

(3) if sent by prepaid post as aforesaid within 48 (forty-eight) hours of posting (exclusive of the hours of Sunday), if posted to an address within the country of posting, and 7 (seven) days of posting if posted to an address outside the country of posting

17. APPROVALS CONSENTS IN WRITING

Any approval or consent or notice to be given under this Agreement shall only be valid if given in writing

18. CLAUSE HEADINGS

The clause headings appearing herein are used for convenience only and shall not be deemed a part of this Agreement nor are they intended to govern as and in the construction of any provision hereof

19. GOVERNING LAW

(1) This Agreement represents the entire agreement between the parties relating to the subject matter hereof at the date hereof and supersedes any prior agreements understandings or arrangements (whether written or oral) relating thereto between the parties hereto. Any amendment or variation hereof shall not be effective unless it is in writing and signed by the parties hereto

(2) This Agreement is governed by and construed in accordance with English Law

A S W I T N E S S the hands of the parties hereto the day and year first above written

SIGNED by:

____

for and on behalf of

THE KNIFE THAT KILLED ME LIMITED

SIGNED by:

____

JOHN MATEER

Appendix 3 –

Website links for *The Knife That Killed Me*

Information for *The Knife That Killed Me*

Green Screen Productions, Monkman, K., Romer, M., Mattinson, T., Latham, A. and Mateer, J.W., *The Knife That Killed Me*, Feature Film, 2014, Universal Pictures UK, Stealth Media.

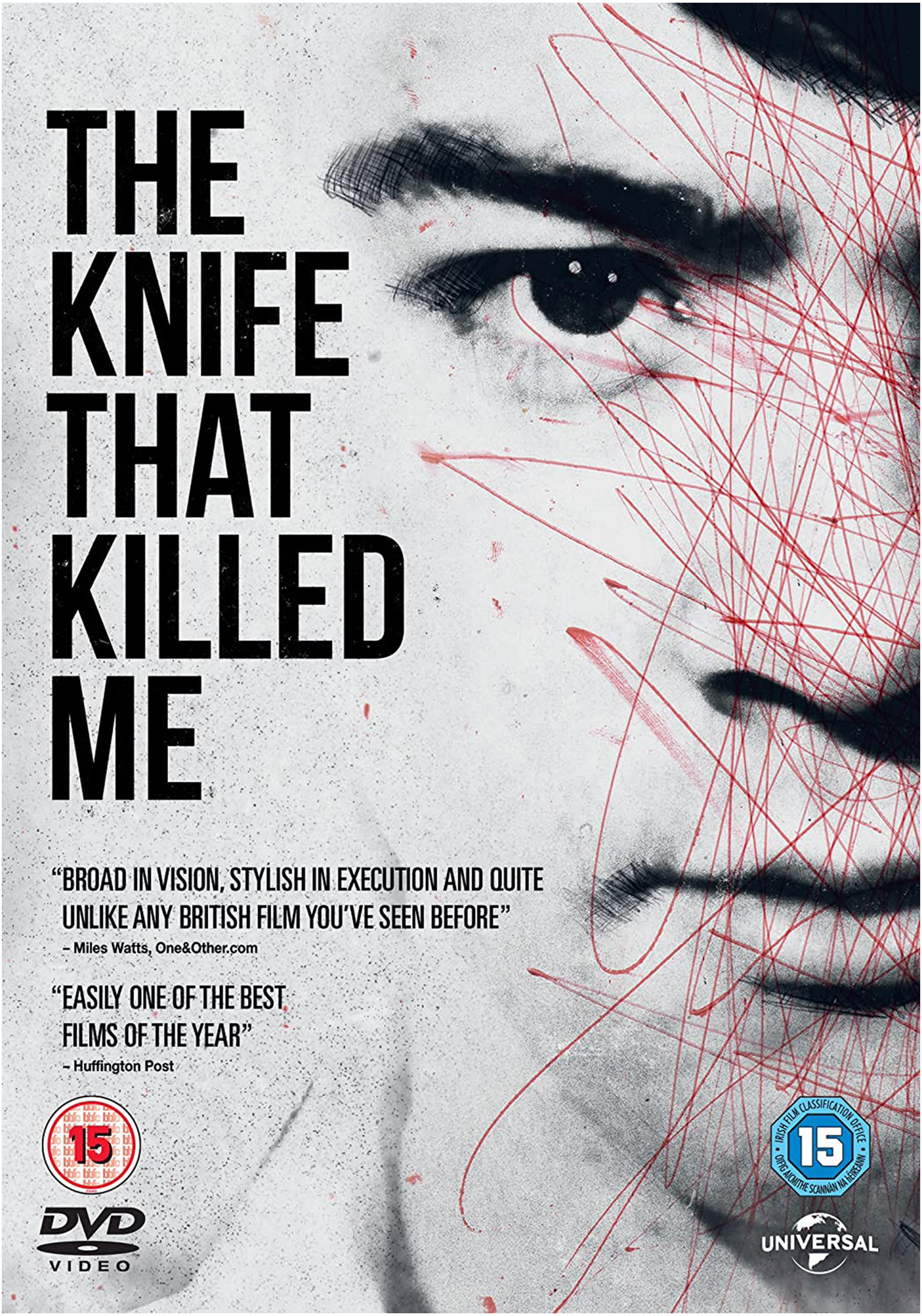
IMDB entry: http://www.imdb.com/title/tt2087982

My roles: Executive Producer, Visual Effects Producer

View at: https://tinyurl.com/AZ-TKTKM

Appendix 4 –

Published reviews of *The Knife That Killed Me*


THE KNIFE THAT KILLED ME
"BROAD IN VISION, STYLISH IN EXECUTION AND QUITE UNLIKE ANY BRITISH FILM YOU'VE SEEN BEFORE"
– Miles Watts, One&Other.com
"EASILY ONE OF THE BEST FILMS OF THE YEAR"
– Huffington Post
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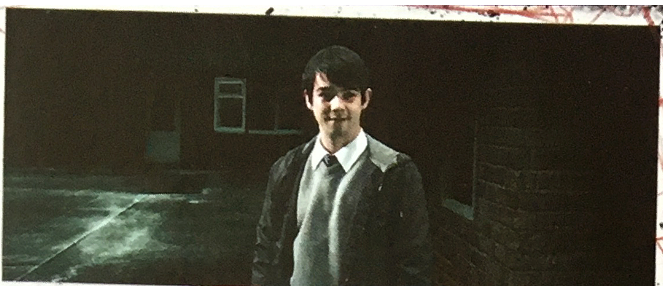
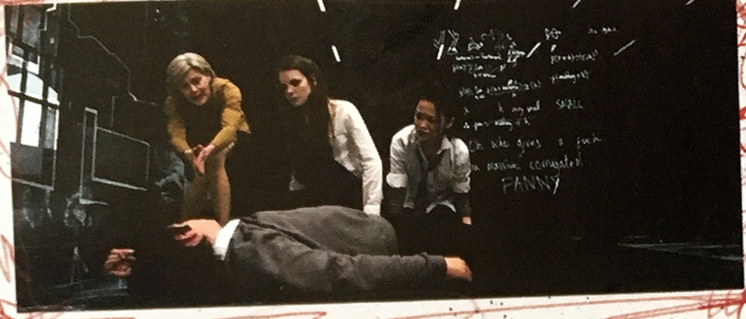
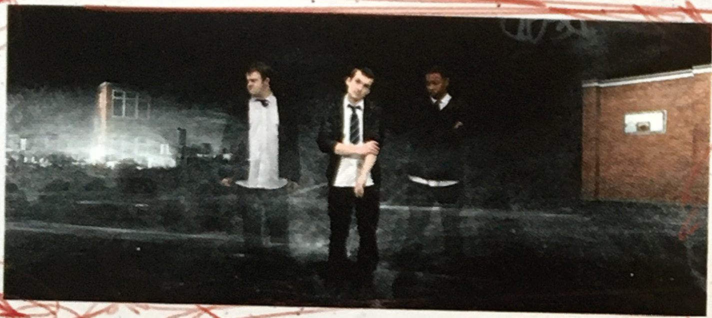
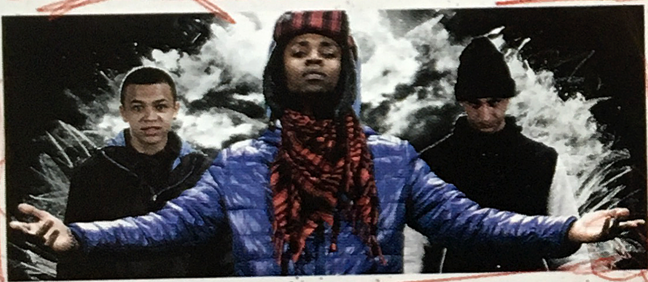
IRISH FILM CLASSIFICATION OFFICE
OIFIG AICMITHE SCANNÁN NA hÉIREANN
DVD
VIDEO
UNIVERSAL

THE KNIFE THAT KILLED ME









"THE KNIFE THAT KILLED ME" IS A COMPELLING JOURNEY THROUGH THE MEMORIES OF TEENAGER PAUL VARDERMAN AS HE REFLECTS ON THE EVENTS LEADING TO THE FATAL MOMENT HIS LIFE IS CUT SHORT.

PAUL MOVES TO A NEW SCHOOL AND BECOMES INVOLVED WITH 'THE FREAKS', A GROUP ON THE PERIPHERY OF SCHOOL LIFE, THOSE WHO DON'T FIT IN: SCENE KIDS, EMO KIDS, INDIE KIDS. OUTSIDERS.

AT THE SAME TIME HE ATTRACTS THE ATTENTION OF THE SCHOOL'S TWISTED AND MANIPULATIVE BULLY, ROTH. WHEN PAUL DELIVERS A MESSAGE FROM ROTH TO THE LEADER OF A GANG AT A RIVAL SCHOOL, IT SPARKS A DANGEROUS FEUD.

FACED WITH GROWING PRESSURES FROM BOTH GROUPS, PAUL MUST DECIDE WHERE HIS FRIENDSHIP LIES, A DECISION THAT MAY COST HIM HIS LIFE.

BASED ON THE BEST SELLING NOVEL BY ANTHONY MCGOWAN, ADAPTED BY MARCUS ROMER AND KIT MONKMAN THIS VISUALLY RICH AND THOUGHT-PROVOKING STORY IS BEAUTIFULLY TOLD WITH STRIKING PERFORMANCES FROM A TALENTED YOUNG CAST.

STEALTH MEDIA GROUP PRESENTS A GREEN SCREEN PRODUCTIONS LTD PRODUCTION IN ASSOCIATION WITH PILOT THEATRE GLOUCESTER PLACE FILMS AND PREMIERE PICTURES
A FILM BY MARCUS ROMER KIT MONKMAN THOMAS MATTINSON STARRING JACK MCMULLEN REECE DINSDALE "THE KNIFE THAT KILLED ME" JAMIE SHELTON ANDREW ELLIS KERRON DARBY OLIVER LEE ROSIE GODDARD RICHARD CREHAN CHARLES MNENE CASTING BY JEREMY ZIMMERMANN HAIR AND MAKE UP JO SWEETING COSTUME DESIGNER CATHERINE CHAPMAN LIGHTING DIRECTOR TERRY MASKELL VISUAL EFFECTS BY TOM WEXLER COMPOSER TOM ADAMS EXECUTIVE PRODUCERS PETER BATES JOHN MATEER NIGEL THOMAS CHARLOTTE WALLS MICHAEL LIONELLO BOSCARDI COWAN SEAN O'KELLY JASON GARRETT DAVID ROGERS CORMAC A CRAWFORD STEPHEN EVANS IAN FOXLEY SCREENPLAY BY KIT MONKMAN MARCUS ROMER BASED ON THE NOVEL BY ANTHONY MCGOWAN
PRODUCED BY ALAN LATHAM THOMAS MATTINSON DIRECTED BY KIT MONKMAN MARCUS ROMER

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15

very strong language, strong sex references, strong violence, drug use

Suitable only for persons of 15 years and over. Not to be supplied to any person below that age.

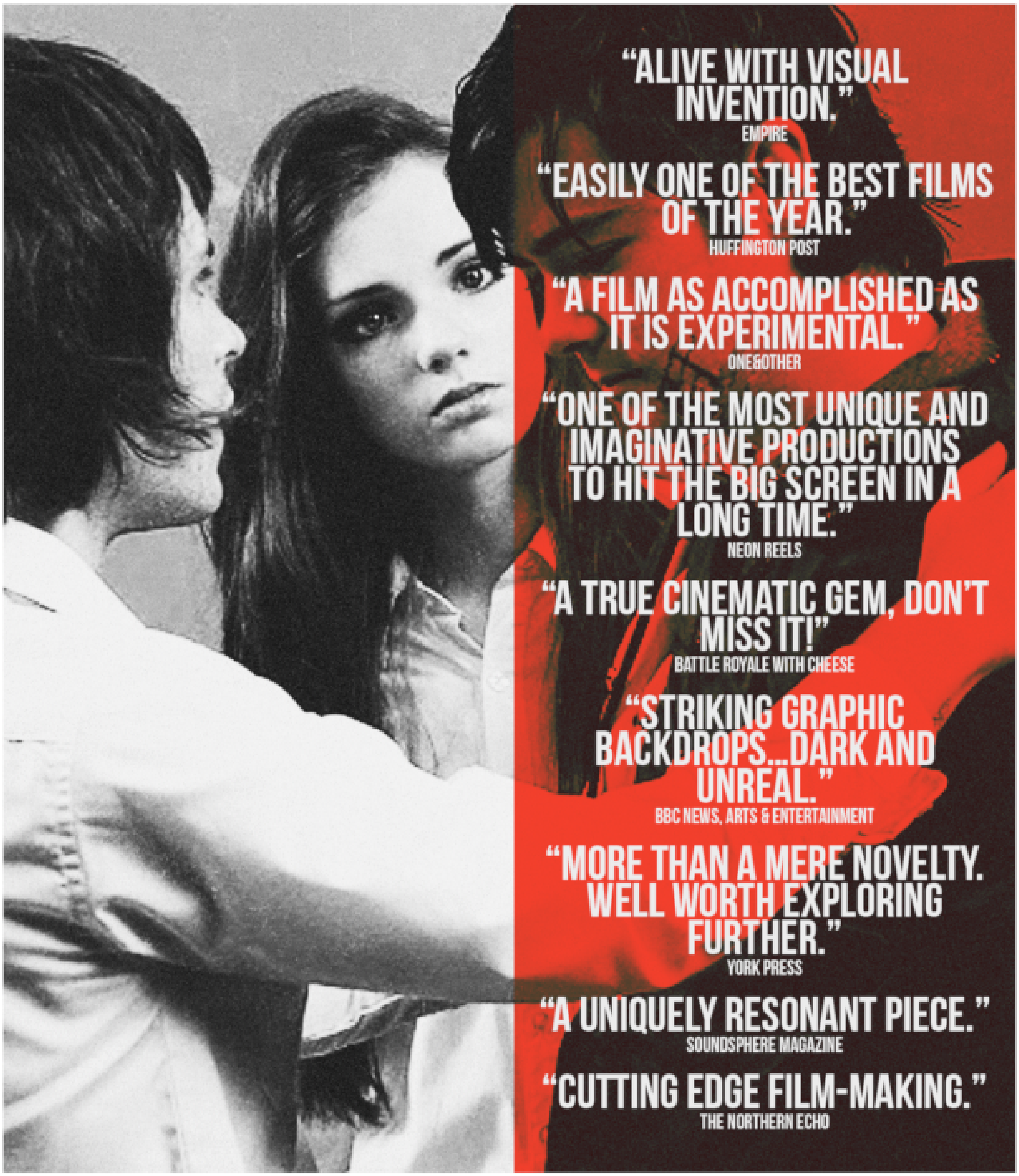
IRISH FILM CLASSIFICATION OFFICE 15 OIFIG AICMITHE SCANNÁN NA hÉIREANN

FIT FOR VIEWING by persons aged 15 YEARS OR MORE

UNIVERSAL A COMCAST COMPANY — This DVD is copy protected — VIDEO PACKAGING REVIEW COMMITTEE VPRC — FACT — DOLBY DIGITAL — 2 PAL — 1.78:1 ANAMORPHIC WIDESCREEN — Green Screen Productions Ltd — DVD VIDEO

MAIN FEATURE	
AUDIO	English 5.1, Stereo 2.0
SUBTITLES	English SDH

DVD 829 693 4 • 11


"ALIVE WITH VISUAL INVENTION."
EMPIRE
"EASILY ONE OF THE BEST FILMS OF THE YEAR."
HUFFINGTON POST
"A FILM AS ACCOMPLISHED AS IT IS EXPERIMENTAL."
ONE&OTHER
"ONE OF THE MOST UNIQUE AND IMAGINATIVE PRODUCTIONS TO HIT THE BIG SCREEN IN A LONG TIME."
NEON REELS
"A TRUE CINEMATIC GEM, DON'T MISS IT!"
BATTLE ROYALE WITH CHEESE
"STRIKING GRAPHIC BACKDROPS...DARK AND UNREAL."
BBC NEWS, ARTS & ENTERTAINMENT
"MORE THAN A MERE NOVELTY. WELL WORTH EXPLORING FURTHER."
YORK PRESS
"A UNIQUELY RESONANT PIECE."
SOUNDSPHERE MAGAZINE
"CUTTING EDGE FILM-MAKING."
THE NORTHERN ECHO

THE BLOG

The Knife That Killed Me - The Review

Made on a modest budget on a small set in East Yorkshire, enhanced with the aid of stylish virtual sets, it features a handful of familiar faces from projects such asand recentdrama.


By Roger Crow

Showbusiness and Travel Features Writer

24/07/2014 06:02am BST | **Updated** September 22, 2014

I could have posted this review a week ago having been at the Bradford premiere of **The Knife That Killed Me**. But occasionally it's nice to let the dust settle for a while and then reflect on the experience.

When the cold reality of day hits, sometimes you look back on a film and realise it wasn't what you thought it was.

However, the fact that my wife and I are still thinking about **The Knife...** a week later is testament to its brilliance as a fine piece of storytelling.

It examines the memories of teenager *Paul Varderman (Jack McMullen)* as he looks back on events leading to the fatal moment his life is cut short.

When he moves to a new school, *Paul* becomes involved with a group on the fringes of school life. He also attracts the attention of charming psycho bully *Roth* (brilliantly played by *Jamie Shelton*).

Acting as Roth's delivery boy, *Paul* takes a package to the leader of a gang at a rival school, leading to a dangerous feud.

Naturally Paul has to decide where his loyalty lies, leading to a violent finale.

I hadn't read *Anthony McGowan's* source novel, but *Marcus Romer and Kit Monkman* did a fine job of giving us a fresh take on an all too familiar tale.

Made on a modest budget on a small set in East Yorkshire, enhanced with the aid of stylish virtual sets, it features a handful of familiar faces from projects such as *Waterloo Road* and recent *Jimmy McGovern* drama *Common*.

Reminiscent of *The Curious Incident of the Dog in the Night Time*, this tale of gang wars and one young protagonist's love for his fellow student is mesmerising.

Imagine a mix of **Kes** and **Sin City** and you get the idea behind this clever and inventive movie.

Easily one of the best films of the year.

[For more details on the Sunday July 27 screening in York.]

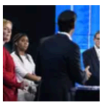
/ TRENDING /


How Keir Starmer Plans To Move On From The Latest Battle In Labour's Civil War


Neighbours' Final Scene Was A Tear-Jerking Nostalgia Trip, And Fans Are Not OK


Rylan Blasts Tory Party In-Fighting In Passionate Last Leg Takedown: 'Stop Being A F***ing A***hole'


Rishi Sunak Says He Was 'Silly' To Say He Had No Working Class Friends


Fresh Blow For Rishi Sunak As Tom Tugendhat Backs Liz Truss For Tory Leader

[Roma 2014] Recensione The Knife that killed me

'The Knife that killed me' è una pellicola che si fonda quasi interamente sulla scelta estetica di un mondo ridotto ad una scala di grigi, una sorta di girone dantesco ottenuto con il green screen, in cui si muove un'adolescenza shakespeariana fatta di violenza, soprusi e tensione all'autodistruzione.

di Erika Pomella / 18.10.2014

Tratto dal bestseller omonimo di Anthony McGowan, *The Knife That Killed Me* di **Kit Monkman** e **Marcus Romer** è uno dei titoli che concorrono per il premio nella sezione autonoma di Alice nella città, all'interno della kermesse capitolina, giunta alla sua nona edizione: il Festival Internazionale del Film di Roma. La pellicola, presentata alla presenza di alcune classi di licei romani, è incentrata sulle (dis)avventure di Paul (**Jack McMullen**), adolescente che dopo la morte della madre si trasferisce nella città natale del padre, dovendo così affrontare l'incubo di un nuovo primo giorno a scuola, una sorta di girone dantesco dove il male sembra aver trovato dimora. A scuola, Paul è diviso dalla seduzione del potere operata dal bullo Roth (**Jamie Shelton**), l'amore per Maddy (**Rosie Goddard**) e l'amicizia con Shane (**Oliver Lee**), leader di un gruppo di emarginati che si autodefiniscono freaks. In questo scenario, Paul dovrà capire da che parte stare e, mentre insegue il fantasma della madre collegato ad una segreteria telefonica ormai fatta puramente di etere, si troverà immischiato in una guerra con la gang della scuola rivale.

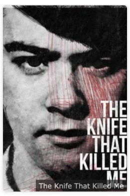
George Lucas, una volta, ha detto che gli effetti visivi, per quanto stupefacenti possano essere, se non sono al servizio di una buona storia, non sono altro che un affare decisamente noioso. *The Knife that killed me* è, a conti fatti, una pellicola che si basa quasi interamente sul suo aspetto visivo, ottenuto grazie all'utilizzo massiccio, totale perenne del green screen. Ed è proprio la scelta stilistica con cui è stato pensato e realizzato l'aspetto più interessante di questo film quasi indie, che sembra vivere fuori dai percorsi prestabiliti dell'industria cinematografica britannica. A metà strada tra lo spazio scenico re-inventato di *Dogville* e il bianco e nero astratto di *Sin City*, il mondo di *The Knife that killed me* è un collage misto, un insieme di parti mancanti di un puzzle gigante. L'atmosfera è ferrosa, cupa, piena di tonalità scure che si uniscono ai nembocumuli che gravano sulla testa del protagonista e che sembrano avvolgerso in una sorta di oscurità da cui non si può scappare. A questo si unisce una costruzione scenica a volte più concreta e a volte più sfuggente, piena di parole scritte sul nulla di una quarta parete inesistente, disegni che tornano come ossessioni e incubi; indizi, questi, di una storia più ampia, il cui senso generale diventa leggibile solo alla fine della pellicola, quando lo spettatore si trova armato di tutti gli elementi utili per decifrare un codice stilistico che è, come dicevamo, l'elemento distintivo di questa operazione. Sì perchè, proprio come è stato dichiarato dai due registi, *The Knife that killed me* è prima di tutto un esperimento, una sperimentazione tecnica e strutturale che, se in un primo momento può lasciare basiti o comunque trasmettere un senso di disorientamento e di disagio, alla fine diventa una sorta di creatura tentacolare che allunga i suoi artigli verso chi è seduto in poltrona, afferrandolo e trascinandolo in un tango macabro, teso, e pieno di ombre. In questo senso, allora, non si può scindere *The Knife that killed me* dalla tecnica con cui è stato realizzato: perchè proprio lo stile è il cuore pulsante del racconto, il suo marchio distintivo, il motivo per cui qualcuno possa desiderare di comprare il biglietto del cinema.

Tuttavia va detto che anche il reparto contenutistico non lascia delusi; il merito, senza dubbio, va allo scrittore che ha ideato questo racconto di perdita, autodistruzione e perdita della libertà. Difficile parlarne senza svelare nessun elemento, visto che *The Knife that Killed me* è una pellicola che va recepita, accolta e compresa poco alla volta, proprio per non mandare persa la struttura a balzi voluta dai creatori, che creano un labirinto narrativo con svolte improvvise, salti temporali ed inganni di sceneggiatura che prendono lo spettatore in contropiede, costringendolo a rivalutare ogni scena vista. Dove, comunque, il film funziona di più è senza dubbio nel ritratto di una realtà scolastica molto più vicina a quanto avviene quotidianamente di quanto ci piaccia pensare. Una realtà fatta di soprusi e violenze, dove vige la regola del più forte e dove a farla da padrone è un'omertà di fondo, in cui la paura impedisce alla giustizia di farsi largo tra tutti gli sbagli, le risse, i soprusi. In *The Knife that killed me* c'è qualcosa di profondamente shakespeariano, qualcosa che sembra richiamare *Amleto,* qualcosa da cui non si può sfuggire: una condanna che aleggia per tutto il film e che tiene lo spettatore avvinto e, al tempo stesso, disgustato. Il tutto reso da dialoghi e monologhi in voice-over che aprono le porte a numerose riflessioni ma anche a sentimenti tutt'altro che positivi: guardando questa pellicola il pubblico si trova costretto ad affrontare il suo odio, il suo bisogno di vendetta e di farsi giustizia da sè. Questo film sembra tirare fuori non solo il peggio dei suoi protagonisti, ma anche di chi decide di guardarli. Tutto questo non sempre funziona alla perfezione e ci sono dei momenti in cui la ridondanza di scrittura appesantisce la diegesi, mentre la tecnica scelta a volte sembra troppo sopra le righe anche per la cifra stilistica utilizzata. Eppure, nonostante questo, possiamo dire che se *The Knife that killed me* è *solo* un primo esperimento, è lecito aspettarsi molto da questi cineasti divisi a metà tra immagini e parole.

Valutazione di Erika Pomella: 7 su **10**

The Knife That Killed Me | Festival del Cinema di Roma 2014

Festival del Cinema di Roma 2014



The Knife That Killed Me

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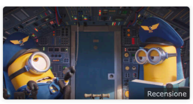
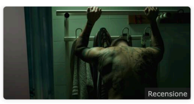

Recensione
Minions 2 - Come Gru diventa cattivissimo, recensione


Recensione
Barber Ring, recensione del film di Alessio Di Cosimo


Recensione
Le voci sole, il film con Giovanni Storti che racconta la pandemia e i social


Il talento di Mr. C, rece commedia con Nicolas Pascal

Translation of https://www.movietele.it/recensione/roma-2014-the-knife-that-killed-me-recensione

[Rome 2014] Review: *The Knife That Killed Me*

"The Knife That Killed Me' is a film that is based almost entirely on the aesthetic choice of a world reduced to grayscale, a sort of Dante's circle obtained with the green screen, in which a Shakespearean adolescence made of violence moves tensely towards self-destruction."

by Erika Pomella / 18.10.2014

Taken from the bestseller of the same name by Anthony McGowan, *The Knife That Killed Me* by Kit Monkman and Marcus Romer is one of the titles to compete for an award in the Alice Nella Città, a side-bar competition now in its ninth edition, that takes place alongside of the International Film Festival of Rome. The film, reminiscent of some Roman high school classes, focuses on the (mis) adventures of Paul (Jack McMullen), a teenager who, after the death of his mother, moves to his father's hometown, thus having to face the nightmare of a new first day at school, a sort of Dante's circle where evil seems to have found a home. At the school, Paul is torn between bully Roth's (Jamie Shelton) seduction of power, his love for Maddy (Rosie Goddard), and his friendship with Shane (Oliver Lee), the leader of a group of outcasts who call themselves 'The Freaks'. In the story, Paul has to figure out which side to take, while also being haunted by his mother's ghost (via an answering machine message). He finds himself embroiled in a war with the rival school gang.

George Lucas once said that if visual effects, as stunning as they may be, are not in the service of a good story, they are nothing but a very boring business. *The Knife That Killed Me* is, on balance, a film that is based almost entirely on its visual design, obtained thanks to the massive and total use of green screen. And it is precisely this stylistic choice that is the most interesting aspect of this indie film, which was conceived and created (it seems) to live outside the established paths of the British film industry. Halfway between the re-invented setting of *Dogville* and the abstract black and white of *Sin City*, the world of *The Knife That Killed Me* is a mixed collage, a collection of missing parts from a giant puzzle. The atmosphere is gloomy, full of dark shades that join the clouds that weigh in the protagonist's head and seem wrapped in a sort of darkness from which there is no escape. This is joined by a set design that is sometimes concrete and sometimes more elusive, full of words written on the nothingness of a non-existent fourth wall, drawings that return as obsessions and nightmares. These provide clues to the broader story, the general meaning of which becomes clear only at the end of the film, when the viewer is armed with all the elements useful for deciphering a stylistic code which is, as we said, is the distinctive element of the approach. As the two directors have stated, *The Knife That Killed Me* is first of all an experiment, both technically and structurally, which, if at first can leave you stunned or with a sense of disorientation and discomfort. In the end it becomes a kind of sprawling creature that stretches its claws towards whoever is sitting in the armchair, grabbing him and dragging him in a macabre, tense, and full of shadows tango. In this sense, *The Knife That Killed Me* cannot be separated from the technique with which it was made. Style is the beating heart of the story, its distinctive mark, and the reason why someone might want to buy a ticket to the cinema to see it.

However, it must be said that the story itself does not disappoint. The credit, no doubt, goes to the writer who conceived this tale of loss, self-destruction and loss of freedom. It is difficult to talk about it without revealing any of the important elements. *The Knife That Killed Me* is a film that must be watched, received and understood little by little, precisely in order so as not to lose the surprises desired by the creators, who create a narrative labyrinth with sudden twists, jumps in time and script deceptions that take the viewer off guard, forcing them to re-evaluate each scene. However, where the film works best is undoubtedly in the portrait of a school reality much closer to what happens every day than we like to think. A reality made up of abuses and violence, where the rule of the strongest is in force and where a basic silence is the master, and fear prevents justice from making its way through all the mistakes, fights, abuses. In *The Knife That Killed Me* there is something deeply Shakespearean, something that seems to recall Hamlet, something from which there is no escape – a condemnation that hangs throughout the film that keeps the viewer captivated and, at the same time, disgusted. Voiceover dialogue and monologues open the door to numerous reflections but also to feelings that are anything but positive. Watching this film, the public is forced to face their own hatred, their own need for revenge and justice by itself. This film seems to bring out not only the worst of its protagonists, but also of those who decide to watch them. The film does not always work perfectly and there are times when the repetitiveness of writing weighs down the diegesis, while the chosen technique sometimes seems too over the top even for the stylistic code used. Yet, despite this, we can say that if *The Knife That Killed Me* is only a first experiment, it is legitimate to expect a lot from these filmmakers divided between their images and words.

Evaluation of Erika Pomella: 7 out of 10

The Knife That Killed Me

Ambitious but flawed teen drama from Kit Monkman and Marcus Romer boasting a bold visual style

- **Source:** The List
- **Date:** 20 October 2014
- **Written by:** Henry Northmore

comments

Given the title, it's no spoiler to say **The Knife That Killed Me** opens with a lethal stabbing. The victim, Paul Varderman (**Jack McMullen**), narrates his way through the events that led to his fateful encounter with the blade: moving to Leeds after his mum dies, trying to fit in at his new school, falling in love with Maddy (**Rosie Goddard**), getting involved with school bully Roth (**Jamie Shelton**) and eventually a turf war.

Based on **Anthony McGowan**'s young adult novel this morality tale deals with the frustration of adolescence. Paul struggles to find his place in the world, negotiating the social cliques at school while drifting from his father (**Reece Dinsdale**) at home. He finds friendship among the 'freaks' and their de facto leader Shane (**Oliver Lee**) but still gets pulled to the dark side.

What's most startling about *The Knife That Killed Me* is its near-monochromatic visual style. Filmed entirely on a green screen stage in Yorkshire built specifically for the movie, it comes across like a teenage **Sin City**. At first the design work is striking, adding annotations in the form of scrawled messages, graphics and graffiti; and the technique is employed to remarkable effect as multiple images are overlaid. However, after a while it becomes repetitive, as every scene is painted with the same overcast greys and heavy black.

The method means everything appears flat and stagey. Transitions are awkward and when characters walk any distance (particularly towards the screen) it looks unnatural, like they're moving on a treadmill. The over-stylisation removes the action from reality, so that the film resembles a nightmarish urban cartoon and this disconnection means it's hard to get emotionally involved in the unfolding drama.

McMullen just about carries the film but regrettably some of the other performances are less successful. It's an ambitious project from directors **Kit Monkman** and **Marcus Romer**, who are attempting something never before seen in British cinema. Their ambition is to be applauded; *The Knife That Killed Me* is a very interesting but nevertheless flawed experiment.

Selected release from Fri 24 Oct.

The Knife that Killed Me

- ●●●○○
- 2014
- UK
- 90 min
- *15*

- **Directed by:** Kit Monkman/Marcus Romer
- **Cast:** Jack McMullen, Reece Dinsdale, Jamie Shelton
- **UK release:** 24 October 2014

It's not a spoiler: Paul (McMullen) narrates the events that led to his fatal stabbing, as he started at a new school, fell in love, made friends but got pulled to the dark side. Made entirely on green-screen, it resembles a nightmarish urban cartoon; the stylised approach, initially remarkable, makes it hard to get…

The Knife That Killed Me (2014) - Trailer (First Look)

Comments

Post a comment

Name Choose a name Comment Enter your comment

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The Knife That Killed Me review – earnest, anti-violence school drama

★★☆☆☆

Laudable aims and impressive, highly stylised visual effects are undermined by painfully weak acting

Leslie Felperin

Thu 23 Oct 2014 21.45 BST

Inner-city anxiety ... The Knife That Killed Me

Adapted from Anthony McGowan's well-regarded young-adult novel of the same name, this Kickstarter-funded feature revolves around 16-year-old Paul (Jack McMullen), the new kid at an inner-city Leeds school as he navigates the usual cliques and gangs. It's earnestly didactic, anti-violence stuff, laudably aimed at the impressionable age bracket it depicts. Unfortunately, the acting is painfully weak, especially from the supporting players who mug and shout as if they're trying to get the attention of the sleepy parents at the back of the hall at a school assembly. The film's big saving grace is the highly stylised look, produced by shooting entirely in front of green screens with pencil-sketch drawings and photographic fragments spliced in later via visual effects, making the finished product look like a hi-tech version of Lars von Trier's Dogville. It's enough to make one very curious about where co-directors Marcus Romer and Kit Monkman will go next. Hopefully, to classes in how to handle actors.

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The Knife That Killed Me

Wendy Ide

Friday October 24 2014, 1.01am, The Times

An experimental British drama, **The Knife That Killed Me** takes a well-worn subject — school bullying, knife violence and teen cliques — and gives it a refreshing new spin. The film, directed by Kit Monkman and the actor Marcus Romer, was entirely shot in front of a green screen. This voyage through the memories of teenager Paul Varderman (Jack McMullen), dealing with the events that lead up to his fatal stabbing, is handled with a densely inventive visual verve. Using overlayered text and graphics, the film looks unlike anything you will have seen before. However, without the grounding of a location, some of the performances feel overheated. **Kit Monkman and Marcus Romer, 15, 101min**

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Reviews

STAR RATINGS EXPLAINED

Unmissable	★★★★★
Excellent	★★★★
Good	★★★
Poor	★★
Tragic	★

The Knife That Killed Me

Teenage snikts

★★★

Plot

Destined to die in a stabbing, teenager Paul Varderman (McMullen) looks back at the events that lead up to the fatal incident.

Review

Dramatically, this adaption of Anthony McGowan's novel about school gangs offers few surprises. But the use of greenscreen backdrops to convey the blur of memories flashing through a dying teenager's mind is inspired, if at times imperfect.

Verdict

There's nothing too groundbreaking in the dramatisation of school cliques and the growing pains of teenagers, but the execution is alive with visual invention.

★★★

Reviewed by David Parkinson

FILM DETAILS

Certificate
15

Cast
Jack McMullen
Reece Dinsdale
Jamie Shelton
Oliver Lee.

Directors
Kit Monkman
Marcus Romer.

Screenwriters
Kit Monkman
Marcus Romer.

Running Time
101 minutes

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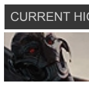
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Appendix 5 –

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DEVELOPING EFFECTIVE TEST SETS AND METRICS FOR EVALUATING AUTOMATED MEDIA ANALYSIS SYSTEMS

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ABSTRACT

This paper first looks at current methods of evaluating automated content-based media analysis systems. Several key deficiencies are identified, particularly with regard to test set creation and metric design. A new framework is proposed that better reflects real-world conditions and end-user requirements. This is based on the author's experience as a professional filmmaker and researcher in this domain. Specific approaches for data set selection, including the importance of understanding the physical, production and aesthetic attributes of footage, are presented. A discussion of related evaluation methods and means of effective assessment follow. It is hoped the suggestions proposed will facilitate more effective analysis of these systems.

1. INTRODUCTION

As research into automated media analysis has matured claims have emerged that low-level attributes, such as cut location and basic camera movement, are obtainable with consistently high degrees of accuracy (for example [1-3]). This has lead to the impression that these problems are basically solved and thus do not warrant further investigation. The present emphasis on research appears to have shifted toward techniques on extracting higher-level semantic information, a seemingly more challenging task. But how can we be certain of the true effectiveness of any of these techniques in a real-world context? How far has the state-of-the-art actually advanced? Are any claims in this area validated? It has been suggested that end-user requirements must be fully considered if content-based media analysis systems are to be truly viable [4] yet few have seemed to heed this call. As these systems will be used for archiving and professional post-production – both highly precise disciplines – there is a clear need for a common set of metrics based on a formal understanding of these domains. Cinematic production techniques, physical media properties as well as the history of the usage and application of media should formally be considered if proper evaluation is to take place.

2. THE EVALUATION FALLACY

To date, evaluation of automated media systems has typically consisted of trials conducted with footage at hand: easily accessed broadcast television programs, promotional videos produced by the organization or feature films rented from a video store. On the face of it, it would seem that such test sets could be good indicators of system performance. In actual fact, the quality of the analysis depends critically on the specific footage chosen, how much the researcher understands the characteristics of that footage and what he or she expects to learn from the trial. The physical, technical and aesthetic make up of the test set must be thoroughly understood to derive accurate conclusions. Many factors can affect system performance and it is vital these be identified (specific attributes and their impact are described in section 3). The majority of studies that have been conducted use different test sets, rendering comparison with competing approaches virtually impossible. Even trials conducted using different films with similar basic characteristics (i.e., genre, date of production, director, etc.) may not yield comparable results for a number of reasons such as the cinematographic or editing techniques employed to name but two. To properly compare systems common footage in a common format must be used. Fortunately this deficiency has not gone completely unnoticed.

The Text Retrieval Conference Video Retrieval Evaluation (TRECVid [5]) was established specifically to enable direct comparison of competing techniques. With a clear task structure, analysis criteria and a consistent marking scheme, it is generally well conceived. However, as carefully designed as TRECVid has been, its test sets have not been chosen with a full appreciation of the range of real-world footage nor true end-user needs. For example, in 2002 one task was to test techniques for shot boundary detection – hard cuts as well as gradual transitions such as fades and dissolves. The test set was comprised principally of industrial documentaries, old promotional films and home movies – a seemingly good mix of footage. Upon closer examination though it becomes clear that many real-world conditions are not represented. Attributes and techniques such as fast paced montage (where several consecutive shots have very short duration), jump cuts and scenes with heavy occlusion or strong relative subject-camera movement are all lacking. Indeed, even more basic concepts such as drop frames, match transitions and lighting changes are significantly underrepresented. As a result, the findings from TRECVid are skewed and do not adequately reflect system performance on the vast range of conditions present either in production footage or in archives spanning over 100 years. Given shot boundary detection forms the backbone of a vast number of content analysis tasks this is a major shortcoming in an otherwise highly laudable initiative.

3. CONSIDERATIONS FOR TEST SETS

The creation of a challenging yet fair test set for evaluating automated media analysis tools requires a recognition and understanding of numerous footage characteristics. This is not to say that all features will be relevant to a specific area being tested. However, physical, production and aesthetic attributes are closely interrelated -- any one can have a profound impact on the interpretation of another – therefore it is important to consider them together.

3.1. Physical Media Attributes

Media footage varies greatly in quality. Attributes such as substrate density, tears, marks, flicker and the use of splice tape can drastically effect the parsing of film. In the same way, tape stock, format, standard encoding (i.e., NTSC, PAL, etc.) and generational loss can affect video. In both media, frame rates and aspect ratios must equally be considered, particularly with regard to films transferred to video where fundamental changes can occur depending on the type of transfer (i.e., direct, letterboxed or pan-and-scan). This is particularly pronounced with early film where frame rates are non-standard.

Color characteristics are a vital consideration. Some techniques, such as color histogram analysis, are often ineffective on black and white or faded footage. Likewise certain types of tints, including hand tinting prevalent in the early days of filmmaking and even cel-based animation, must be understood and accommodated if a system is to be tested on all types of footage.

In the creation of test sets subtle issues may arise that are not immediately apparent. For example, a modern feature film is typically shot on 35mm film at 24 frames per second then transferred to NTSC video (with a frame rate of 29.97fps) using a field insertion process known as 3:2 pull down. If this footage is then converted to an AVI to facilitate analysis, it can contain regular occurrences of duplicate frames, potentially yielding an incorrect detection of a series of freeze sequences or other anomalies. Likewise if a set of JPEG stills is created directly from the source film, it will contain fewer frames than the AVI thus possibly negating the validity of direct comparison between systems using the two sets. Attention must be given to the original format of test footage to ensure the test set is valid.

3.2. Production Techniques

Directors employ a vast range of cinematographic, aural and editorial techniques to convey information in a style appropriate to their audiences. The genre and intended aim of the piece help to guide the director's approach. Specific methods can be examined individually, however for the purposes of selecting test footage, it is worthwhile to examine the cinematic language being used by the director to understand the use of these methods in context. Cinematic language in this instance does not refer to critical constructs but rather specific styles of filmmaking.

Richards defines a number of cinematic languages as used by directors for production [6]. The most common of these is Master Scene Cinema Language, whereby an initial wide shot establishes the scene and subsequent closer shots (e.g., medium and close-up) present the salient information. Camera movement is minimal, the pace of editing is relatively regular and the overall presentation is highly controlled (a good example is Wyler's *The Big Country*). As a result, source footage using these techniques is less challenging than footage employing other types of cinematic language for the identification of basic attributes (e.g., cut location, camera movement, etc.). It may, however, be well suited to higher-level analysis (e.g., scene identification, location detection, etc.). Approaches such as Constructive and Collision Cinema Languages, where shots are presented in a consistent pattern and pace so that juxtaposition imparts meaning (as in Eisenstein's *Battleship Potempkin*) are also likely better suited for evaluating the effectiveness of extracting higher-level information.

More modern languages, such as Vorkapich Cinema Language, where an action is broken down and shown using several component shots rather than one longer shot (as exemplified in Katzkin's *Le Mans*), and Cinema Verité, where events are shown with as little intervention as possible (i.e., in terms of camera angle change, editing, lighting, etc.), are best suited for testing robustness of more extreme, real-world conditions. Footage using these languages can contain challenging uses of camera consisting of shaky handheld shots, swish pans, snap zooms, selective and rack focus, dynamic moving point-of-view shots and/or shots with high levels of occlusion, making them a good choice for testing the classification of camera work. The related editorial methods include fast montage, jump cuts, match transitions, freezes and/or fast or slow motion thus creating significant temporal discontinuity. It is this type of footage that can fully test the effectiveness of boundary detection strategies.

By recognizing and understanding how cinematic languages are used and the techniques behind them, test set selection can be much more accurate and efficient.

3.3. Aesthetics and Historical Context

In order for a test set to best reflect the breadth of conditions present in real-world archives it is important to have an appreciation of the historical context and purpose of test footage. The numerous vaults of unclassified footage span a wide range of eras and genres. To categorize and index them effectively requires an understanding of the context in which they were made and their intended purpose. Genre detection is a key component and a hot area for research yet present test sets fail to reflect an appreciation for the complexities involved. For example, documentaries of the 1920's (such as Flaherty's staged *Nanook of the North*) vary significantly in style to those of the 1960's (Wiseman's Cinema Verité *Titicut Follies*, for instance) even though they are within the same genre. Likewise propaganda films often employ the same presentation style as documentaries yet their purpose is decidedly different. To reliably classify footage according to genre requires a deep understanding of that genre and a test set that reflects the variety within the domain.

It is also important to recognize latent grammars that have evolved with visual media over time, particularly that of "continuity." Continuity and its components – consistency of motion, time and space, and most notably "the line" [7,8] – have been used in the vast majority of programs irrespective of genre. Identifying how continuity is created (or destroyed) by the director – through manipulation of composition, focus, eye line or editing, for example – can provide insight into the extraction of higher-level semantic information. Film theorists have studied this extensively and it is valuable to be clear on concepts such as the effect of deep focus in imparting meaning (as used by Renoir in *Grand Illusion*) when selecting test footage for semantic analysis. Mast and Cohen provide a relevant and well-conceived compilation of several key film theories [9].

By understanding the specific objectives of a particular trial and selecting test footage based on a considered understanding of the three areas above, evaluation can become much more efficient and effective.

4. EVALUATION STRATEGIES

Once a representative test set has been created, metrics must be used that accurately assess performance of the system or technique in question in an equally targeted manner. Many researchers have fallen back on the common measures of "precision" and "recall" as indicators. However, these do not fully take into account the complexities of the media domain nor the ultimate needs of end-users. New metrics, based on the requirements of archival and post-production professionals, are necessary for these systems to be useful.

4.1. "Hard" Versus "Soft" Measures

Many attributes of films or videos are immediately quantifiable. For example, the accuracy of cut detection is easily measured – the location of the cut is either correct, or it is not. To media professionals this must be absolute as frame accuracy is vital to the editorial process. If a reported cut is actually one frame off, it should be counted as two mistakes – one for the missed cut, the other for the false detection. There are numerous other fundamental characteristics that require such precision – drop frame detection, camera movement *classification* and location identification to name but three. These should also be scored in such a rigorous manner.

Some attributes do not require such precision. For example, locating the exact beginning and end frames of a camera move is desirable, although in practice edits are rarely made using these precise points of the movement. Traditionally, there is a small pause (or 'beat' [6]) where the camera holds, before gradually starting the motion, with another beat at the end of the move. Indeed, 'feathered' moves (where the camera starts and stops in a very smooth, graduated motion) make precise start and stop frame detection difficult even for human experts. It is reasonable therefore that this type of information be judged with a relative accuracy, typically ± 5 frames (though there is no clear consensus for this number). For many types of semantic analysis this approach should be equally valid. The key to designing effective metrics lies with understanding the ultimate use of the system being examined.

4.2. The Importance of Standardized Nomenclature

Media professionals use particular terminology to characterize all aspects of pre-production, production, post-production and archiving. Systems designed to extract content from media should use the same common nomenclature. Camera work and shot types are best described using ubiquitous Hollywood terms (e.g., "pan right to a medium two-shot," "zoom in to an extreme close-up," etc. [7]). Likewise editing attributes should be categorized in a similar way (e.g., "25 frame dissolve," "30 frame wipe right," etc. [10]). The use of consistent terminology enables direct the comparison of different systems.

Asset management should also be performed in a manner consistent with standard industry practice. To date, management of test sets has been done using a variety of methods. Some studies, such as TRECVid, utilize Gregorian day time coding (ISO 8601) as a means of indexing footage. While this standard is growing in acceptance in a number of different communities, it is by no means universal in this domain; the vast majority of post-production and stock footage archives utilize a reel number/time code metaphor (with SMPTE time code or related variations). Until other standards are firmly established the latter method should be adopted to simplify direct comparison and thus standardize evaluation. It also has the added benefit of making system integration with existing post-production equipment more efficient.

4.3 Measures of Attributes

Attributes of media footage range greatly and must be classified in ways appropriate to their context. Evaluating the effectiveness of classification techniques requires the use of a number of different measures to provide an overall picture. In our work on *ASAP*, an automated shot analysis program for post-production [11], Robinson and I developed specific metrics to test the characterization of camera movement. Our approach utilizes generic techniques than can be applied in a number of contexts.

The ground truth log should be prepared by an expert with a full understanding of the test footage (as described in section 3). Accuracy of this log is vital if the evaluation is to be effective. Metrics should be developed based on the significance and relative value of the extracted information. Typically this means first a measure for whether a classification was *correct*. We check that the attribute identified by the system has extents that overlap with an identical attribute in the ground truth. If it does not, the classification is reported as *false* and any different attributes listed in the ground truth are counted as *missed*. The *classification rate* per shot (or scene) is calculated as the number of correct attribute classifications divided by the total of correct, false and missed instances. *Classification accuracy* is calculated as the *proportion* of time the attribute is listed by both the system and ground truth as occurring divided by the *total length* of time either list the attribute as being present. *Average category classification accuracy* simply expands the analysis to gauge the performance of classifying related attributes as a group. *Duration-weighted accuracy*, defined by the proportion of frames within a shot or scene that the system and ground truth report the same attribute present divided by the total number of frames in the section, emphasizes the overall amount the time the system is correct so attributes present over a longer period carry more weight than shorter ones.

Using all of these measures it is possible to gauge *relative* versus *overall* effectiveness, particularly useful in assessing the extraction of multi-level data (i.e., where attributes are interdependent). Through the use of 'hard' or 'soft' measures different end-user requirements can be represented. Care must be taken when choosing these as an inappropriate choice can skew or invalidate the results.

5. CONCLUSIONS

This paper has examined current methods of evaluating automated content-based media analysis systems and identified several deficiencies. It is suggested that any system ultimately intended for professional use should be assessed using representative test sets and measures based on end-user requirements, and judged on its effectiveness in meeting real-world needs. A new framework for developing suitable data sets and appropriate metrics, based on standard methods and practice, has been presented. It is hoped that continued research will help to further develop and refine the approaches described.

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ROBUST AUTOMATED FOOTAGE ANALYSIS FOR PROFESSIONAL MEDIA APPLICATIONS

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ABSTRACT

We report a method for automated video indexing and shot characterization that meets the specific requirements of professional post-production and archivist end users. *ASAP – Automated Shot Analysis Program* – interprets source video material in a manner consistent with industry practice and generates logs and searchable databases of cut location and camera activity. It uses projective transform estimation methods in conjunction with temporal filtering to resolve complex subject motion. Using challenging test footage and rigorous metrics we show that *ASAP* is more robust than well-established colour histogram boundary detection methods and effective at parsing complex camera movement. These results indicate that our techniques are potentially valuable for professional application.

INTRODUCTION

Shot boundary detection and camera movement classification are the backbone of any automated footage parsing system. In professional applications robustness and accuracy are vital whether for archiving historical material or streamlining and enhancing the editing process. In both contexts source footage can be of diverse quality with significant variation in visual clarity, camera and subject movement, and overall shot duration. As a result it is paramount that an automated method interpret footage accurately in a wide range of conditions. We have designed *ASAP – Automated Shot Analysis Program* – with these industry needs in mind.

Research into this area is not new. Seyler's analysis of differences between video frames (1) was the first of a host of studies into shot boundary detection (such as (2-5)), camera movement classification (6-7) and other content extraction techniques (8-10).

Several researchers have reported methods of cut detection that can yield over 95% accuracy with a false detection rate of 5% or less (typified by Lienhart (4)). The presentation of impressive results from these studies has led many to believe that this problem has effectively been solved. But all of these results are highly dependent on the footage analysed. We suggest that insufficient attention has been paid to selection of test cases that accurately reflect the range of conditions in archival and production footage (Mateer presents a detailed critique and new approach in (11)). As a result, important failure modes go unanalysed. For example approaches that combine colour histogram matching and temporal consistency often fail to accurately parse shots of very short duration (<5 frames), segments with intermittent occlusion and cuts between different but graphically similar shots (an example follows). In this paper we not only report our method and tests, but also show how appropriately chosen test footage reveals the true performance of shot analysers.

METHOD: *"ASAP – AUTOMATED SHOT ANALYSIS PROGRAM"*

ASAP consists of a frame-by-frame camera motion estimator applied both with and without temporal pre-filtering. A movement parser then connects interframe movements into strings and applies syntactic rules to distinguish different types of movement.

Camera Motion Estimator

We use a fast, high-accuracy, simplex-based projective transform estimator developed by Robinson (a detailed description can be found in (12)). The estimator uses simplex minimization of a disparity function calculated over a mesh of samples taken from the picture. In comparison tests with other perspective estimators, it performs as accurately but several times faster than its competitors. This estimator has been used for object-based video analysis and coding (13-14), but in *ASAP* we simply take the output of eight perspective transform parameters, along with a single measure of disparity, for input to the movement parser.

Temporal Filter

The motion estimator is applied directly to the raw video input and to a temporally-filtered version of the input. We use a 16-tap temporal median filter that attenuates the effect of temporary scene occlusions. This allows us to disambiguate between genuine cuts and gross image changes caused by fast-moving foreground objects.

Classifier

The classifier consists of a movement parser that also functions as a cut detector. It clusters consistent movements over consecutive frames into tentative zooms, pans and tilts. If the best perspective transform between two frames yields a significant final disparity, its parameters are examined for consistency with the temporally-filtered information, and if inconsistent, a cut is declared. Pans and tilts are detected from translation parameters, and zooms from a combination of the scale/rotation matrix entries in the projective transform. It is also possible to detect and quantify camera roll.

Having divided the stream of camera movements into *tentative* zooms, pans and tilts (which may happen in parallel), the classifier applies a second level of analysis. The zooms are examined first. If of sufficient magnitude, they are accepted as fundamental motions and subsume any other kind of movement. For pans and tilts, the parser examines the series of tentative movements in the shot, and infers that the movement is one of three types: (i) a fundamental pan or tilt, which is a consistent movement in a particular trajectory, (ii) tracking, where the camera appears to be following a moving object, (iii) jitter. The last of these is ultimately classified as part of a hold, along with any genuinely stationary camera shots. The motion estimator is able to correct for jitter with motion stabilization if necessary.

The output of the classifier is presented in two main forms. First, a shot log with time code for in/out points, duration, a representative frame of each camera movement and a mosaic showing complex moves in a storyboard-like format, provides a quick visual reference for the footage (a web-based example without mosaics can be seen at (15)). Second, a searchable database is generated that enables easy location of cuts or movements of a particular type, duration, extent and speed. This later feature enables editors to easily find matching motions within shots enabling seamless match transitions, a highly time consuming task when done manually.

Linear and Hierarchical Processing

ASAP is built around a fast global projective estimation algorithm. We are able to achieve a low average processing time (<140ms per pair of 720x560 frames on a 2 GHz Pentium IV, before temporal filtering) by applying it in a hierarchical way. First we examine frames separated by four frame periods using the fastest version of the perspective analyser. When the estimate produced is sufficiently accurate, the movement parameters are scaled to per-frame values and accepted. When the estimate is poor, *ASAP* switches down through a sequence of increasingly accurate matches.

For a low-activity video sequence, it is possible to run the hierarchical version of *ASAP* at an average rate below 40ms/frame (i.e. video frame rate). For high activity, large buffers or a higher performance processor would be required in a real-time system.

EXPERIMENTS AND ANALYSIS

Heretofore many analyses of similar automated parsing systems have consisted of footage chosen arbitrarily, often based on footage at hand. Initiatives such as TRECVid (16) have attempted to provide a large-scale dataset as a representative sample of real-world conditions. However, despite covering a range of genres, film and video types and historical periods, that test set was not compiled with specific input from post-production or archivist end-users nor with any specific criteria based on expert knowledge of cinematic language or production convention. As such it is not fully indicative of the range of conditions present in these domains, particularly with regard to editing and camerawork. Fast-paced montage, jump cuts, graphic match cuts, swish pans, snap zooms and racking focus are some of the attributes found in source footage that are not represented. Our contention is that performance cannot be adequately analysed without a clearly principled basis for choosing sample sets, including a formal understanding of the cinematic style employed by the programme makers (11), if a system is to ultimately be applied in a real-world setting.

Test Footage Employed

Reviewing recognised technical and critical cinema texts (17-19) as well as drawing on professional filmmaking expertise we chose source footage from the 1970 film *Le Mans* specifically due to its directorial and editorial style. The section tested encompasses the first 290 shots (32,229 frames) after the head title sequence. It consists of a mix of location Cinema Verité hand-held footage and conventional staged narrative production. Editing builds from a slow, expository pace and to a very fast montage of shots reaching a visual climax in which the duration of some shots is very short (<4 frames, see fig. 1).

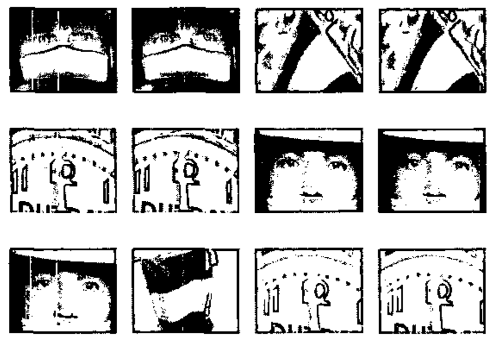

Figure 1: Consecutive frames showing fast edits

In addition, there are several instances of intentional jump and graphic match cuts. There is a wide range of shot types with many complex compositional elements, including significant subject occlusion (fig. 2), complex relative motion and fast motion of both subject and camera.

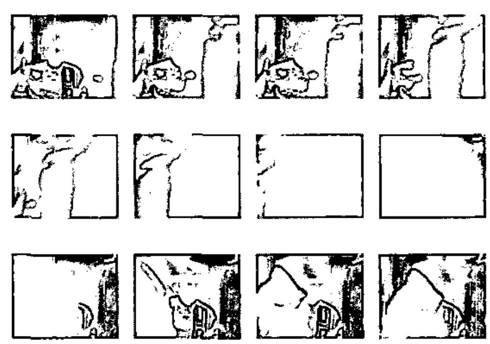

Figure 2: Consecutive frames showing occlusion

Taken as a whole, this footage represents a very significant challenge for automated analysis.

Experimental Method

An AVI file and an identical set of JPEG stills were generated from a NTSC video master of the 290 shot test sequence. A hand log of the test footage was created using industry-standard criteria to characterize start/end times, shot type and camera movements, all with frame accurate precision. This was then converted to a simple text file using abbreviations for moves (e.g., L for Pan Left, etc.) to enable automated scoring.

Cut Detection

Media professionals require shot boundary detection to be truly frame accurate. As such common measures of *Precision* and *Recall* are not best suited for this analysis. Straightforward measurement is possible in terms of missed and erroneously flagged cuts. However, any cut that is not frame accurate should be counted as two mistakes: a completely missed cut, plus an additional false cut. We measure overall accuracy as given by

$$\text{Accuracy} = 1 - N_{missed} / N_{true} - N_{false} / (N_{true} - N_{missed} + N_{false})$$

To compare *ASAP* against established methods we obtained a copy of Lienhart's *CutDet* (20) to directly gauge relative performance in cut detection using a well-studied and reportedly highly effective approach. Several trials were run using different thresholds to determine optimal settings and compare areas of strength and weakness in both systems (see fig. 3).

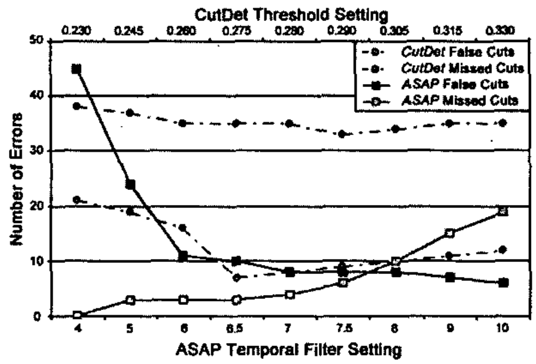

Figure 3: Cut detection performance over 290 shots

With a temporal filter setting of 5 or higher, *ASAP* correctly detects over 90% of cuts for the test footage. For this data set, the optimal setting is 7, with cut detection accuracy of 95.9% overall. This compares very favourably with *CutDet*'s best result of 85.2% at a threshold of 0.275. It is recognised that this version of *CutDet* cannot be modified to attempt the detection of shots with a duration of fewer than six frames, as occurs in shots 254-271. Discounting that section of the test set *ASAP* still outperforms *CutDet* by nearly 4%, significant in a professional end-user context. Examining the areas where the systems failed it is clear that *ASAP* is much better able to cope with occlusion, failing in only one instance. *ASAP* also correctly parsed all four graphic match cuts whereas *CutDet* was only able to detect two. Neither system was able to parse the two one-frame jump cuts. This is important as the detection of drop frames is vital to editors and thus warrants further investigation. Overall results indicate that *ASAP* is highly effective and we would welcome the opportunity for direct comparison with other approaches.

Camera Move Categorization

Locating the exact start frame of a camera move is desirable although in practice edits are rarely made using the precise start and end points of the movement. For evaluation purposes, however, it is important to judge a system based on its absolute performance.

Camera move characterization and camera move frame accuracy were analysed using a programme that took *ASAP*'s output and compared it to the expert's hand log. At present, *ASAP* cannot parse fully moving camera shots (e.g., dolly, crane, Steadicam, etc.) and so was penalised for this. The performance scores were calculated based on the following criteria:

A move was considered *correctly classified* if *ASAP* identified a move with extents that overlapped with a move of the same type in the hand log. *ASAP*'s other moves were categorized as *false*, and the hand log's other moves were categorized *missed*. The *Classification Rate* per shot is the number of correctly classified moves divided by the total of correct, false and missed moves.

A correctly classified move was assessed for frame-accuracy. The *move accuracy* was defined as the proportion of the time that the hand log and *ASAP*'s log both identified the move as happening, divided by the total extent of time from when either log identified the move starting, to when either log identified it as ending. The *average move accuracy* gives the accuracy performance of all recognized moves within a shot.

Duration-weighted accuracy measures the proportion of frames within a shot where *ASAP* and the hand log report the same movement in progress (or both report a static hold) divided by the total number of frames in the shot.

The first two metrics evaluate the parsing independent of move durations. They respectively assess the syntactical correctness of the *ASAP* log and the precision of the transitions between one move (or hold) and another. The third metric emphasizes the amount of time that *ASAP* is right (or wrong), so that long moves have more weight than short moves. Which of these metrics is more appropriate is application dependent. We therefore present results for all. Figure 4 summarizes *ASAP*'s performance using a windowed average of ± 15 shots.

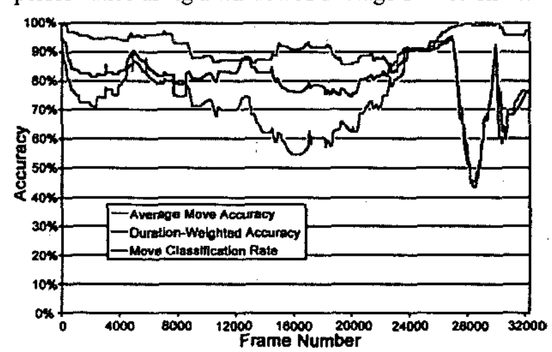

Figure 4. Move classification performance.

Overall *ASAP* correctly identified 71.3% of camera moves within the shots, including complex camerawork with multi-directional movement (e.g., a zoom in that pans left and tilts down). There are two areas where parsing is less accurate – frames 14,892-18,288 and 27,726-29,025. In the former heavy occlusion adversely affected accuracy. In the latter, the very short duration of shots coupled with the small scale of camera movement in two shots that are cut between several times caused errors (discounting these two repeating shots alone raises overall accuracy by ≈5%).

When *ASAP* correctly classified a camera move, it detected start and end points with an overall average move accuracy of nearly 95%. As an absolute measure this is a remarkable result. However, it should be noted that this reflects *overall accuracy* and does not take into account how *beneficial* the output would be to an end-user. Developing such a metric would require a survey of professionals and industry guidance.

ASAP is most accurate in charting start and end times of moves where there were low levels of subject motion or highly controlled movements (i.e., camera on a tripod in controlled conditions). Instances of handheld shots, multiple subject motion and particularly occlusion are more difficult for the system although it is quite robust, able to detect severe moves such as the snap zoom in shot 281 (where cars start coming around a turn).

One notable finding is that the 'feathering' of camera moves (i.e., the tapering of the start and end of the move to create a smooth, fluid motion) can cause frame accuracy errors as can shots with a low rate of movement (e.g., slow pans). This suggests adaptive variation of detection thresholds and is thus another area for future work.

In examining other sequences that posed problems, we identified several conditions that likely require a system to have a more formal model of visual perception. Camera moves that keep the subject static within frame as the subject physically moves can fail if the background does not have a clear pattern or texture (e.g., the clear sky in shot 10 or the unmarked tarmac in shot 56, where cars are being tracked as they slowly move). Likewise *ASAP* can have trouble distinguishing the direction of camera movement in shots where the dominant movement is not objectively clear. We believe that such errors are not unique to our perspective estimation approach but apply to other non-intelligent methods as well. Alternative camera motion classification systems were not available for direct comparison. We hope to include these in future work.

CONCLUSIONS

ASAP is a film and TV industry oriented video shot analysis and documentation tool that quickly and robustly creates logs and searchable databases of footage based on camera activity. We have shown that its cut detection is more robust than other current approaches and that it can parse complex camera movements from complex source footage. Future work will include incorporating motion segmentation capabilities to interpret object movement, the parsing of full camera movement (e.g., dolly moves) and developing *ASAP* as a plug-in for existing post-production tools.

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Automated Reverse Storyboarding

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Abstract
Storyboarding is a standard method for visual summarization of shots in film and video preproduction. Reverse storyboarding is the generation of similar visualizations from existing footage. We identify the key attributes of preproduction storyboards then develop computational techniques that extract corresponding features from video, render them appropriately, then composite them into a single storyboard image. The result succinctly represents background composition, foreground object appearance and motion, and camera motion. For tracking shots, we show that the visual representation conveys all the essential elements of shot composition.

1 Introduction

Visual summaries play an important role in the production and analysis of media. Practitioners, researchers and archivists all demand that the information presented is accurate and described in a consistent form using common metaphors derived from industry nomenclature. The goal is to enable quick access to details of specific shots or sequences without having to view the footage itself.

In the media production industry, visual summarization is typically achieved through *storyboards*. Storyboards are drawn during preproduction then used throughout production and postproduction in tasks like set design, location lighting and image compositing. They provide for all participants a common reference to the "vision" of the piece. Shorthand descriptions of all important visual components of each shot provide clear and accurate depictions of motion sequences in static form. These include specific methods of describing camera or subject movement through the use of various drawing techniques. While the term storyboard has been applied in the context of automated media analysis to a sequence of consecutive still images extracted from a film or video programme, the representations traditionally used in the production industry are much richer. Our usage in this paper corresponds to film production storyboarding: *i.e.*, we seek to describe the temporal evolution of a shot through a single picture using rich visual cues.

Storyboards incorporate the following types of information:

1. Composition of the shot, including start, end and notable intermediate camera positions
2. General appearance (perhaps sketchy) of background and foreground elements showing salient features
3. Depiction of object movement
4. Depiction of camera movement

The techniques used for depicting object movement are:

Onion skins show multiple instances of a subject that indicate its intermediate positions between the start and end frames. Figure 1 is an example.

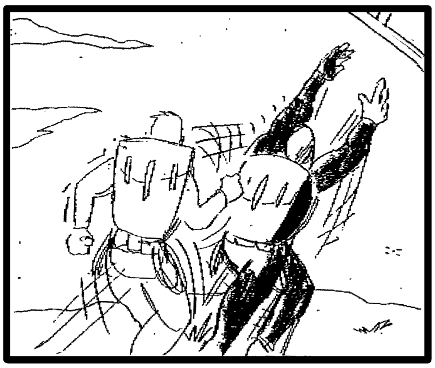


Figure 1: Onion skin effect conveying motion

Streaks are lines that show the trajectory of a moving object. The long arcs in the direction of motion in figure 2 are streaks.

Trail lines are repetitions of the trailing edge of a moving object. (Trail lines are sometimes called "ghosts": we avoid this usage because animators sometimes refer to onion skins as ghosts.) Trail lines are often used with streaks (to which they are roughly perpendicular) as in figure 2.

Arrows are sometimes used to emphasize the direction of motion

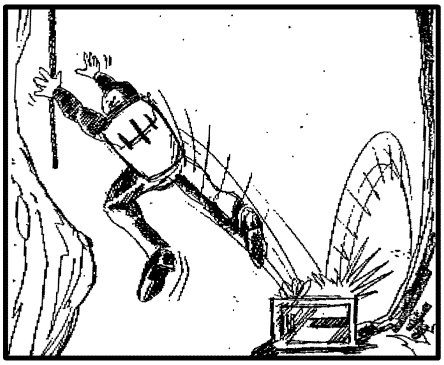


Figure 2: Motion trail lines to show speed and motion

The techniques used for depicting camera movement are:

Mosaics are storyboards that show the full panorama viewed in a pan or tilt. Again, frame outlines for start and end frames are drawn. See figure 3.

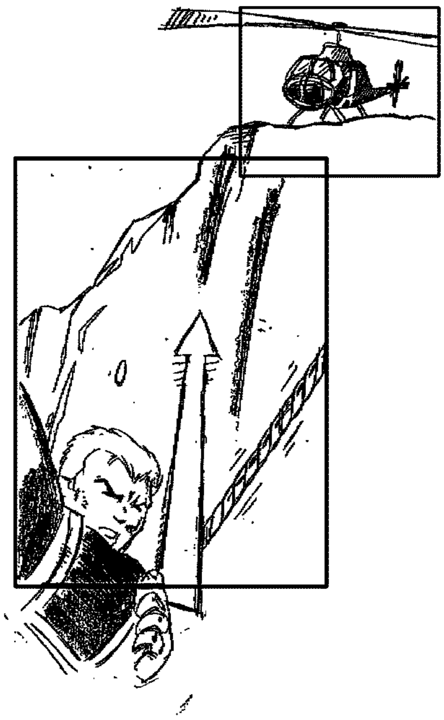


Figure 3: Mosaic storyboard showing full scope of shot

Arrows are sometimes used to emphasize the direction of camera motion.

Field cuts are frame outlines drawn on the storyboard indicating an initial or final zoom position [12], an example of which is shown in figure 4.

Given the effectiveness of storyboarding in creative development, it follows that similar motion metaphors may prove valuable in the creation of visual summaries of existing film and video sequences. The use of established visual conventions should mean that summaries created in this manner are more intuitive and more easily interpreted than those from other video summarisation techniques.

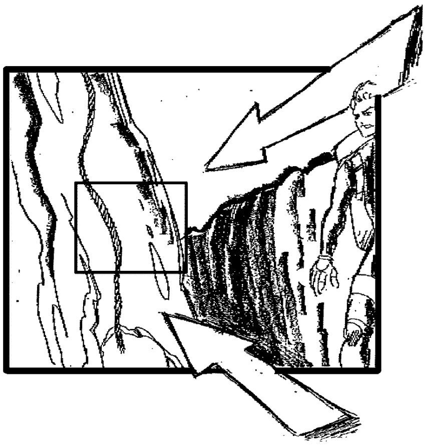


Figure 4: Field cut showing camera motion

This paper describes new work in developing image processing methods applied to footage-based storyboards that incorporate some of the same techniques used by industry storyboard artists to provide more effective descriptions that are more readily accessible to these user groups.

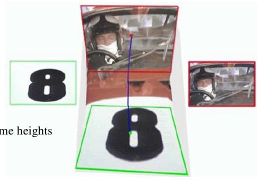
2 Prior Work

Because the number of still frames contained in even a short footage sequence is large, significant work has been carried out to determine more efficient means of visually describing content. Many of these studies have focused on means of determining which particular frames, or "keyframes," best convey a sequence [8] and ways of presenting those frames in more intuitive ways including the determination and subsequent larger display of dominant frames [27] and the use of the Japanese comic book-inspired Manga layouts described in [6]. Other work has looked at different forms of video abstraction and summarization [13], [10]. However, there has been only limited research on the way media practitioners create and utilise storyboards with a view toward creating systems for automated summarisation [14]. Likewise, research into the use of mosaics in an industry storyboarding context is very limited. The generation and overlaying of cartoon-style motion cues, widely used by industry storyboard artists, has been examined [4] but relies on the user identifying specific objects or areas of interest within frames.

Our interest in reverse storyboarding arose from development of a system for semi-automated footage logging for archiving or post-production [18] (Semi-Automated Logging with Semantic Annotation, or *SALSA*). *SALSA* provides two mechanisms for shot visualization: the keyframe and the mosaic. *SALSA*'s extraction of keyframes from static holds is intelligent. If the hold is interrupted by the passage of a transient occluding object, *SALSA* will avoid the frames with the object in its choice of keyframe. Similarly *SALSA* can mosaic shots in which there is a pan, tilt or zoom, registering successfully even in the presence of moderate foreground motion. *SALSA*'s output mosaics have start and end frames outlined by bounding boxes, and the frame centres are connected by a trajectory line. They therefore summarize camera motion is a similar way to storyboards. However, they do not represent object motion, except artifactually through moving objects that may appear smeared in the mosaic.

The adequacy of keyframes plus mosaics to represent footage is content dependent. The 20 minute sequence from the 1971 feature film *Le Mans* [22] used in our previous work [18] yields the *SALSA* log, an example portion of which is shown in figure 5. The entire log of the shot analysis portion of *SALSA* for *Le Mans* can be found at [17].

Shot	Start frame	End frame	Start time	End time	Duration	Description
161	25502	25503	17:00:01	17:00:02	0:00:02	Hold
	25504	25611	17:00:03	17:04:10	0:04:08	Tilt up 1.17949 frame heights
	25612	25631	17:04:11	17:05:05	0:00:20	Hold



Starts on tight close-up of number 8 on car bonnet tilts to loose close-up of driver

——————————CUT——————————

Shot	Start frame	End frame	Start time	End time	Duration	Description
162	25632	25689	17:05:06	17:07:13	0:02:08	Hold

Tight close-up of driver

Figure 5: SALSA example output from *Le Mans*

Figure 6 illustrates an example mosaic with the camera movement, a zoom out with minor motion, shown. In the *Le Mans* trial sequence the shots may be informally categorized as follows:

- Holds with little significant foreground motion except for transient occluding objects: 164 shots.
- Holds with significant foreground motion: 50 shots.
- Shots with a mosaic-able camera move and little other significant motion: 40 shots.
- Shots with a camera move and little other significant motion that are not immediately mosaic-able (i.e. dolly moves): 2 shots.
- Tracking shots: 17 shots.
- Tracking shots wrongly interpreted by *SALSA* as holds: 2 shots.
- Other shots involving both camera movement and significant movement of foreground objects: 11 shots.

It cannot be overemphasized that the relative number of different types of shots is a function of film language and the vision of the director. This particular sequence includes a montage that accounts for a high proportion of the 164 simple holds. It should be noted this sequence is an extreme example chosen for its complexity. The holds

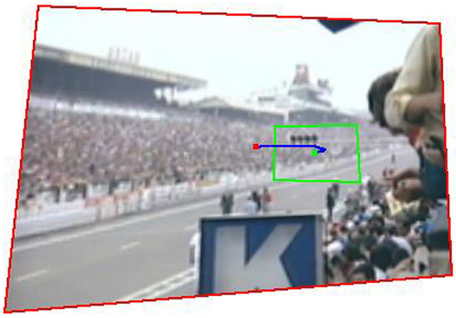


Figure 6: SALSA example output showing mosaic with start frame box, end frame box, and camera path all overlayed

and moves it contains, with significant object motion, are more complicated than may be encountered in many types of footage.

As would be expected from the figures above, *SALSA* as previously reported can efficiently summarize about two thirds of the *Le Mans* sequence with keyframes for the simple holds and mosaics for the simple moves. Of the remainder, the shots with significant foreground object motion vary greatly in complexity. Some involve the interaction of several objects translating and rotating in 3-space. Some illustrate the difficulty of automatically making good representation choices. For example in one shot, most of the measurable movement is in one part of the scene, but the story of the shot is in the movement of one person's eyes, which occupy a tiny proportion of the frame.

To extend the coverage of *SALSA*'s shot summarization facilities, and take a significant step towards a rich reverse storyboarding system, we have therefore turned to the representation of tracking shots. In these the camera follows a subject as it moves in the scene. Provided the object is not too large, the camera move is correctly detected and the frames mosaiced correctly with respect to the background. (If the object is too large in the frame, the result is a tracking shot incorrectly interpreted as a hold.) The framing of the subject in a tracking shot takes away the semantic problem of moving objects mentioned in the previous paragraph: in a tracking shot, the object being followed is the most important. Although good representation of tracking shots only adds 17 more visualizations to *SALSA*'s log of *Le Mans*, it represents the most tractable extension. The problem we are left with is how to represent the movement of the camera and the subject in a meaningful way.

3 Methods

Storyboard artists use a number of techniques as discussed in section 1 to convey the important elements of a shot including background, foreground elements, object motion, and camera motion. Our goal is to extract these elements from production video footage and convey them in a manner consistent with a traditional storyboard presentation. We must therefore identify the artists' techniques we wish to imitate for depicting these elements. Once these are identified, the next task becomes the development of, first, efficient procedures for processing the digital footage to extract the required elements and then of visualisation techniques to portray these elements consistent with the chosen artistic techniques.

We address each of the four elements in turn below.

3.1 Background

The background is a sketch of the static elements of the scene upon which the moving foreground objects can be drawn. For the purposes of storyboarding, we wish to create a mosaic from the video footage to represent only the background. Therefore it is necessary to remove the moving objects as they will be added to the storyboard separately.

The generation of mosaics from moving video is an extensively researched topic [5, 9, 11, 15, 20, 26]. Most techniques involve two stages: the estimation of the projective transforms from the video sequence that map frame co-ordinates to mosaic co-ordinates, and a method of combining the frame images using the transforms.

There are numerous methods in the literature for estimating the projective transforms, *e.g.*, [9, 15]. For this work, we employ the projective estimator used in *SALSA*. It is a fast, highly-accurate, estimator previously developed for image mosaicing and registration in augmented reality [23]. The estimator uses simplex minimization of a disparity function calculated over a mesh of samples taken from the picture. This estimator has been used for object-based video analysis and coding [24, 25], but the method only uses the output of eight perspective transform parameters to calculate the correspondence between frames. We then accumulate these parameters to calculate a set of transformations, $\mathcal{P}_i$, one for each frame i, that maps the frame co-ordinate $\vec{x}_{f_i} = (x_{f_i}, y_{f_i})^T$ to the mosaic co-ordinate $\vec{x}_m = (x_m, y_m)^T$ as

$$\vec{x}_m = \mathcal{P}_i \vec{x}_{f_i} \quad (1)$$

The inverse transformation is simply $\mathcal{P}_i^{-1}$.

The problem now remains of how to combine the frame images under the set of transformations to produce an appropriate mosaic. Unfortunately, when examining previous work, most of the applications for such work has focused on tele-reality, virtual reality environments, and panoramic composites for consumer photography. Research into the use of mosaics in an industry storyboarding context is limited. Many of the approaches to mosaicing assume a static scene and therefore do not explicitly take into consideration moving objects. Others do consider motion within the scene, but the goal is to produce a "pleasing" image. For storyboarding, the proper consideration of motion is crucial to the final representation.

We can classify the various frame combination methods into two general categories: sequential and statistical. For sequential methods, the most widely investigated of the two, the frames are combined in some order of presentation. For statistical methods, the statistics of the group of frame pixels corresponding to a location in the mosaic are examined. We may be able to devise an operator using such statistics that extracts only the background pixel value for incorporation into the mosaic.

We evaluate a number of methods from both approaches below. To illustrate the differences between the background mosaic construction methods being considered, we have chosen a tracking shot from music video for *Stargazer* [19]. Stills of every 10th frame of the 200 total are shown in figure 7. The video was shot in black and white PAL widescreen format. This results in an artifact whereby 16:9 aspect ratio shots are digitally encoded into 4:3 aspect ratio video frames, thus the images appear "squeezed". The camera pans right, tracking a man and a woman walking to the right. They are initially with a couple standing still. As they walk to the right, the man exits through the door seen in the middle of the shot. The woman eventually stops and crouches down to place her handbag on the floor. The camera continues to pan right until the last frame showing the woman now crouching down and two new people just having entered the field of view - a seated woman and a man walking left.

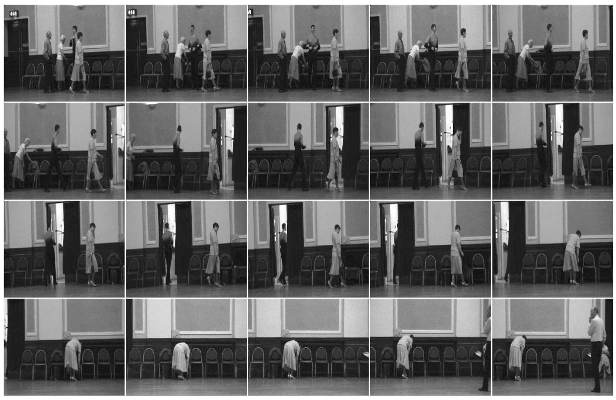


Figure 7: Tracking shot used for evaluating mosacing methods

The *Stargazer* tracking shot was chosen as an exemplar for this evaluation because it illustrates a range of features encountered in tracking shots, including the movement of multiple independent objects, the occurence of objects that appear only in one or two end frames, and the disappearance of objects (in this case because someone walks through a door). The commentary below refers directly to the *Stargazer* example, but the conclusions apply generally and have been observed consistently on a test set of a number of tracking shots of diverse kinds.

3.1.1 Sequential Mosaic Generation

Lapped Overwrite To illustrate the characteristics of sequential methods we first consider a simplistic approach where the mosaic is generated by overwriting the mosaic pixels of those of each successively new frame. This method, while being easy to implement, can introduce minor discontinuities at the edges of the frames. By modifying the algorithm to use a weighted overlap at the frame edges such edge artifacts can be reduced.

Figure 8 shows the result for the lapped overwrite approach on the above shot. The resulting mosaic appears quite well-formed without apparent artifacts. Since most of the pixels come from near the edges of the individual frames, objects that never leave the field of view do not appear in the mosaic. For example, we never see the walking man who exits through the centre door. However, moving objects which enter or leave the field of view are recorded in the mosaic. If an object were to move with the camera and remain at the trailing edge of the field of view during a portion of the shot, the object would appear as a long, drawn-out smudge. The only region in the mosaic without any possibility of such distortion is the last frame. It appears completely intact in the right-hand side of the mosaic, with all subjects appearing irrespective of their previous motion. The result for this approach can vary significantly depending on the order in which the frames are processed, for example in reverse order or middle outwards. Further, the method is not explicitly designed to extract only the static background. As a result, the output is not consistently suitable for our work.

Figure 8: Result of lapped overwrite mosaic generation

Optimal Boundary Davis [5] composites images by stitching a new, registered, frame into an existing mosaic along a data-determined, usually irregular, boundary. The boundary is computed by finding the absolute differences between the new frame and the mosaic at every overlapping point, then using Dijkstra's algorithm to define the minimum-total-difference path through each overlapping section. Points on one side of that boundary are taken from the old mosaic; points on the other side are taken from the new frame. There is no blending, simply a juxtaposing of frames. Davis shows that, in certain circumstances, the method can create effective mosaics of moving objects, because the objects are not blurred through blending.

Figure 9 shows the effect of applying Davis' method to the *Stargazer* sequence. Note that the method does indeed prevent blurring due to moving objects. However, as soon as the camera moves so that an object's position in the first frame goes out of shot, the object is re-rendered in the mosaic. For example, the walking man who exits through the middle door is depicted twice and so is the walking woman who ends up crouching down. Further, an interesting artifact is introduced in the left-most rendering of the walking man – his upper and lower bodies are somewhat shifted relative to each other. The final appearance of the mosaic can be altered if it is generated from last frame to first, or in some other order. Although some outputs are fortuitously similar to onion skin motion representation, others are not. As with simple overwriting and lapped joints, the Davis method, being order-sensitive, generates a background with unpredictable foreground content and is therefore also unsuitable for our purpose.

Figure 9: Result of Davis' optimal boundary mosaic generation

3.1.2 Statistical Mosaic Generation

The sequential methods are not explicitly designed to extract only the static background in the presence of moving foreground elements. It is not surprising, then, that such methods are inadequate for our work.

We wish to devise a mosaic generation method that consistently extracts only the background. To this end, we employ a statistical framework. Using the statistical properties of the set of frame pixels corresponding to a particular mosaic co-ordinate it may be possible to classify the intensities into two groups: static background and moving foreground. With such a classification the representative background intensity can be incorporated into the mosaic at each co-ordinate.

To begin, we define $\mathbf{F}_{\vec{x}_m}$ to be the set of all frame images whose frame co-ordinate resulting from the inverse transform of the mosaic co-ordinate, $\mathcal{P}_i^{-1}\vec{x}_m$, falls within the frame image, or more precisely

$$\mathbf{F}_{\vec{x}_m} = \{i \mid \mathcal{P}_i^{-1}\vec{x}_m \in \mathbf{X}_{f_i}\} \quad (2)$$

where $\mathbf{X}_{f_i}$ is the set of valid co-ordinates for frame i. Next, we define $\mathbf{I}_{\vec{x}_m}$ as the set of frame image values at the respective valid locations corresponding to the mosaic co-ordinate $\vec{x}_m$, that is,

$$\mathbf{I}_{\vec{x}_m} = \{I_{f_i}(\mathcal{P}_i^{-1}\vec{x}_m) \mid i \in \mathbf{F}_{\vec{x}_m}\} \quad (3)$$

In other works, the set $\mathbf{I}_{\vec{x}_m}$ contains the frame image intensities from locations that map onto the mosaic co-ordinate $\vec{x}_m$.

If no moving objects were to pass in front of the background at mosaic co-ordinate $\vec{x}_m$, the set $\mathbf{I}_{\vec{x}_m}$ would only contain the intensity value, I_B, of the background. If an object of intensity I_O were to occlude the background for a period of time, the set would contain both intensity values. If we were to assume that the object appears for a shorter time than the background (a not unreasonable condition since it follows from the definition of the background as being the static element of the shot that we expect some degree of permanence), then the number of background intensities in $\mathbf{I}_{\vec{x}_m}$ is larger than those of the object. So, we wish to use an operator which returns the value of the intensity that occurs most frequently in the set.

Mode Based on the above argument, the mode of the set appears to be an appropriate statistic for our use. Therefore a mode-based mosaic can be calculated as

$$I_m(\vec{x}_m) = \arg\max_{I \in \mathbf{I}_{\vec{x}_m}} N_{\mathbf{I}_{\vec{x}_m}}(I) \quad (4)$$

where $N_{\mathbf{I}_{\vec{x}_m}}(I)$ is the number of times intensity I occurs in $\mathbf{I}_{\vec{x}_m}$ also referred to as the histogram. However, when the number of samples is small, the mode operator is very sensitive to noise. To reduce the effects of noise, the histogram is Gaussian smoothed.

Figure 10 shows the result of the mode mosaic generator. It successfully renders a mosaic that is mostly free of moving foreground objects as expected. For example, the crouching woman on the right has been partially removed. As well, the walking man on the left is nowhere to be seen. However where an object appears for a longer length of time, the mosaic is quite noisy. This is quite evident for the crouching woman and man on the right. Further, there are obvious distortions in the intensity values in the image.

Figure 10: Result of mode mosaic generation

In areas where a moving object appears as equally long as the background, for example in a region that appears only briefly in the shot, the set $\mathbf{I}_{\vec{x}_m}$ is bimodal with both intensity values being equally as likely. Under these conditions, the mode operator is unstable so in the presence of even a small degree of noise the median output randomly flips between the two different intensity values.

Median A more stable operator is the median of the set as it is more robust under noise. Where there is a clear distinction between the foreground and background, *i.e.*, there are more background than foreground intensities in the set, the median returns the most numerous intensity, the background. As the distribution becomes more bimodal, the value of the median tends toward the mean, even under a degree of noise. It therefore degrades gracefully as the distinction between foreground and background becomes unclear.

The result of the median mosaic generator is shown in figure 11. In regions where there are no moving objects or objects which appear briefly, the method produces a clean background as it was designed to. Where foreground objects dwell for a relatively longer period of time, the distortion evident in the mode image is gone. Instead, the objects may appear with some varying degree of transparency. For example there is a barely visible "ghost" of the man on the left since he dwelt there for only a short period of time. The crouching woman on the right is far more visible in the mosaic since she was relatively motionless at that location for a period of time.

Unlike the sequential methods above, both the statistical operators are designed to construct mosaics that include only the static background. Where moving objects occlude the background briefly, both are successful at rendering only the background. Under ideal conditions the mode operator appears to be the optimal operator for rendering a mosaic free of such moving objects. However, the median appears to be a more robust operator under real conditions since it introduces less obtrusive artifacts where the distinction between foreground and background is not clear.

Figure 11: Result of median mosaic generation

Further, the statistical results have a very useful byproduct — intensities that are not part of the background are therefore from the foreground elements. In effect, we get the foreground identification for free.

3.2 Foreground Elements

We now turn to the second element in storyboards, the foreground elements.

One approach to identify moving foreground objects in a shot is to employ object tracking techniques [4]. This topic in computer vision has been extensively investigated [1, 2, 3, 7], especially in the context of human motion. The goal of such techniques typically is for measurement and modelling. Further, many require user assistance and can operate in only constrained or simplified environments. The goal of our work is to produce a visual representation of the shot in an automated manner. Therefore such techniques are not suitable for our purpose.

From the above discussion we see that the median operator which we choose for the creation of the background effectively gives us the foreground content at the same time. We use a measure of how confident we are that a frame pixel is from a foreground object by the absolute difference between its intensity value and the median calculated as

$$D_{\text{mot},f_i}(\vec{x}_{f_i}) = |I_{f_i}(\vec{x}_{f_i}) - \text{median}\,(\mathbf{I}_{\vec{x}_m})| \qquad (5)$$

where $\vec{x}_m = \mathcal{P}_i \vec{x}_{f_i}$. When the pixel location is part of the background, then $D_{\text{mot}} \approx 0$ and when it is part of a moving object, $D_{\text{mot}} > 0$. Now, if the moving object has a similar intensity at that location to the background at that same location, then D_{mot} will be small. However, since the goal is to produce a visual representation of the moving object, the small difference in intensities does not pose a problem as we will see later.

Figure 12 shows the resulting moving object images for the middle column of stills shown in figure 7. In general this method of object identification is quite successful despite its simplicity. Where there is a good contrast between a moving object and the background, the object appears quite clearly. As anticipated, there is little response where there is poor contrast. Two artifacts are of interest. In the bottom left frame, the woman appears twice – once

Figure 12: Moving object images for middle column of figure 7

as walking and once as crouching. Referring to the corresponding frame in figure 7 (third row, middle column), we clearly see that she appears only once as walking. The phantom image of her crouching is caused by the incorrect identification of the crouched figure as background as illustrated in figure 11. The second artifact is the presence of faint outlines of objects in the background such as chairs and wall frames. This is due to minor errors in the projective estimation algorithm.

3.3 Object Movement

Storyboard artists draw upon a number of techniques to convey motion within a shot that include, as described in section 1, onion skins, streaks, trail lines, and arrows. A good artist will tend to employ a limited number of these, typically one or two in combination, in a given board to convey succinctly and clearly the essence of the movement. The use of too many devices may introduce unnecessary clutter and confusion. For our work, then, we will focus on a subset of such cues for extraction and rendering.

Onion skins are an effective way of representing the object and its motion. We can make use of the above method of extracting foreground elements to create the multiple poses. In addition, artists commonly use trail lines behind the onion skin figures to further accentuate the motion. For our purposes, these two techniques will suffice. The additional inclusion of streaks is effectively redundant and will only clutter the final rendition. The use of arrows as a motion cue can be less expressive in some cases than other cues. Including arrows may be redundant and interfere with the clean portrayal of the other elements. Further, their placement sometimes requires sophisticated artistic judgment which is not easily copied by an automated system.

3.3.1 Onion Skins

The moving objects identified above in section 3.2 are overlayed on the background with varying degrees of transparency in the manner of the onion skin technique. The opacity of each pixel in the object overlay is proportional to the value found in equation 5. To differentiate these added moving objects from the background in colour images, the objects are shown in monochrome. We set the spacing between the versions as proportional to the over-all camera motion — the more the camera moves, the more versions we can include without introducing undue clutter.

3.3.2 Motion Trail Lines

To produce trailing motion lines behind the onion skin figures, we make use of the time difference between adjacent frames calculated as

$$D_{\mathrm{dt},f_i}(\vec{x}_{f_i}) = \left| I_{f_{i-1}}(\mathcal{P}_{i-1}^{-1}\mathcal{P}_i\vec{x}_{f_i}) - I_{f_i}(\vec{x}_{f_i}) \right| \tag{6}$$

To achieve this effect for each onion skin figure, we calculate the time difference for the preceding n frames from the figure and apply the results to the composite producing n trails following the subject. The trails are drawn in a fixed colour (black in this case) whose opacity is proportional to the motion measure as calculated in equation 6. The opacity of a trail mark further varies as a function of the frame index difference between the mark and object so that the marks appear to fade away behind the object.

3.4 Camera Movement

We now have the information for three of our four storyboard components: background, foreground elements, and motion representation. The fourth component, an indication of camera motion, can be generated from the parameters of the perspective estimation algorithm used to generate the background mosaic. As described in section 1, techniques used for depicting camera movement are field cuts, mosaics and arrows.

In previous work, *SALSA* already incorporates two of these techniques — field cuts and mosaics. It generates a mosaic of the entire shot background and draws boxes showing the fields of view of the start and end frames, the start in green and the end in red, and line segments showing the motion of the centres of the view as the camera moves. The resulting representation has been shown to be very effective in conveying the camera movement so we make use of it in this reverse storyboarding system. As a further aid to visualisation, we also add the first and last frames as opaque overlays where the two frames do not overlap instead of presenting them separately as does *SALSA*.

Since the use of drawing the field cuts on a mosaic provides sufficient motion information, we did not pursue the generation and rendering of arrows as an additional technique. As for the object motion cues, the use of arrows can be redundant and their addition to the final storyboard can unduly clutter the result.

4 Results and Discussion

The final storyboard composite for the video sequence of figure 7 is shown in figure 13. The green box on the left outlines the opening frame of the shot while the red box shows the final frame. The middle blue line with cyan marks shows the path of the camera centre through the shot. As well, the start and end frames themselves are overlayed without any motion markings to anchor the shot. Between the start and the end, three versions of

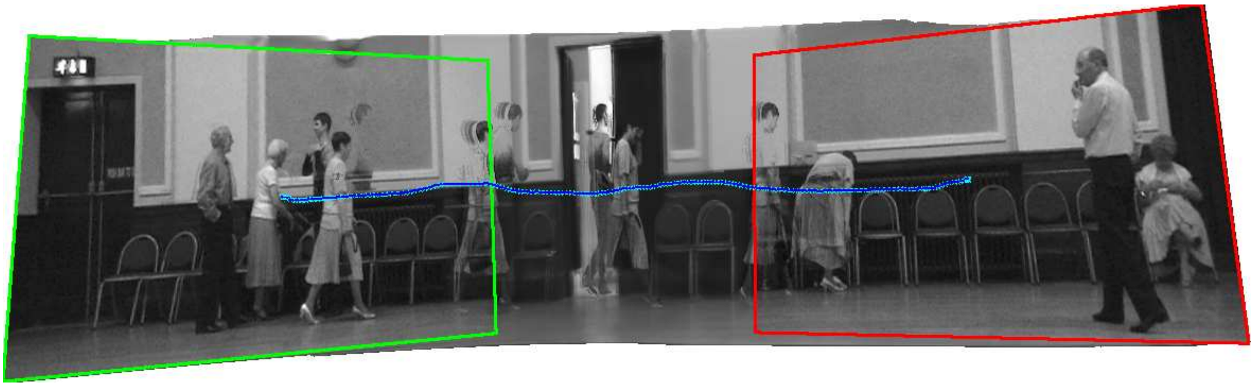


Figure 13: Storyboard automatically generated from video sequence in figure 7

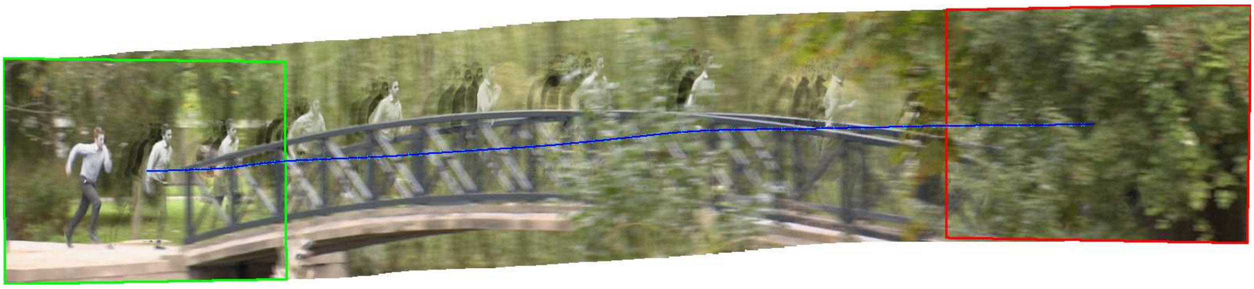


Figure 14: Storyboard automatically generated from *Tick Tock* tracking pan sequence (L-R)

the moving objects were added along with trailing black marks indicating motion.

The storyboard clearly conveys a number of key features of the shot. It is a pan right shot as indicated by the start and end frame boxes. The start frame overlay shows the initial four subjects. During the shot, the motion of the man walking to the right and exiting though the middle door is shown. As well, the motion of the woman walking to the right and eventually crouching down is conveyed. The final frame shows the crouched woman, a third woman sitting on a chair, and a third man walking to the left.

When examining the results of the individual components in sections 3.1-3.3 above, a number of artifacts were identified. However, when all the components are assembled in the storyboard these artifacts are not apparent. For example, the misclassification of the crouching woman figure as background or the figure's absence as a moving object are not visible. On the contrary, the semi-transparent rendering of her helps conveys the sequence of actions. As well, the action of the walking man entering the field of view on the right, while appearing distorted in both the background mosaic and the moving object identifier, is well conveyed by the final mosaic. Further, the discontinuities in the object identification and motion detectors due to low contrast between the object and background are not at all visible.

As another test, a tracking shot of a single person running from the movie short *Tick Tock* [16] was processed. Unlike the *Stargazer* sequence, this is in colour. The method was simply modified to use the colour median operator [21] and the L_1 distance in RGB space to measure differences for motion and object detection. The result is shown in figure 14. The result shows that the method generalises well to colour data. In this example, the elements of the shot are well represented. The onion skin of the versions of the figures and their motion tails convey their movement. Further, the blur due to the fast camera motion also conveys the sense of speed.

As a further test of the system, we processed a number of shots from the film *LeMans*. Figure 15 is from a pan shot of a crowd with a flag being waved. In the shot used for figure 16, the camera follows the man with glasses in the yellow shirt as he stands up. For figure 17, the camera does not move appreciably, but the man is motioning with his right hand. In the final shot, producing figure 18, again there is no camera motion, but subjects are moving.

Even for moderately complex shots, the system is relatively successful in conveying the composition of the shot. Figure 15 clearly shows the pan and the waving flag. However, the complex background in figure 16 interferes with the clear rendition of the moving figure producing a somewhat less than intelligible result. While our goal was initially to focus on tracking pan shots, we have included two holds with motion. The results in figures 17 and 18 show that the system can still convey the sense of motion and gives some indication of the nature of such motion.

5 Conclusions

Storyboarding is a production-industry standard visualisation tool for film and video. A storyboard effectively conveys a visual summary of shot elements such as back-

Figure 15: Storyboard generated from tracking pan (R-L-R)

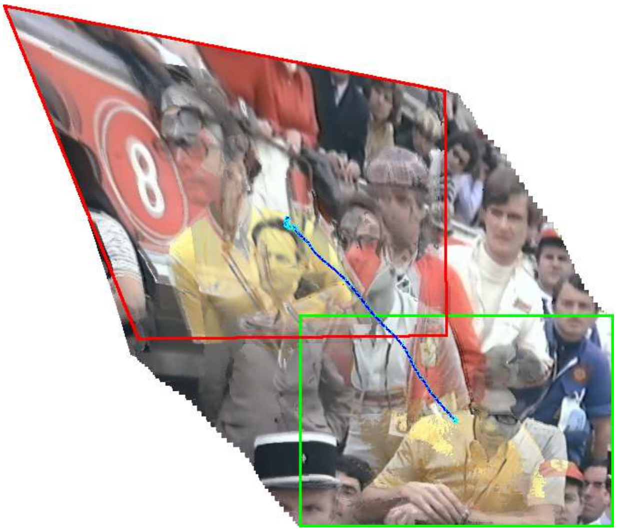


Figure 16: Storyboard generated from tracking tilt (L-Up)

Figure 17: Storyboard generated from handheld static shot (1)

ground, subject motion and camera framing and motion. Our goal has been to develop an automated system which takes raw video footage of a shot and, without the need for operator input, produces a visual representation of the shot in manner analogous to a hand-drawn story-

Figure 18: Storyboard generated from handheld static shot (2)

board frame. Such a system would be a valuable post-production tool. We build on a previously developed tool, *SALSA*, which provided some preliminary visualisation aids. Methods of image mosaicing based on sequential processing of frames do not adequately remove moving objects. We derive a statistical mosaicing method based on the median to produce the storyboard background. Foreground objects are then those that have intensity values which differ from the median. To convey a sense of motion, the difference between adjacent frames is used. The final image is a composite of the background, the moving subjects with motion cues in the manner of the onion skin method in storyboarding, boxes outlining the start and end frames with an overlay of the frames themselves, and a track of the intervening camera movement.

The system was run on a number of video shots. For tracking shots the system produced visual representations that succinctly conveyed the composition. The median-based mosaic generator successfully produced the storyboard background upon which the motion cues were applied. The motion cues produced are similar to the onion skin technique of standard storyboard art. These were generated using simple processing methods requiring no user input. Even for more complex shots, the output conveyed much of the composition. When the system processed shots with little camera movement, it was successful in capturing the essence of the motion. In some cases, however, with complex background and/or motion, the resulting composition is cluttered and can be difficult to interpret.

In all, the results demonstrate that the system fulfills our goal of producing a storyboard using the same devices used by industry storyboard artists in a completely automated manner. It can successfully be used on a number of important types of shots including holds with little foreground motion, shots with a camera movement and little other motion, and tracking shots. It therefore can be a valuable tool for the creation of visual summaries of existing film and video sequences for production, post-production, and archiving applications.

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Techniques for Automated Reverse Storyboarding

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Abstract

Storyboarding is a standard method for visual summarization of shots in film and video preproduction. Reverse storyboarding is the generation of similar visualizations from existing footage. We identify the key attributes of preproduction storyboards then develop computational techniques that extract corresponding features from video, render them appropriately, then composite them into a single storyboard image. The result succinctly represents background composition, foreground object appearance and motion, and camera motion. For a variety of shots, we show that the visual representation conveys all the essential elements of shot composition.

1 Introduction

Visual summaries play an important role in the production and analysis of media. Practitioners, researchers and archivists all demand that the information presented is accurate and described in a consistent form using common metaphors derived from industry nomenclature. The goal is to enable quick access to details of specific shots or sequences without having to view the footage itself.

In the media production industry, visual summarization is typically achieved through *storyboards*. Storyboards are drawn during preproduction then used throughout production and postproduction in tasks like set design, location lighting and image compositing. They provide for all participants a common reference to the “vision” of the piece. Shorthand descriptions of all important visual components of each shot provide clear and accurate depictions of motion sequences in static form. These include specific methods of describing camera or subject movement through the use of various drawing techniques. While the term “storyboard” has been applied in the context of automated media analysis to a sequence of consecutive still images extracted from a film or video programme, the representations traditionally used in the production industry are much richer. Our usage in this paper corresponds to film production storyboarding:

i.e., we seek to describe the temporal evolution of a shot through a single picture using rich visual cues.

These storyboards incorporate the following types of information:

1. Composition of the shot, including start, end and notable intermediate camera positions
2. General appearance (perhaps sketchy) of background and foreground elements showing salient features
3. Depiction of object movement
4. Depiction of camera movement

The techniques used for depicting object movement are:

Onion skins: show multiple instances of a subject that indicate its intermediate positions between the start and end frames. Figure 1 is an example. Note the transparent instance of the man indicating intermediate position contrasted with the inked instance, which shows an absolute position within frame.

[Figure 1 about here.]

Streaks: lines that show the trajectory of a moving object. The long arcs in the direction of motion in figure 2 are streaks that clearly indicate the man's running toward camera then jumping off of the box.

[Figure 2 about here.]

Trail lines: repetitions of the trailing edge of a moving object. (Trail lines are sometimes called "ghosts": we avoid this usage because animators sometimes refer to onion skins as ghosts.) Trail lines are often used with streaks (to which they are roughly perpendicular as in figure 2) to give a sense of the subjects physical orientation during the motion.

Arrows: sometimes used to emphasize the direction of motion

The techniques used for depicting camera movement are:

Mosaics are storyboards that show the full panorama viewed in a pan or tilt. Again, frame outlines for start and end frames are drawn. See figure 3. All salient information related to setting and action are displayed.

[Figure 3 about here.]

Arrows: sometimes used to emphasize the direction of camera motion.

Field cuts: frame outlines drawn on the storyboard indicating an initial or final zoom position [12], an example of which is shown in figure 4. Compositions shown for the start and end positions clear show all relevant positional information.

[Figure 4 about here.]

Given the effectiveness of storyboarding in creative development, it follows that similar motion metaphors may prove valuable in the creation of visual summaries of existing film and video sequences. The use of established visual conventions should mean that summaries created in this manner are more intuitive and more easily interpreted than those from other video summarisation techniques.

Our goal, then, is to develop automated image processing methods to create visual summaries, incorporating some of the same techniques used by industry storyboard artists. Because of the acceptance by the industry of such techniques, the resulting descriptions will be more readily accessible to these user groups. This paper describes this new work and presents results for processing actual production footage.

2 Prior Work

Because the number of still frames contained in even a short footage sequence is large, significant work has been carried out to determine more efficient means of visually describing content. Many of these studies have focused on means of determining which particular frames, or "keyframes," best convey a sequence [8] and ways of presenting those frames in more intuitive ways including the determination and subsequent larger display of dominant frames [28] and the use of the Japanese comic book-inspired Manga layouts described in [6]. Other work has looked at different forms of video abstraction and summarization [13], [10]. However, there has been only limited research on the way media practitioners create and utilise storyboards with a view toward creating systems for automated summarisation [14]. Likewise, research into the use of mosaics in an industry storyboarding context is very limited. The generation and overlaying of cartoon-style motion cues, widely used by industry storyboard artists, has been examined [4] but relies on the user identifying specific objects or areas of interest within frames.

Our interest in reverse storyboarding arose from development of a system for semi-automated footage logging for archiving or post-production [18] (Semi-Automated Logging with Semantic Annotation, or *SALSA*). *SALSA* provides two mechanisms for shot visualization: the keyframe and the mosaic. *SALSA*'s extraction of keyframes from static holds is intelligent. If the hold is interrupted by the passage of a transient occluding object, *SALSA* will avoid the frames with the object in its choice of keyframe. Similarly *SALSA* can mosaic shots in which there is a pan, tilt or zoom, registering successfully even in the presence of moderate foreground motion. *SALSA*'s output mosaics have start and end frames outlined by bounding boxes, and the frame centres are connected by a trajectory line. They therefore summarize camera motion is a similar way to storyboards. However, they do not represent object motion, except artifactually through moving objects that may appear smeared in the mosaic.

The adequacy of keyframes plus mosaics to represent footage is content dependent. The 20 minute sequence from the 1971 feature film *Le Mans* [22] used in our previous work [18] yields the *SALSA* log, an example portion of which is shown in figure 5. The entire log of the shot analysis portion of *SALSA* for *Le Mans* can be found at [17].

[Figure 5 about here.]

Figure 6 illustrates an example mosaic with the camera movement, a zoom out with minor motion (pan left), shown. In the *Le Mans* trial sequence the shots may be informally categorized as follows:

- Holds with little significant foreground motion except for transient occluding objects: 164 shots.
- Holds with significant foreground motion: 50 shots.
- Shots with a mosaic-able camera move and little other significant motion: 40 shots.
- Shots with a camera move and little other significant motion that are not immediately mosaic-able (i.e. dolly moves): 2 shots.
- Tracking shots: 17 shots.
- Tracking shots wrongly interpreted by *SALSA* as holds: 2 shots.
- Other shots involving both camera movement and significant movement of foreground objects: 11 shots.

[Figure 6 about here.]

It cannot be overemphasized that the relative number of different types of shots is a function of film language and the vision of the director. This particular sequence includes a montage that accounts for a high proportion of the 164 simple holds. It should be noted this sequence is an extreme example chosen for its complexity. The holds and moves it contains, with significant object motion, are more complicated than may be encountered in many types of footage.

As would be expected from the figures above, *SALSA* as previously reported can efficiently summarize about two thirds of the *Le Mans* sequence with keyframes for the simple holds and mosaics for the simple moves. Of the remainder, the shots with significant foreground object motion vary greatly in complexity. Some involve the interaction of several objects translating and rotating in 3-space. Some illustrate the difficulty of automatically making good representation choices. For example in one shot, most of the measurable movement is in one part of the scene, but the story of the shot is in the movement of one person's eyes, which occupy a tiny proportion of the frame.

To extend the coverage of *SALSA*'s shot summarization facilities, and take a significant step towards a rich reverse storyboarding system, we have therefore turned to the representation of tracking shots. In these the camera follows a subject as it moves in the scene. Provided the object is not too large, the camera move is correctly detected and the frames mosaiced correctly with respect to the background. If the object is too large in the frame, the result is a tracking shot incorrectly interpreted as a hold. The framing of the subject in a tracking shot takes away the semantic problem of moving objects mentioned in the previous paragraph: in a tracking shot, the object being followed is the most important. Although good representation of tracking shots only adds 17 more visualizations to *SALSA*'s log of *Le Mans*, it represents the most tractable extension. The problem we are left with is how to represent the movement of the camera and the subject in a meaningful way.

3 Methods

Storyboard artists use a number of techniques as discussed in section 1 to convey the important elements of a shot including background, foreground elements, object motion, and camera motion. Our goal is to extract these elements from production video footage and convey them in a manner consistent with a traditional storyboard presentation. We must therefore identify the artists' techniques we wish to imitate for depicting these elements. Once these are identified, the next task becomes the development of, first, efficient procedures for processing the digital footage to extract the required elements and then of visualisation techniques to portray these elements consistent with the chosen artistic techniques.

We address each of the four elements in turn below.

3.1 Background Generation

The background is a sketch of the static elements of the scene upon which the moving foreground objects can be drawn as illustrated in figures 3 and 4. For the purposes of storyboarding, we wish to create a mosaic from the video footage to represent only the background. Therefore it is necessary to remove the moving objects as they will be added to the storyboard separately.

The generation of mosaics from moving video is an extensively researched topic [5, 9, 11, 15, 20, 27]. Most techniques involve two stages: the estimation of the projective transforms from the video sequence that map frame co-ordinates to mosaic co-ordinates, and a method of combining the frame images using the transforms.

There are numerous methods in the literature for estimating the projective transforms, *e.g.*, [9, 15]. For this work, we employ the projective estimator used in *SALSA*. It is a fast, highly-accurate, estimator previously developed for image mosaicing and registration in augmented reality [23]. The estimator uses simplex minimization of a disparity function calculated over a mesh of samples taken from the picture. This estimator has been used for object-based video analysis and coding [25, 26], but the method only uses the output of eight perspective transform parameters to calculate the correspondence between frames. We then accumulate these parameters to calculate a set of transformations, $\mathcal{P}_i$, one for each frame i, that maps the frame co-ordinate $\vec{x}_{f_i} = (x_{f_i}, y_{f_i})^T$ to the mosaic co-ordinate $\vec{x}_m = (x_m, y_m)^T$ as

$$\vec{x}_m = \mathcal{P}_i \vec{x}_{f_i} \tag{1}$$

The inverse transformation is simply $\mathcal{P}_i^{-1}$.

The problem now remains of how to combine the frame images under the set of transformations to produce an appropriate mosaic. Unfortunately, when examining previous work, most of the applications for such work has focused on tele-reality, virtual reality environments, and panoramic composites for consumer photography. Research into the use of mosaics in an industry storyboarding context is limited. Many of the approaches to mosaicing assume a static scene and therefore do not explicitly take into consideration moving objects. Others do consider motion within the scene, but the goal is to produce a "pleasing" image. For storyboarding, the proper consideration of motion is crucial to the final representation.

One approach to account for moving objects in the generation of a mosaic is to employ object tracking techniques. This topic in computer vision has been extensively investigated [1, 2, 3, 7], especially in the context of human motion. The goal of such techniques typically is for measurement and modelling. Further, many require user assistance and can operate in only constrained or simplified environments. The goal of our work is to produce a visual representation of the shot in an automated manner. Therefore such techniques are not suitable for our purpose. We instead devise a frame combination method that uses pixel statistics to extract the static background in an unsupervised manner.

We can classify various frame combination methods into two general categories: sequential and statistical. For sequential methods, the most widely investigated of the two, the frames are combined in some order of presentation. For statistical methods, the statistics of the group of frame pixels corresponding to a location in the mosaic are examined [24]. We may be able to devise an operator using such statistics that extracts only the background pixel value for incorporation into the mosaic.

We evaluate a number of methods from both approaches below. To illustrate the differences between the background mosaic construction methods being considered, we have chosen a tracking shot from the music video *Stargazer* [19]. Stills of every 10th frame of the 200 total are shown in figure 7. The video was shot in black and white PAL widescreen format. This results in an artifact whereby 16:9 aspect ratio shots are digitally encoded into 4:3 aspect ratio video frames, thus the images appear “squeezed”. The camera pans right, tracking a man and a woman walking to the right. They are initially with a couple standing still. As they walk to the right, the man exits through the door seen in the middle of the shot. The woman eventually stops and crouches down to place her handbag on the floor. The camera continues to pan right until the last frame showing the woman now crouching down and two new people just having entered the field of view - a seated woman and a man walking left.

[Figure 7 about here.]

The *Stargazer* tracking shot was chosen as an exemplar for this evaluation because it illustrates a range of features encountered in tracking shots, including the movement of multiple independent objects, the occurence of objects that appear only in one or two end frames, and the disappearance of objects (in this case because someone walks through a door). The commentary below refers directly to the *Stargazer* example, but the conclusions apply generally and have been observed consistently on a test set of a number of tracking shots of diverse kinds.

3.1.1 Sequential Mosaic Generation

Lapped Overwrite To illustrate the characteristics of sequential methods we first consider a simplistic approach where the mosaic is generated by overwriting the mosaic pixels of those of each successively new frame. This method, while being easy to implement, can introduce minor discontinuities at the edges of the frames. By modifying the algorithm to use a weighted overlap at the frame edges such edge artifacts can be reduced.

Figure 8 shows the result for the lapped overwrite approach on the above shot. The resulting mosaic appears quite well-formed without apparent artifacts. Since most of the pixels come from near the edges of the individual frames, objects that never leave the field of view do not appear in the mosaic. For example, we never see the walking man who exits through the centre door. However, moving objects which enter or leave the field of view are recorded in the mosaic. If an object were to move with the camera and remain at the trailing edge of the field of view during a portion of the shot, the object would appear as a long, drawn-out smudge. The only region in the mosaic without any possibility of such distortion is the last frame. It appears completely intact in the right-hand side of the mosaic, with all subjects appearing irrespective of their previous motion. The result for this approach can vary significantly depending on the order in which the frames are processed, for example in reverse order or middle outwards. Further, the method is not explicitly designed to extract only the static background. As a result, the output is not consistently suitable for our work.

[Figure 8 about here.]

Optimal Boundary Davis [5] composites images by stitching a new, registered, frame into an existing mosaic along a data-determined, usually irregular, boundary. The boundary is computed by finding the absolute differences between the new frame and the mosaic at every overlapping point, then using Dijkstra's algorithm to define the minimum-total-difference path through each overlapping section. Points on one side of that boundary are taken from the old mosaic; points on the other side are taken from the new frame. There is no blending, simply a juxtaposing of frames. Davis shows that, in certain circumstances, the method can create effective mosaics of moving objects, because the objects are not blurred through blending.

Figure 9 shows the effect of applying Davis' method to the *Stargazer* sequence. Note that the method does indeed prevent blurring due to moving objects. However, as soon as the camera moves so that an object's position in the first frame goes out of shot, the object is re-rendered in the mosaic. For example, the walking man who exits through the middle door is depicted twice and so is the walking woman who ends up crouching down. Further, an interesting artifact is introduced in the left-most rendering of the walking man – his upper and lower bodies are somewhat shifted relative to each other. The final appearance of the mosaic can be altered if it is generated from last frame to first, or in some other order. Although some outputs are fortuitously similar to onion skin motion representation, others are not. As with simple overwriting and lapped joints, the Davis method, being order-sensitive, generates a background with unpredictable foreground content and is therefore also unsuitable for our purpose.

[Figure 9 about here.]

3.1.2 Statistical Mosaic Generation

The sequential methods are not explicitly designed to extract only the static background in the presence of moving foreground elements. It is not surprising, then, that such methods are inadequate for our work.

We wish to devise a mosaic generation method that consistently extracts only the background. To this end, we employ a statistical framework. Using the statistical properties of the set of frame pixels corresponding to a particular mosaic co-ordinate it may be possible to classify the intensities into two groups: static background and moving foreground. With such a classification the representative background intensity can be incorporated into the mosaic at each co-ordinate.

To begin, we define $\mathbf{F}_{\vec{x}_m}$ to be the set of all frame images whose frame co-ordinate resulting from the inverse transform of the mosaic co-ordinate, $\mathcal{P}_i^{-1}\vec{x}_m$, falls within the frame image, or more precisely

$$\mathbf{F}_{\vec{x}_m} = \{i \mid \mathcal{P}_i^{-1}\vec{x}_m \in \mathbf{X}_{f_i}\} \tag{2}$$

where $\mathbf{X}_{f_i}$ is the set of valid co-ordinates for frame i. Next, we define $\mathbf{I}_{\vec{x}_m}$ as the set of frame image values at the respective valid locations corresponding to the mosaic co-ordinate $\vec{x}_m$, that is,

$$\mathbf{I}_{\vec{x}_m} = \{I_{f_i}(\mathcal{P}_i^{-1}\vec{x}_m) \mid i \in \mathbf{F}_{\vec{x}_m}\} \tag{3}$$

In other works, the set $\mathbf{I}_{\vec{x}_m}$ contains the frame image intensities from locations that map onto the mosaic co-ordinate $\vec{x}_m$.

If no moving objects were to pass in front of the background at mosaic co-ordinate $\vec{x}_m$, the set $\mathbf{I}_{\vec{x}_m}$ would only contain the intensity value, I_B, of the background. If an object of intensity I_O were to occlude the background for a period of time, the set would contain both intensity values. If we were to assume that the object appears for a shorter time than the background (a not unreasonable condition since it follows from the definition of the background as being the static element of the shot that we expect some degree of permanence), then the number of background intensities in $\mathbf{I}_{\vec{x}_m}$ is larger than those of the object. So, we wish to use an operator which returns the value of the intensity that occurs most frequently in the set.

Mode Based on the above argument, the mode of the set appears to be an appropriate statistic for our use. Therefore a mode-based mosaic can be calculated as

$$I_m(\vec{x}_m) = \arg \max_{I \in \mathbf{I}_{\vec{x}_m}} N_{\mathbf{I}_{\vec{x}_m}}(I) \tag{4}$$

where $N_{\mathbf{I}_{\vec{x}_m}}(I)$ is the number of times intensity I occurs in $\mathbf{I}_{\vec{x}_m}$ also referred to as the histogram. However, when the number of samples is small, the mode operator is very sensitive to noise. To reduce the effects of noise, the histogram is Gaussian smoothed.

Figure 10 shows the result of the mode mosaic generator. It successfully renders a mosaic that is mostly free of moving foreground objects as expected. For example, the crouching woman on the right has been partially removed. As well, the walking man on the left is nowhere to be seen. However where an object appears for a longer length of time, the mosaic is quite noisy. This is quite evident for the crouching woman and man on the right. Further, there are obvious distortions in the intensity values in the image.

[Figure 10 about here.]

In areas where a moving object appears as equally long as the background, for example in a region that appears only briefly in the shot, the set $\mathbf{I}_{\vec{x}_m}$ is bimodal with both intensity values being equally as likely. Under these conditions, the mode operator is unstable so in the presence of even a small degree of noise the median output randomly flips between the two different intensity values.

Median A more stable operator is the median of the set as it is more robust under noise. Where there is a clear distinction between the foreground and background, *i.e.*, there are more background than foreground intensities in the set, the median returns the most numerous intensity, the background. As the distribution becomes more bimodal, the value of the median tends toward the mean, even under a degree of noise. It therefore degrades gracefully as the distinction between foreground and background becomes unclear.

The result of the median mosaic generator is shown in figure 11. In regions where there are no moving objects or objects which appear briefly, the method produces a clean background as it was designed to. Where foreground objects dwell for a relatively longer period of time, the distortion evident in the mode image is gone. Instead, the objects may appear with some varying degree of transparency. For example there is a barely visible “ghost” of the man on the left since he dwelt there for only a short period of time. The crouching woman on the right is far more visible in the mosaic since she was relatively motionless at that location for a period of time.

[Figure 11 about here.]

Unlike the sequential methods above, both the statistical operators are designed to construct mosaics that include only the static background. Where moving objects occlude the background briefly, both are successful at rendering only the background. Under ideal conditions the mode operator appears to be the optimal operator for rendering a mosaic free of such moving objects. However, the median appears to be a more robust operator under real conditions since it introduces less obtrusive artifacts where the distinction between foreground and background is not clear.

Further, the statistical results have a very useful byproduct — intensities that are not part of the background are therefore from the foreground elements. In effect, we get the foreground identification for free.

3.2 Foreground Elements

We now turn to the second element in storyboards, the foreground elements.

As discussed in Section 3.1, one approach to identify moving foreground objects is through object tracking [4]. However, with our proposed approach, there is no need for such methods.

As we have just seen, the median operator which we choose for the creation of the background effectively gives us the foreground content at the same time. We use a measure of how confident we are that a frame pixel is from a foreground object by the absolute difference between its intensity value and the median calculated as

$$D_{\text{mot},f_i}(\vec{x}_{f_i}) = |I_{f_i}(\vec{x}_{f_i}) - \text{median}\ (\mathbf{I}_{\vec{x}_m})| \tag{5}$$

where $\vec{x}_m = \mathcal{P}_i \vec{x}_{f_i}$. When the pixel location is part of the background, then $D_{\text{mot}} \approx 0$ and when it is part of a moving object, $D_{\text{mot}} > 0$. Now, if the moving object has a similar intensity at that location to the background at that same location, then D_{mot} will be small. However, since the goal is to produce a visual representation of the moving object, the small difference in intensities does not pose a problem as we will see later.

Figure 12 shows the resulting moving object images for the middle column of stills shown in figure 7. In general this method of object identification is quite successful despite its simplicity. Where there is a good contrast between a moving object and the background, the object appears quite clearly. As anticipated, there is little response where there is poor contrast. Two artifacts are of interest. In the bottom left frame, the woman appears twice – once as walking and once as crouching. Referring to the corresponding frame in figure 7 (third row, middle column), we clearly see that she appears only once as walking. The phantom image of her crouching is caused by the incorrect identification of the crouched figure as background as illustrated in figure 11. The second artifact is the presence of faint outlines of objects in the background such as chairs and wall frames. This is due to minor errors in the projective estimation algorithm.

[Figure 12 about here.]

3.3 Object Movement

Storyboard artists draw upon a number of techniques to convey motion within a shot that include, as described in section 1, onion skins, streaks, trail lines, and arrows. A good artist will tend to employ a limited number of these, typically one or two in combination, in a given board to convey succinctly and clearly the essence of the movement. The use of too many devices may introduce unnecessary clutter and confusion. For our work, then, we will focus on a subset of such cues for extraction and rendering.

Onion skins, as illustrated in figure 1, are an effective way of representing the object and its motion. We can make use of the above method of extracting foreground elements to create the multiple poses. In addition, artists commonly use trail lines, as illustrated in figure 2, behind the onion skin figures to further accentuate the motion. For our purposes, these two techniques will suffice. The additional inclusion of streaks is effectively redundant and will only clutter the final rendition. The use of arrows as a motion cue can be less expressive in some cases than other cues. Including arrows may be redundant and interfere with the clean portrayal of the other elements. Further, their placement sometimes requires sophisticated artistic judgment, which is not easily copied by an automated system (although this may be worthy of formal exploration in future work).

3.3.1 Onion Skins

The moving objects identified above in section 3.2 are overlayed on the background with varying degrees of transparency in the manner of the onion skin technique. The opacity of each pixel in the object overlay is proportional to the value found in equation 5. To differentiate these added moving objects from the background in colour images, the objects are shown in monochrome. We set the spacing between the versions as proportional to the over-all camera motion — the more the camera moves, the more versions we can include without introducing undue clutter.

3.3.2 Motion Trail Lines

Motion trail lines are typically drawn as partial outlines of the trailing edge of a moving object. Their spacing tends to convey the speed of motion — the larger the distance between successive lines, the faster the motion. To construct the trail lines, we make use of the previously identified objects in the preceding n frames from each onion skin. The resulting differences from equation 5 are thresholded and then morphologically filtered via a closing operator followed by an opening operator to clean up the resulting object shapes. It was found that a threshold of 25% of the maximum value resulted in an adequate segmentation. The shapes were further processed by removing small shapes and isolated shapes, *i.e.*, shapes that did not overlap any others in the previous and/or next frames.

Thin outlines of the shapes are simply created by an edge operator, such as the Sobel operator, on the binarised shapes. However, since trail lines are only drawn behind the trailing edges of the objects, motion analysis on the shapes was also carried out. To determine the motion of a given shape, we use the location of its centroid and the centroid locations of the connecting shapes from the previous and next frames. We then project the gradient of the binarised shape from the edge operator onto the direction vector. The resulting length is maximum, being a positive value, when the directions of the gradient and the motion coincide. This maximum occurs at the trailing edge. Conversely, at the leading edge, a negative length results since the gradient and motion are in opposite directions. We use the positive projection lengths at the shape edge to create the trail lines. The darkness along a trail line is proportional to the projection length, *i.e.*, how closely the direction and the edge gradient coincide.

To enhance the trail lines, an additional motion cue based on the time difference between adjacent frames was added. The time difference is calculated as

$$D_{\text{dt},f_i}(\vec{x}_{f_i}) = \left| I_{f_{i-1}}(\mathcal{P}_{i-1}^{-1}\mathcal{P}_i\vec{x}_{f_i}) - I_{f_i}(\vec{x}_{f_i}) \right| \tag{6}$$

To achieve this effect for the set of trail lines for each onion skin figure, we calculate the time difference for the preceding n frames from the figure and apply the results to the composite producing n trails following the subject. These *trailing motion cues* are drawn in a fixed colour (black in this case) whose opacity is proportional to the motion measure as calculated in equation 6. The opacity of a such a cue further varies as a function of the frame index difference between the mark and object so that the marks appear to fade away behind the object.

The resulting trail lines convey the motion quite effectively. For fast motion, the larger displacement between adjacent frames results in a greater spacing of the lines. Further, the trailing motion cue based on the time difference is more spread out. Conversely for slower motion, the lines are more compact. The location of the lines, *i.e.*, trailing the moving objects, also clearly indicates the direction of the motion. As a result, no additional motion cues, such as streaks or arrows, were incorporated to convey the motion of objects.

3.4 Camera Movement

We now have the information for three of our four storyboard components: background, foreground elements, and motion representation. The fourth component, an indication of camera motion, can be generated from the parameters of the perspective estimation algorithm used to generate the background mosaic. As described in section 1, techniques used for depicting camera movement are field cuts, mosaics and arrows.

In previous work, *SALSA* already incorporates two of these techniques — field cuts and mosaics. It generates a mosaic of the entire shot background and draws boxes showing the fields of view of the start and end frames, the start in green and the end in red, and line segments showing the motion of the centres of the view as the camera moves. The resulting representation has been shown to be very effective in conveying the camera movement so we make use of it in this reverse storyboarding system. As a further aid to visualisation, we also add the first and last frames as opaque overlays where the two frames do not overlap instead of presenting them separately as does *SALSA*.

Since the use of drawing the field cuts on a mosaic provides sufficient motion information, we did not pursue the generation and rendering of arrows as an additional technique. As for the object motion cues, the use of arrows can be redundant and their addition to the final storyboard can unduly clutter the result.

4 Results and Discussion

The final storyboard composite for the video sequence of figure 7 is shown in figure 13. The green box on the left outlines the opening frame of the shot while the red box shows the final frame. The middle blue line with cyan marks shows the path of the camera centre through the shot. As well, the start and end frames themselves are overlayed without any motion markings to anchor the shot. Between the start and the end, three versions of the moving objects were added along with trailing black marks indicating motion.

[Figure 13 about here.]

The processing of the footage has effectively created elements found in standard storyboards. The onion skin elements are similar to those used in storyboards, an example of which was illustrated in figure 1. Further, the motion trail lines incorporated in the result are analogous to those shown in figure 2. The camera motion is represented with frame outlines drawn on the storyboard in the same manner as figures 3, 4, and the full scope of the shot, showing the complete panorama, is also displayed.

The resulting mix of storyboard elements clearly conveys a number of key features of the shot. It is a pan right shot as indicated by the start and end frame boxes. The start frame overlay shows the initial four subjects. During the shot, the motion of the man walking to the right and exiting though the middle door is shown. As well, the motion of the woman walking to the right and eventually crouching down is conveyed. The final frame shows the crouched woman, a third woman sitting on a chair, and a third man walking to the left.

When examining the results of the individual components in sections 3.1-3.3 above, a number of artifacts were identified. However, when all the components are assembled in the storyboard these artifacts are not apparent. For example, the misclassification of the crouching woman figure as background or the figure's absence as a moving object are not visible. On the contrary, the semi-transparent rendering of her helps conveys the sequence of actions. As well, the action of the walking man entering the field of view on the right, while appearing distorted in both the background mosaic and the moving object identifier, is well conveyed by the final mosaic. Further, the discontinuities in the object identification and motion detectors due to low contrast between the object and background are not at all visible.

As another test, a tracking shot of a single person running from the movie short *Tick Tock* [16] was processed. Unlike the *Stargazer* sequence, this is in colour. The method was simply modified to use the colour median operator [21] and the L_1 distance in RGB space to measure differences for motion and object detection. The result is shown in figure 14. The result shows that the method generalises well to colour data. In this example, the elements of the shot are well represented. The onion skin of the versions of the figures and their motion tails convey their movement. Further, the blur due to the fast camera motion also conveys the sense of speed.

[Figure 14 about here.]

As a further test of the system, we processed a number of shots from the film *LeMans*. Figure 15 is from a pan shot of a crowd with a flag being waved. In the shot used for figure 16, the camera follows the man with glasses in the yellow shirt as he stands up. For figure 17, the camera does not move appreciably, but the man is motioning with his right hand. In the final shot, producing figure 18, again there is no camera motion, but subjects are moving.

[Figure 15 about here.]

[Figure 16 about here.]

[Figure 17 about here.]

[Figure 18 about here.]

Even for moderately complex shots, the system is relatively successful in conveying the salient attributes of the shot. Figure 15 clearly shows the pan and the waving flag. However, the complex background in figure 16 interferes with the clear rendition of the moving figure resulting in a somewhat less than satisfactory result. That being said, a good degree of the motion, the man in the yellow shirt standing up, is still rather discernible. While our goal was initially to focus on tracking pan shots, we have included two holds with motion. The results in figures 17 and 18 show that the system can still convey the sense of motion and give some indication of the nature of such motion. In the former, the motion of the beckoning hand is quite well represented. However the movement of the microphone boom in figure 18 is somewhat less so.

5 Conclusions

Storyboarding is a production-industry standard visualisation tool for film and video. A storyboard effectively conveys a visual summary of shot elements such as background, subject motion and camera framing and motion. Our goal has been to develop an automated system which takes raw video footage of a shot and, without the need for operator input, produces a visual representation of the shot in manner analogous to a hand-drawn storyboard frame. Such a system would be a valuable post-production tool. We build on a previously developed tool, *SALSA*, which provided some preliminary visualisation aids.

Methods of image mosaicing based on sequential processing of frames do not adequately remove moving objects. We derive a statistical mosaicing method based on the median to produce the storyboard background. Foreground objects are then those that have intensity values which differ from the median. To convey a sense of motion, trail lines are constructed from the trailing edges of the segmented moving objects. The trail lines are further enhanced by using the difference between adjacent frames. The final image is a composite of the background, the moving subjects with trailing motion cues in the manner of the onion skin method in storyboarding, boxes outlining the start and end frames with an overlay of the frames themselves, and a track of the intervening camera movement.

The system was run on a number of video shots. For tracking shots the system produced visual representations that succinctly conveyed the composition. The median-based mosaic generator successfully produced the storyboard background upon which the trailing motion cues were applied. The trailing motion cues produced are similar to the onion skin technique of standard storyboard art. These were generated using simple processing methods requiring no user input. Even for more complex shots, the output conveyed much of the composition. When the system processed shots with little camera movement, it was successful in capturing the essence of the motion. In some cases, with complex background and/or motion, the resulting composition, while being somewhat less than ideal, still expresses much of the essential motion.

In all, the results demonstrate that the system fulfills our goal of producing a storyboard using the same devices used by industry storyboard artists in a completely automated manner. Comparing the results to the example storyboards illustrated in figures 1 to 4, we see that the system can create elements analogous to onion skins, motion trail lines, background mosaic, and field cuts that are used in storyboards.

The system can successfully be used on a number of important types of shots including holds with little foreground motion, shots with a camera movement and little other motion, and tracking shots. It therefore can be a valuable tool for the creation of visual summaries of existing film and video sequences for production, post-production, and archiving applications.

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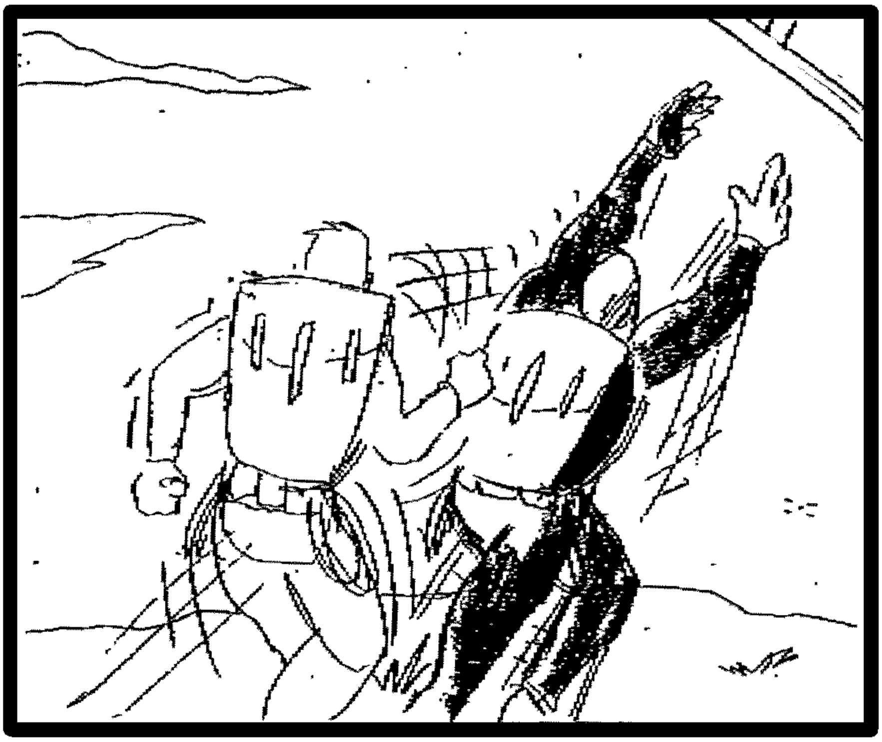


Figure 1: Onion skin effect conveying motion

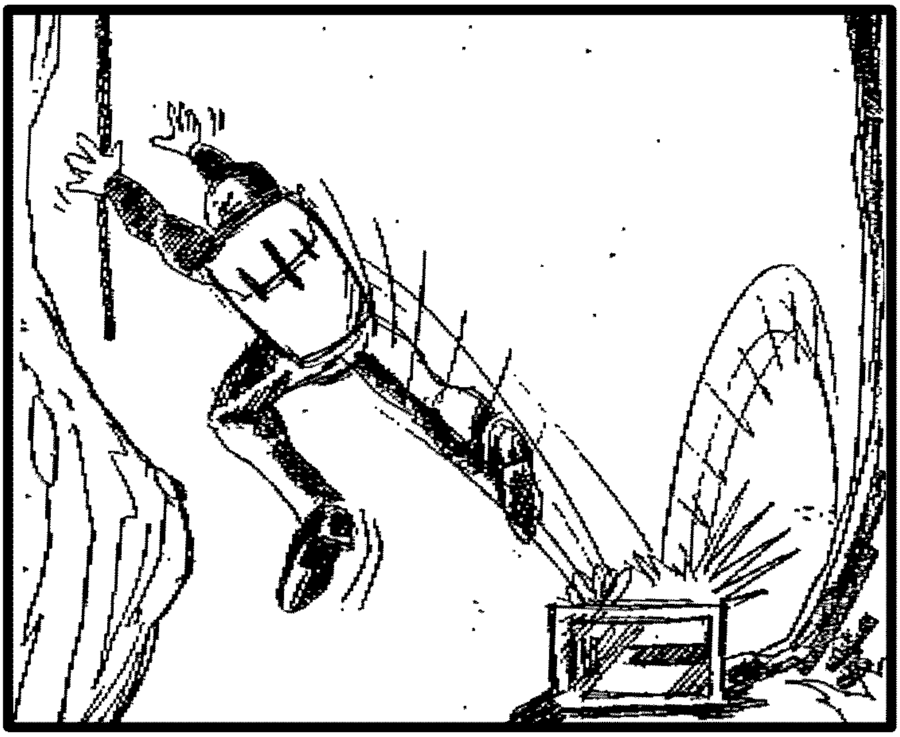


Figure 2: Motion trail lines to show speed and motion

Figure 3: Mosaic storyboard showing full scope of shot

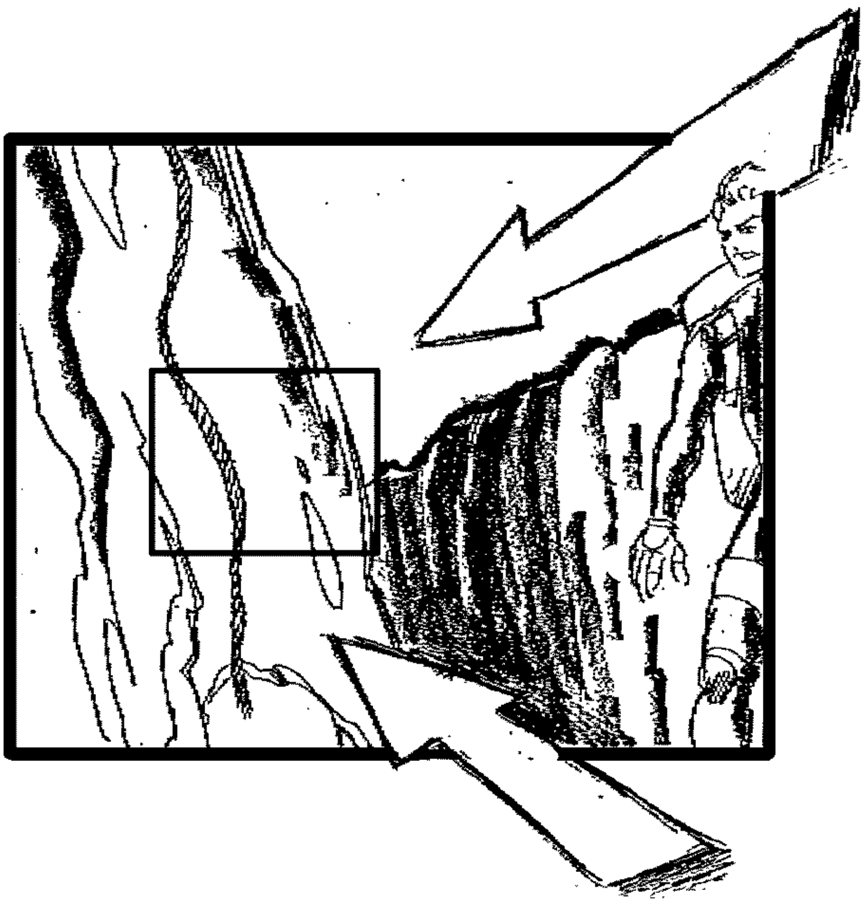
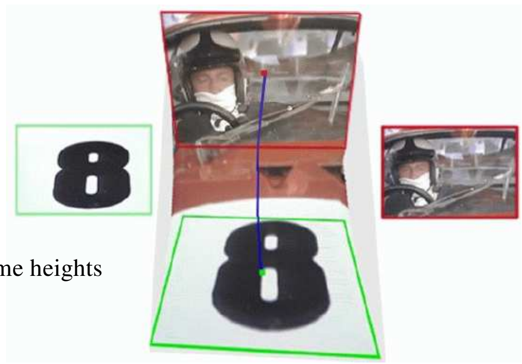


Figure 4: Field cut showing camera motion

Shot	Start frame	End frame	Start time	End time	Duration	Description
161	25502	25503	17:00:01	17:00:02	0:00:02	Hold
	25504	25611	17:00:03	17:04:10	0:04:08	Tilt up 1.17949 frame heights
	25612	25631	17:04:11	17:05:05	0:00:20	Hold



Starts on tight close-up of number 8 on car bonnet tilts to loose close-up of driver

——————————————CUT——————————————

162	25632	25689	17:05:06	17:07:13	0:02:08	Hold

Tight close-up of driver

Figure 5: *SALSA* example output from *Le Mans*. Each shot is identified by a number. Within each shot, the different camera motions are identified with the start and end frames, times, and durations.

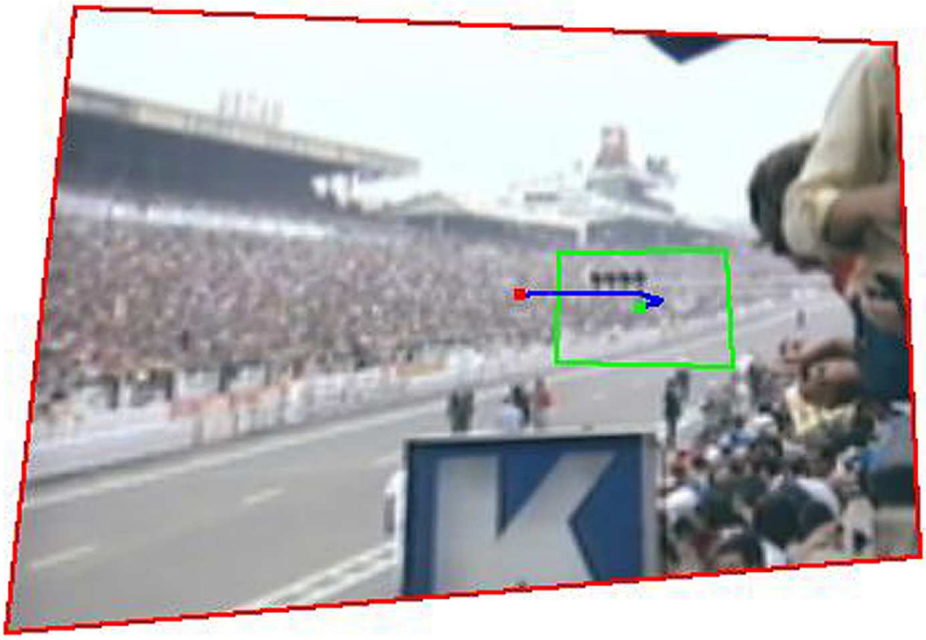


Figure 6: *SALSA* example output showing mosaic with start frame box in green, end frame box in red, and camera path in blue, all overlayed

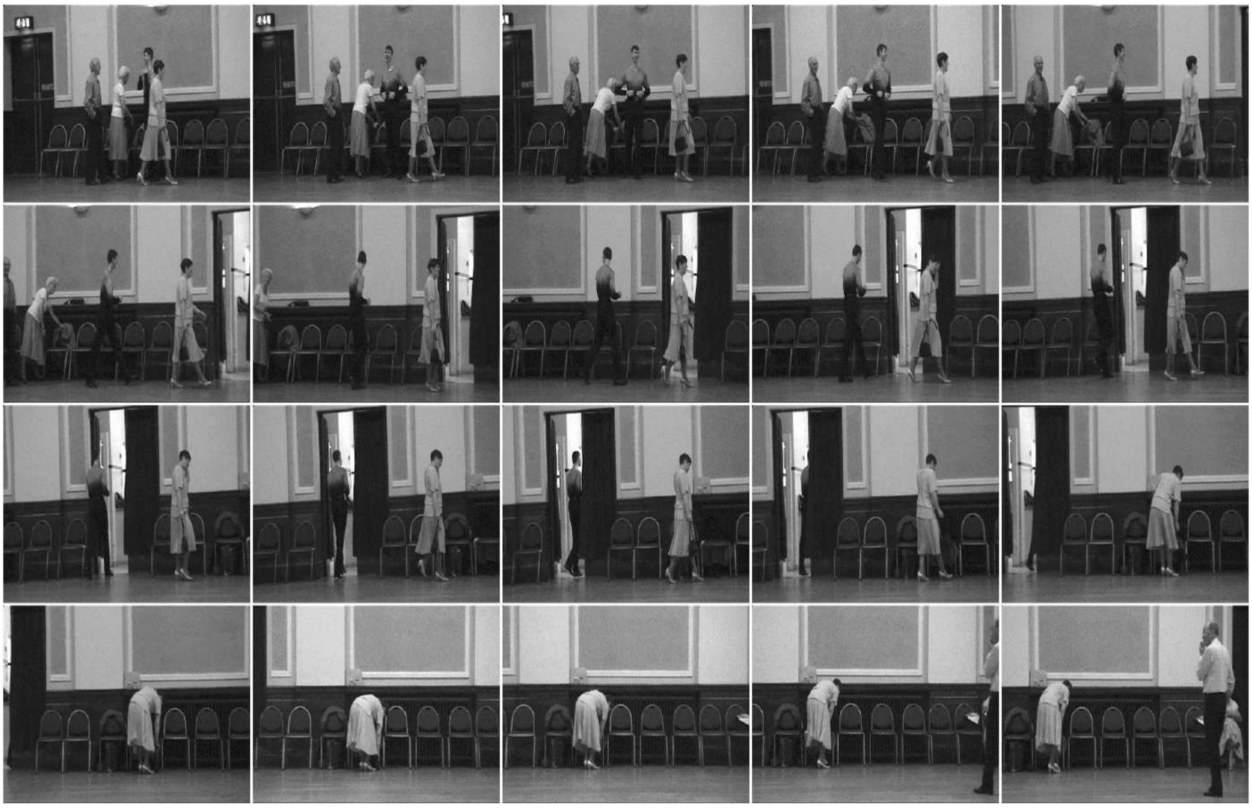


Figure 7: Tracking shot used for evaluating mosacing methods. Note the camera pan from left to right, tracking the two walking subjects, one of whom exits during the shot.

Figure 8: Result of lapped overwrite mosaic generation. Note the absence of the moving subjects

Figure 9: Result of Davis' optimal boundary mosaic generation. Note that the two moving subjects each appear twice in the mosaic

Figure 10: Result of mode mosaic generation. Note the distorted intensity values and the artefacts where the moving subjects have only partially been removed.

Figure 11: Result of median mosaic generation. The moving subjects have been removed except for some ghosting where they were motionless for some period of time.

Figure 12: Moving object images for middle column of figure 7. The moving elements are shown in white.

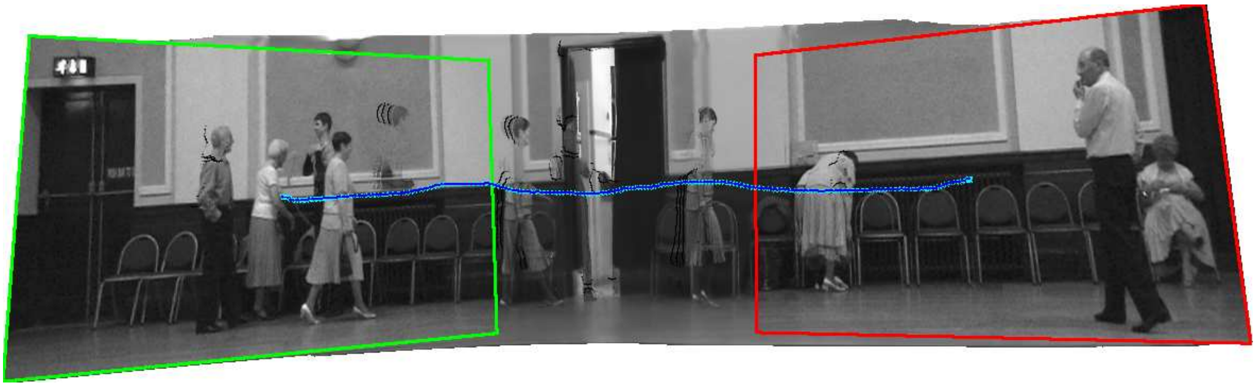


Figure 13: Storyboard automatically generated from video sequence in figure 7. The start and end frames are shown as green and red boxes respectively and the camera motion by a blue line. The onion skin effect shows the motion of the two walking subjects and the trail lines indicate a relative speed and direction.

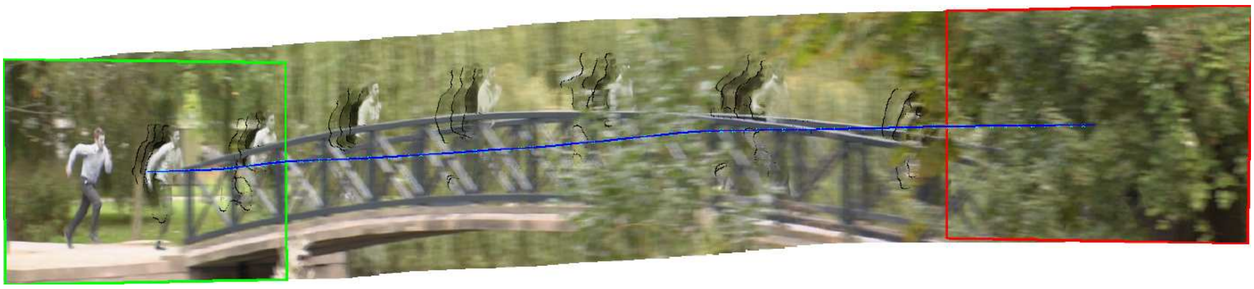


Figure 14: Storyboard automatically generated from *Tick Tock* tracking pan sequence (L-R). The result clearly shows the composition of the shot, tracking the subject running quickly across the bridge.

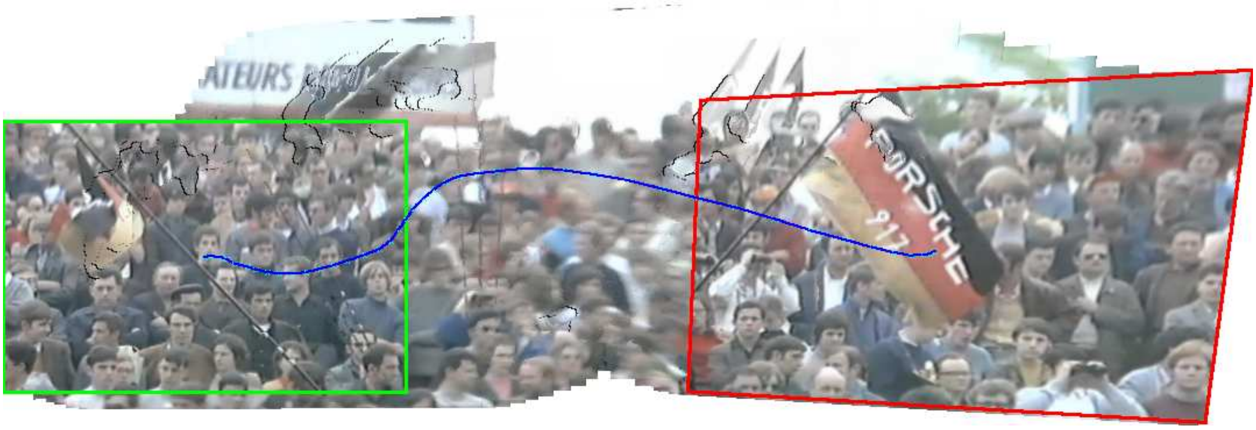


Figure 15: Storyboard generated from tracking pan (L-R). The onion skin and trail line effects convey the motion of the flag waving from left to right.

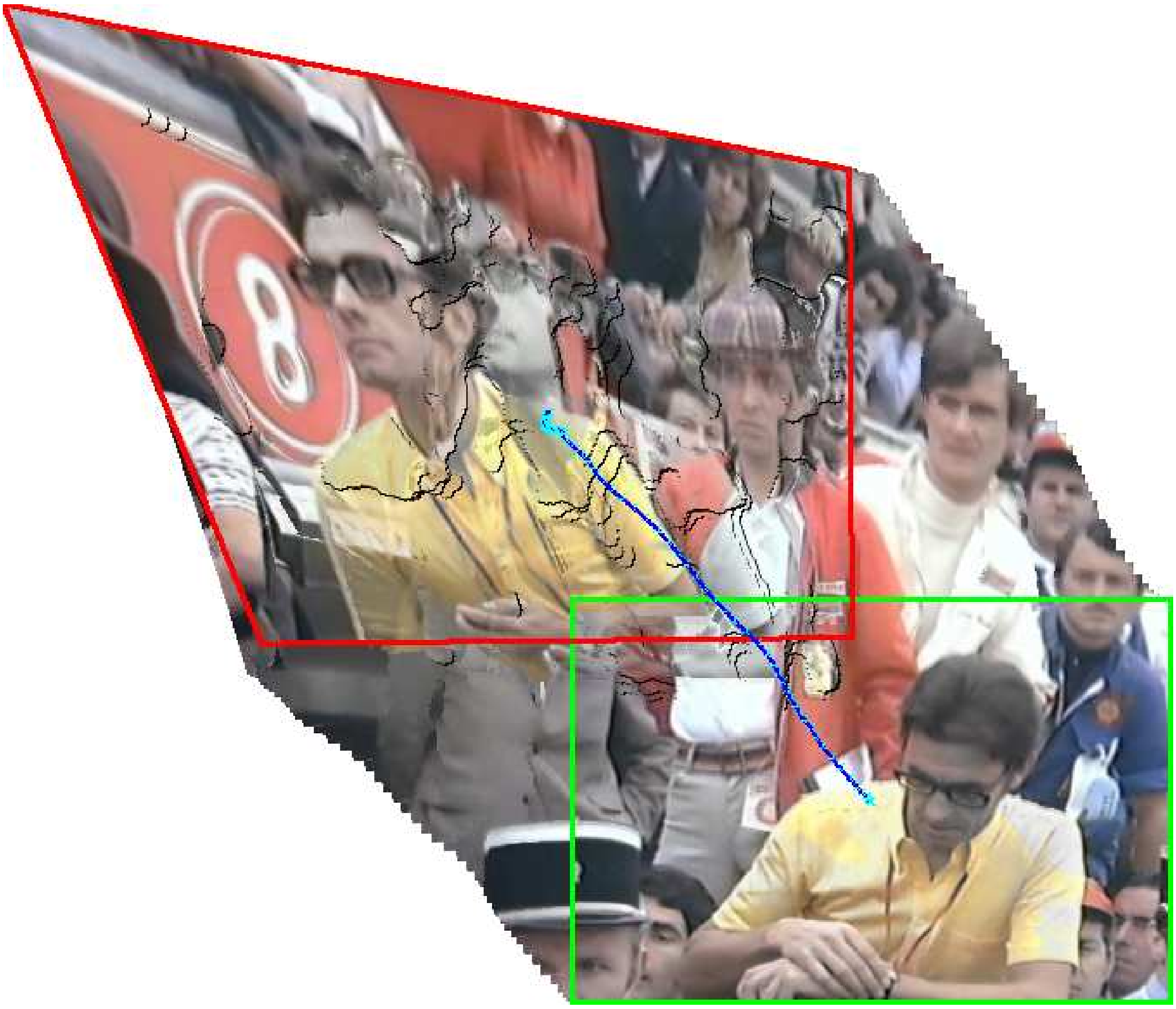


Figure 16: Storyboard generated from tracking tilt (L-Up). Note the man in the yellow shirt standing up during the shot. Despite the motion in the background, the trail lines do indicate a sense of the motion.

Figure 17: Storyboard generated from handheld static shot (1). Note how the method conveys the motion of the right hand.

Figure 18: Storyboard generated from handheld static shot (2). Some of the motion of the microphone boom is indicated by the trail lines.

ICONIC VERSUS NATURALISTIC MOTION CUES IN AUTOMATED REVERSE STORYBOARDING

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Keywords: Video analysis, summarisation, visualisation.

ABSTRACT

Storyboarding is a standard method for visual summaristion of shots in film and video preproduction. Reverse storyboarding is the generation of similar visualizations from existing footage. We have previously demonstrated that the use of storyboarding techniques, such as trail lines, onion skins and streaks in conjunction with mosaic constructions, can succinctly summarise many visual sequences. However, there are specific instances involving complex subject and/or camera movement where such approaches are not successful. We identify specific types of these that require alternative summarisation strategies and propose new methods using graphic arrows to effectively accommodate these cases. The generation and rendering of arrows indicating subject motion within frame, and the determination and application of arrows to indicate intermediate camera motions are discussed in detail. These techniques result in clear and succinct representations of complex camera and subject motion by breaking sequences into easily interpretable parts.

1 Introduction

The summarisation of film, video and television content is vital to many production, archival and analysis tasks. Workers in these areas require access to specific details or attributes of footage without having to refer to the source material. This information should be presented in a consistent form utilising standard terms and representations commonly found within the domain.

In media production industries, *storyboards* – static two-dimensional graphic depictions of content of each shot and scene – are widely used for visual summarisation. Tasks such as set design, location lighting and image compositing are made more efficient through the availability of a common reference to the ‘vision’ of the piece. Shorthand descriptions of all important visual components of each shot provide clear and accurate depictions of motion sequences in static form. Many researchers working in the area of automated media analysis use the term storyboard to denote a series of still images or keyframes extracted from a visual sequence to describe its content. Production storyboards – those used by content producers – are much more detailed. They are used in numerous pre-production, production and post-production contexts when a succinct visual summary of what is to appear on screen is required. In this paper we use the term in its production context.

To provide the detail required by practitioners for production, storyboards incorporate the following types of information:

1. Composition of the overall shot
2. Appearance of foreground elements
3. Indication of object movement
4. Indication of camera movement

The first two types are typically conveyed through simple drawings rendered in the correct aspect ratio of the medium used (e.g., 16:9 for widescreen television, etc.) These drawings can be either black and white or full colour. The amount of detail included will be dictated by the importance of elements to the production of the shot. For example, if the purpose of a shot is to show that a character has a gun in their pocket, the drawing should show a suitable bulging shape in the fabric to make this clear to the viewer (and production team). Insignificant elements can be shown in a very rough form or excluded entirely.

Hollywood has developed specific drawing techniques to convey the last two types of information. *Onion skins* (multiple instances of a subject that indicate specific intermediate positions), *streaks* (lines that show the trajectory of a moving object) and *trail lines* (repetitions of the trailing edge of a moving object to indicate the speed of motion of the moving object) are long-established summarisation methods, similar to those used in comic books. *Field cuts* (outlines of intermediate camera positions in the correct aspect ratio) and *mosaics* (panoramic views showing the area caught on camera) are used to denote important aspects of composition and content during camera movement.

In our previous work [1] we argued that the storyboard metaphor, which is highly effective for preproduction visualisation, could be equally effective as a means of summarising visual media content. We developed *Automated Reverse Storyboarding*, a set of computational methods to automatically create visual summaries of existing video footage using *mosaics*,

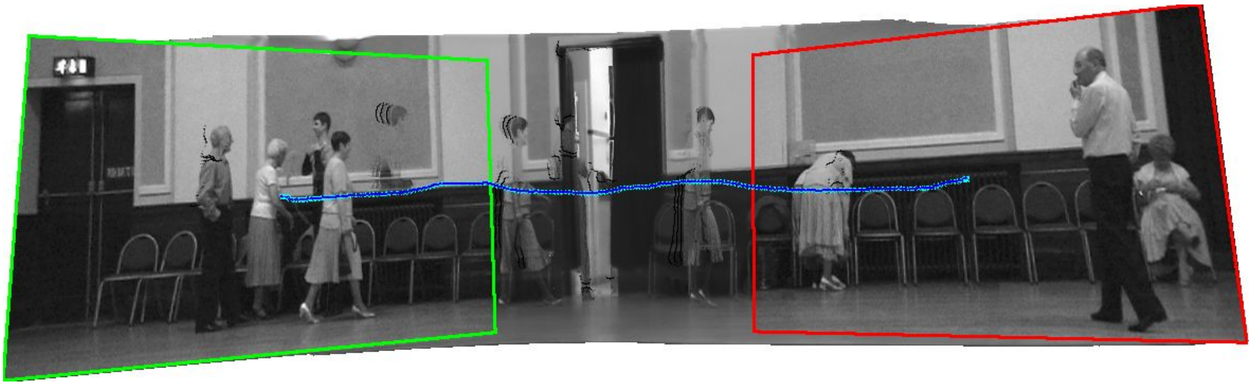

Figure 1: Naturalistic reverse storyboard illustrating mosaicing, onion skins, trail lines and field cuts

onion skins and *trail lines* in keeping with the production storyboard metaphor. In many circumstances, where there is object and/or camera motion in a single direction, these prove very effective at concisely describing shots. Figure 1 shows an example (sources used to create reverse storyboards in figures presented are listed in section 6).

However, in highly complex shots, where subject motion overlaps or camera motion occurs along multiple axes, results from these techniques can be unsatisfactory. (Some examples are shown in later figures.) This leads us to consider using motion arrows, which are the last important visualization cue of preproduction storyboarding. Figures 2 and 3 show examples of their use for both object and camera motion visualization.

Figure 2: Arrows indicating subject motion

Arrows and field cuts are "iconic" ways of conveying object motion. They do not augment the shot imagery in a naturalistic way, by merging semi-realistic visual cues into the scene, as streaks and trail lines do. Rather they overlay the visual material, clearly distinct from it. Although we have used field cuts previously, our storyboards have otherwise been naturalistic. We therefore consider in this paper the generation of boards at the opposite end of a naturalistic/iconic continuum: using arrows for both camera and object motion cues, dispensing with the integrative shot mosaic as well as with trail lines and onions skins. Later we consider how the two approaches may be merged into storyboards that combine naturalistic and iconic cues, just as preproduction boards do.

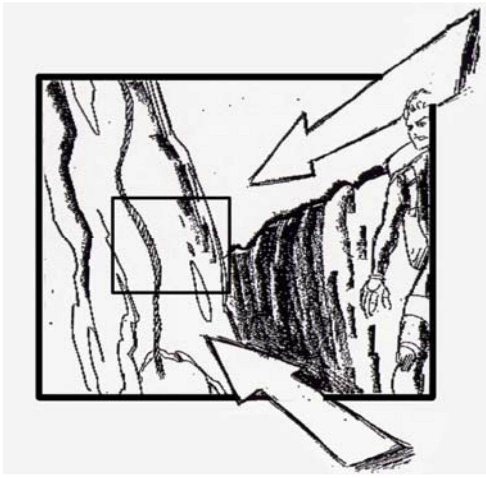

Figure 3: Arrows indicating camera motion

2 Prior Work

Katz provides an excellent description of how storyboards are created and used by practitioners [2]. However, this process has not been widely considered for automated summarisation outside of Mackay and Pagani's work [9] and our own [1,3]. The generation and overlaying of cartoon-style motion cues, widely used by industry storyboard artists, has been examined [10] but relies on the user identifying specific objects or areas of interest within frames. As of this writing we are unaware of any work examining the role of arrows in describing either subject or camera movement within shots.

As discussed below, our new technique overlays arrows on one or two keyframes. The extraction of keyframes as a means of content summarisation has been widely studied. Many researchers have focused on establishing which single shot best conveys a sequence (such as [4, 12-14]) whilst others have centred on finding more intuitive ways to present those frames (including the determination and subsequent larger display of dominant frames [5] and the use of the Japanese comic book-inspired Manga layouts described in [6]). Other work has looked at different forms of video abstraction (including [7]) and appreciable effort has been expended to enable accurate automated summarisation (an example is [8]).

We now briefly review our prior work on reverse storyboarding. The initial stages – parsing into shots and preliminary analysis of movement within the shot -- are common to the earlier work and the new system reported here.

In order to effectively summarise film or video content using storyboarding metaphors we must first categorise shots based on other parameters. Using *ASAP*, an automated shot analysis program [11], we segment visual sequences into shots and then classify the camera movement contained within each shot (i.e., pan, tilt or zoom). ASAP also provides frame-to-frame projective transform estimates. By composing these, we can generate shot mosaics, which, in our earlier work, were used as the background for all storyboards.

If a shot is static (i.e., a 'hold') and there is no motion or simple subject motion, such as movement in one direction or a small repetition within a confined area of the frame then the use of onion skins and trail lines can be very effective. Figure 4 shows an example from the earlier system. Note how both start and end framings are marked even though this shot is almost a hold.

Figure 4: Onion skins showing repetitive motion

If camera motion is present and does not change direction along a single axis, then mosaics with field cuts present a clear depiction of the shot.

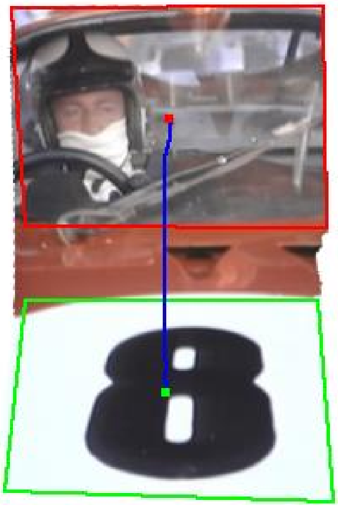

Figure 5: Mosaic description of tilt up

Note, the camera work can be fairly complex including multiple moves, such as a pan right followed by a tilt up with a zoom in, so long as the motion does not double back upon itself.

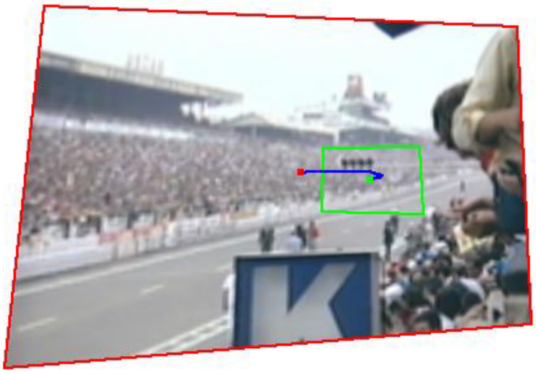

Figure 6: Mosaic description of compound camera move

If camera motion and subject motion are both present, onion skin, trail line, field cut and mosaicing techniques can all be used with good effect as illustrated in figure 1.

When camera motion is complex, the shot is segmented into subshots at the boundaries of major camera motion. Some examples of this are shown in later figures.

The examples above all illustrate that naturalistic visualization works for many simple shots. However, examples shown later illustrate its limitations.

3. An arrow-based reverse storyboarding method

We propose an alternative to naturalistic reverse storyboarding that relies on just one or two keyframes overlaid with graphical elements (arrows) to convey all the motion information in the shot. As in our earlier system, we begin by parsing camera motion, segmenting a shot into subshots if necessary. We then determine whether a subshot involves a substantial camera move. If so, we use two keyframes; if not we use only a single frame. Arrows are then derived from the camera motion estimator and a foreground-object analyser as described below.

Keyframe selection

In common with previous researchers we have investigated keyframe selection based on spatial and temporal features of the frames within a shot. We developed a statistical classification strategy that used combinations of motion vectors and image histograms. We also implemented a prior-art keyframe selection algorithm [13], plus a middle-frame selector.

In evaluating keyframe extractors we compared their outputs with preproduction boards as one method of assessing performance. In this process we noted that the distribution of keyframes as selected by *humans* within a shot is approximately uniform. It appears not to have been argued previously that if closeness in time correlates with image similarity, then a frame taken from the middle of the shot has highest expected similarity with the true keyframe. In our experiments, we found no significant advantage for a complicated keyframe selection algorithm over choosing the middle frame, and we therefore adopt the middle frame when the move is a hold or contains minor camera movement.

When a shot or subshot contains a substantial camera move we must represent the extent of that move accurately. Preproduction storyboards always show start and end framing when the two are radically different, and we therefore use the first and last frame to represent the range of the shot. These first and last keyframes are arranged relative to the direction of camera motion. For example, in the first part of figure 11, the camera pans right so the last shot is positioned to the right of the first. With the addition of an arrow indicating the direction of camera motion, the result can succinctly convey the essential camera motion of many shots.

Foreground Elements – Arrow generation

Once keyframes are identified, motion cues of objects within the shot are then drawn using arrows. One approach to identify moving foreground objects in a shot is to employ object tracking techniques [15]. This topic in computer vision has been extensively investigated [16-19] especially in the context of human motion. The goal of such techniques typically is for measurement and modelling. Further, many require user assistance and can operate in only constrained or simplified environments. The goal of our work is to produce a visual representation of the shot in an automated manner. Therefore such techniques are not suitable for our purpose.

We instead turn to the method previously developed in [1]. In this approach, a statistical operator, namely the median, is applied to the distribution of pixel values from the same spatial location after first correcting for any camera motion. The median was shown to be very effective in extracting the static background from the shot since the pixel intensities of moving foreground objects are less likely to occur relative the intensity of the static background. The foreground objects are then simply identified as those regions in a frame that differ from the background.

Figure 7 shows the results of such a segmentation for 2 frames from a hold shot of a camera crew as shown in figure 8. Note that the microphone boom and moving person in the lower right are well segmented from the background. As the crew members do not move much during the shot, they are considered as background by the median operator. They therefore do not show up under this segmentation scheme. These two frames are from the middle portion of the shot and are four frames apart. The motion of the objects, namely the microphone boom and the moving person, are quite apparent in this sequence.

Figure 7: Segmentation of two frames, four frames apart from the middle of a hold shot. Note the segmentation of the microphone boom in the centre of the frames and the moving person in the lower right corner.

The moving objects are thusly identified for the keyframes. To determine the motion of the objects, object identification is performed on a number of frames previous to the keyframe. The segmentation maps are processed via morphological operators to remove spurious regions and fill in gaps. The individual objects are identified and tracked through each of the *n* preceding frames. Segmented regions are considered as contiguous objects if some overlap exists between frames at any portion of the sequence. Throughout this tracking, the camera movement is accounted for through the use of the projective transform previously calculated. The tracking of the objects allows for splits and merges due to possible inaccuracies in the segmentation. Further, thresholding based on object size and movement is applied to filter out small objects. The first location of each object, *j*, is taken as its centroid of the first of the *n* frames preceding the keyframe and is calculated as

$$x_j = \frac{1}{N_j} \sum_{x \in O_j} x_i$$

$$y_j = \frac{1}{N_j} \sum_{x \in O_j} y_i$$

Note that because of the need to establish the motion before a keyframe, in the case of a pan, the first keyframe is actually a number of frames after the first frame. Similarly, the last location of an object is calculated as the centroid of the object as it appears in the keyframe.

The first and last locations are used to draw the arrow representing the motion. The head of the arrow is spaced back from the object by its approximate radius calculated as

$$r = \sqrt{N / \pi}$$

where N is the number of pixels in the object. The length of the arrow is proportional to the Euclidean distance between the start and end points. For visual effect, a scaling factor of two was used, i.e. the length of the arrow is twice the amount of object movement. The width of the arrow is an indication of the size of the object. It is set to half the object radius as calculated above.

4 Results and Discussion

We present paired comparisons of shots summarised with keyframes and arrows as described in section 3, and with mosaics, trail lines and onion skins (our previous method). The figure captions provide some indicators of the tradeoffs, but the reader will observe that interpretation depends on shot content in a complicated way.

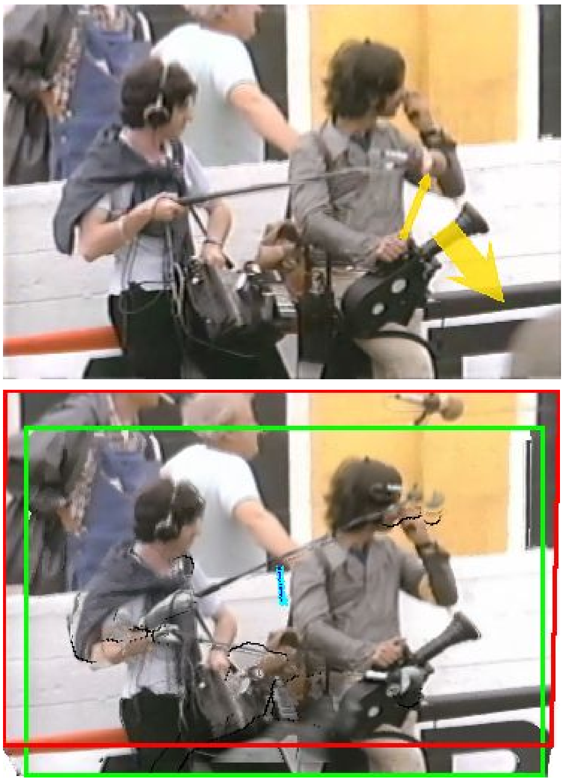

Figure 8. Two objects in motion within a hold. The arrows version gives a clearer representation of the moves. (This is the shot illustrated in figure 7)

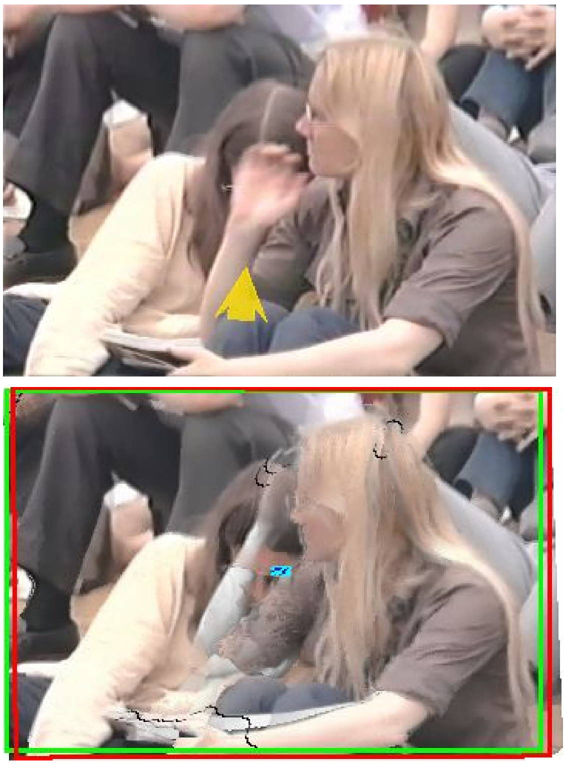

Figure 9. A hold with a single large movement (raising the arm) then a small repeated movement (brushing the hair). While the arrow provides the superior cue for the first, the trail lines suggest the second.

Figure 10. A pan/tilt with large object motion. In this case the mosaic generation is successful despite the large moving object in the frame. However the onion skin visualization is ambiguous and there are too many trail lines. The arrow version is again cleaner though the connection between the start and end frames would be better represented by aligning them more closely.

Figure 11 (next page). The three parts of a complicated multi-movement shot. The mosaics for parts 1 and 3 of the shot are distorted because the projective transform estimator is confounded by the different directions of camera and large-object movement. Here the arrow representations are cleaner. Although the arrow representation of part 3 of the shot does not represent the subject's movement towards the camera, this may be inferred from by comparison of the part 2 and part 3 boards.

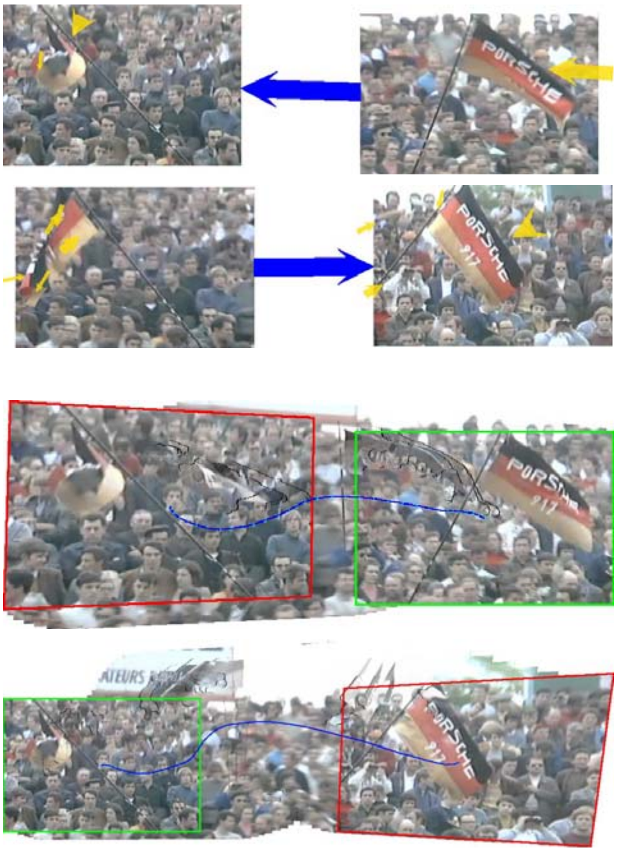

Figure 12. Another two-part shot with a waving flag. The subtleties of flag flap are captured better in the arrow version, but the mosaic provides better context over the whole shot.

As the figure captions discuss, there are tradeoffs between mosaics and arrows in representing both camera and object motion. Which is better depends on the shot content, suggesting either that an automated system for choosing between the two would be useful, or that combination of both would be better than either alone. We investigated the combination of both methods. This requires the modification of parameters so that storyboards do not become too cluttered. Results for two of the subshots shown previously are given in figure 13.

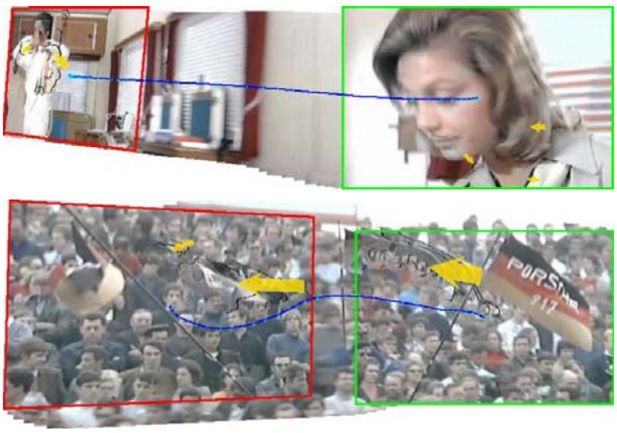

Figure 13. Two examples combining mosciaing, trail lines and arrows

The two examples above are wide pans and it is this type of shot for which the combination of visualizations is most effective. A storyboard shown earlier as figure 1 is made even clearer with addition of object motion arrows, as figure 14 shows.

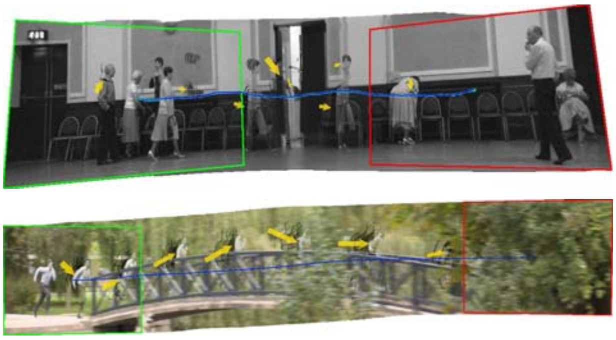

Figure 14. Pan mosaics enhanced with arrows

Based on the above results, we propose the following algorithm for generating storyboards that combine the strengths of naturalistic visualization and iconic representation via arrows.

1. Generate a shot or subshot mosaic by composing estimated frame-to-frame projective transforms.

2. if the positions of the first and last frames when warped into the mosaic do not overlap:

- use the mosaic for visualization, add trail lines, onion skins and field cuts as in [1] and add object (yellow) arrows as this paper.

else if the position of the last frame centre is outside the boundary of the first frame in the mosaic

- use first and last frames as keyframes, position according to the dominant camera move and add camera (blue) and object (yellow) arrows as in this paper.

else

- use the middle frame as a keyframe, and add object (yellow) arrows as in this paper.

This algorithm generates good composite storyboards for the 26 shots on which we have applied it. In future work we will generate composite storyboards for entire movies and identify the limitations of the algorithm for selecting and combining storyboard components.

5 Conclusions

We have developed an iconic reverse storyboarding system to complement our earlier naturalistic system. We have presented results comparing the two approaches, illustrating how each has superior properties depending on shot content. We have also showed how naturalistic elements (background mosaic, onion skins, trail lines) and iconic elements (object motion arrows, field cuts) can be combined in an integrated presentation. The results show that due to the rich variety of shot composition found in production footage, no single approach works for all cases. We have proposed an algorithm that chooses between the different visualisation methods investigated here.

6 Figures

The source footage used in this research to create reverse storyboards shown in this paper's figures is from *Stargazer* (copyright 2001, John Mateer and The Zephyrs), figs 1 and 14, *Tick Tock 4 O'clock* (copyright 2003, The University of York), fig 14, and *Le Mans* (copyright 1971, Paramount Pictures), figs 4-13. The storyboards in figures 2 and 3 are copyright 1999, Jonathan Goodson Productions.

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Semi-Automated Logging for Professional Media Applications

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Abstract

We report a novel method for logging and annotating video footage specifically for professional post-production and archivist end users. SALSA – Semi-Automated Logging with Semantic Annotation – is a hybrid system that utilises automated footage analysis for cut detection and camera movement classification, in conjunction with a stenographic-like keyboard input system to enable the logging of higher-level semantic information. Output is presented in both standard printed log form, with the addition of mosaic visual representations of shots, and in a fully searchable database. Results from preliminary experiments are reported.

1. Introduction

Post-production personnel and media archivists share a number of common objectives when reviewing footage. Television and film editors look to obtain technical aspects – start and end time codes, duration of shots, framing, types of camera or subject movement within shots, etc – in preparation for editing. They also need to understand specific information concerning subject-based content – locations, props, specific actors and actions, to name but a few. Archivists often require even higher-level semantic information relating to theme, style and genre. Both groups demand that the information gathered is accurate and presented in a consistent form. This often means the use of standard Hollywood nomenclature (e.g., "Medium Two Shot", "Pan Right to Close-up", etc.[19]) to characterise filmmaking attributes as well as semantic descriptions of content (e.g., "Interior Bar – Reeves drunkenly trips on a chair, spilling his drink" for narrative, "Train derailment – diesel locomotive lying on its side being examined by a salvage crew" for documentary, etc.). The goal is to enable quick access to specific shots and sequences without having to revisit the footage.

For the past several years there has been a significant amount of work undertaken to create fully automated video indexing and media analysis systems to address these needs. Although techniques have advanced and technologies have matured we are still a long way from having a computer adequately and accurately characterise the full content of a film or video. Indeed, research into the extraction of high-level semantic information is very much in its infancy. There are, however, certain footage attributes that can be obtained reliably and consistently, including shot boundary location and descriptions of camera movement. The automated extraction of this information could be of great benefit and time savings to practitioners yet such technology has barely been implemented in professional systems. Little has been written concerning how best to meet the present needs of these end-users whilst fully automated technologies evolve.

We have created *SALSA* – a *Semi-Automated Logging with Semantic Annotation* program – with the aim of determining whether some aspects of automated content analysis can be of immediate use to post-production and archivist users. *SALSA* is a hybrid system that combines an automated footage analysis system, to extract technical information from source material, with a streamlined text-based annotation input system based in part on stenographic models of interaction. Output consists of a combination of conventional log form, utilising time code and text annotation, with mosaic representations of each shot in addition to start and end frame thumbnails to provided a concise but complete print reference. A database is also automatically generated that enables direct searches by keywords, descriptions and other criteria. The objective is to enable faster, more accurate logging than is possible through current means.

2. Previous Work

There have been numerous studies into various aspects of automated media analysis techniques including shot boundary detection (such as described by Boreczky and Rowe[1] and Lienhart[2]), camera movement classification (Patel and Sethi[3] and Bouthemy et al.[4], for example) and the extraction of semantic information (Snoek and Worring[5] present a worthwhile broad review). Research into semi-automated editing tools is much more limited (Girgensohn et al.[6] is perhaps the most relevant to this paper) suggesting this is an area for further exploration. A number of commercial products, including *VideoLogger*[7], *The Executive Producer*[8] and *SceneStealer*[9], have been specifically designed for the logging of footage and include some limited automated cut detection capabilities. Few studies have been conducted into the specific needs of post-production and archivist end-users although Mateer[10] does provide a detailed description of important considerations of automated systems targeted for these groups. There has been extensive research into the generation and application of mosaics. These include significant contributions by Szeliski[11], Mann and Picard[12], Peleg and Herman[13], and Davis[14].

3. Method: *SALSA – Semi-Automated Logging with Semantic Annotation*

The automation of logging for archiving or post-production represents the 'Holy Grail' of automated media analysis. Unfortunately such a system is still a long way off, as stated above. However robust technologies do now exist that can be used to at least streamline and speed up the process. Used in conjunction with some user input, automated parsing systems should enable great time savings with no loss in logging accuracy.

One of the most time consuming tasks in manual logging or indexing is the determination of the exact start and end frame of a shot or camera movement. This typically requires running footage back and forth through a playback system, noting the time code of the event. Whilst professional editing systems make this a relatively simple matter, often logging can only take place using less precise VCRs making this a tedious process. Clearly the automation of this process could be a valuable time saver.

SALSA combines proven automated media analysis methods with an enhanced input system to create a semi-intelligent logging tool. It consists of five basic components: an automated shot boundary and camera movement parsing system, a keyboard input based annotation system, a mosaic generation system, a log output system and a database generation system.

3.1 Parsing System

The parsing engine is based directly on *ASAP*, our automated shot analysis program[15]. It consists of a frame-by-frame camera motion estimator applied both with and without temporal pre-filtering. A movement parser then connects interframe movements into strings and applies syntactic rules to distinguish different types of movement.

3.1.1 Camera Motion Estimator

We use a fast, high-accuracy, perspective estimator developed for image mosaicing and registration in augmented reality[16]. The estimator uses simplex minimization of a disparity function calculated over a mesh of samples taken from the picture (described in detail by Robinson[17]). In comparison tests with other perspective estimators, it performs as well as the state of the art but up to 30 times faster than its competitors. This estimator has been used for object-based video analysis and coding[18], but *SALSA* and *ASAP* only use the output of eight perspective transform parameters, along with a single measure of disparity, for input to the movement parser.

3.1.2 Temporal Filter

The motion estimator is applied directly to the raw video input and to a temporally filtered version of the input. We use a 16-tap temporal median filter that attenuates the effect of temporary scene occlusions. This allows us to disambiguate between genuine cuts and gross image changes caused by fast-moving foreground objects.

3.1.3 Movement Parser

The movement parser clusters consistent movements over consecutive frames into tentative zooms, pans and tilts. It also detects cuts. While there are several methods for cut detection from both raw and coded video[1, 2], we are able to use the output of our motion estimator directly. If the best perspective transform between two frames yields a significant final disparity, its parameters are examined for consistency with the temporally-filtered information, and if inconsistent, a cut is declared. Pans and tilts are easily detected from translation parameters, and zooms from a combination of the scale/rotation matrix entries in the perspective transform. It is also possible to detect and quantify camera roll, though this is such an unusual movement that we do not parse it.

Having divided the stream of camera movements provisionally into zooms, pans and tilts (which may happen in parallel), the parser applies a second level of analysis. If zooms are of sufficient magnitude, they are accepted as fundamental motions and subsume any other kind of movement. For pans and tilts, the parser examines the series of tentative movements in the shot, and infers that the movement is one of three types: (i) a fundamental pan or tilt, which is a consistent movement in a particular trajectory, (ii) tracking, where the camera appears to be following a moving object, (iii) jitter. The last of these is ultimately classified as part of a hold, along with any genuinely stationary camera shots. The motion estimator is able to correct for jitter with motion stabilization if necessary.

3.1.4 Processing Speed

At maximum accuracy the global perspective estimation algorithm used processes a pair of 720x560 frames in about 1.6s on a 2 GHz Pentium IV. Through control of a speed/accuracy parameter, this can be accelerated to below 140ms per frame pair.

We are able to achieve a low average processing time by applying *ASAP* in a hierarchical way. First we examine frames separated by four frame periods using the fastest version of the perspective analyser. When the estimate produced is sufficiently accurate, the movement parameters are scaled to per-frame values and accepted. When the estimate is poor, *SALSA/ASAP* switches down through a sequence of increasingly accurate matches.

For a low-activity video sequence, it is possible to run the hierarchical version of the program at an average rate of below 40ms/frame (i.e. video frame rate). For high activity, large buffers or a higher performance processor would be required in a real-time system. In the experiments reported below, ASAP was run at full accuracy (not hierarchically), so the processing time was approximately 1.6s per frame.

3.1.5 Cut Detection and Move Classification Accuracy

Media professionals require cut detection to be truly frame accurate. Straightforward measurement is therefore possible in terms of missed and erroneously flagged cuts. Any cut that is not frame accurate should be counted as two mistakes: a completely missed cut, plus an additional false cut. Overall accuracy is given by

$$\text{Accuracy} = 1 - N_{missed}/N_{true} - N_{false}/(N_{true} - N_{missed} + N_{false})$$

We have previously compared *ASAP* against established histogram-based methods (specifically *CutDet*[21]) to directly gauge relative performance in cut detection[15]. Several trials were run using different thresholds to determine optimal settings and compare areas of strength and weakness in both systems using rigorous sample footage chosen with principled criteria[10]. Examining results obtained using the optimal settings for both systems, *ASAP*'s score of 95.9% overall compares very favourably with *CutDet*'s best result of 85.2%. Looking at the areas where the systems failed it is clear that *ASAP* is much better able to cope with occlusion, failing in only one instance. Figure 1 summarises the results.

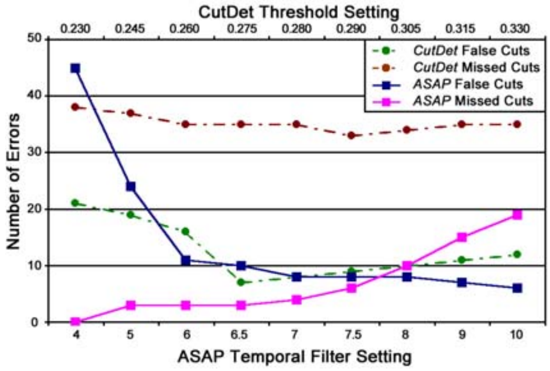

Figure 1: *Cut detection performance.*

The classification of camera movement is not typically regarded as a frame accurate measurement[10], however, for testing purposes we treat it as such. Previously we have tested *ASAP*'s camera move characterization and camera move frame accuracy using a programme that took *ASAP*'s output and compared it to an expert's hand log[15]. Overall the system correctly identified 71.3% of camera moves from an extreme case test set that included complex camerawork with multi-directional movement (e.g., a zoom in that pans left and tilts down). Results are summarized in Figure 2 using a windowed average of ± 15 shots.

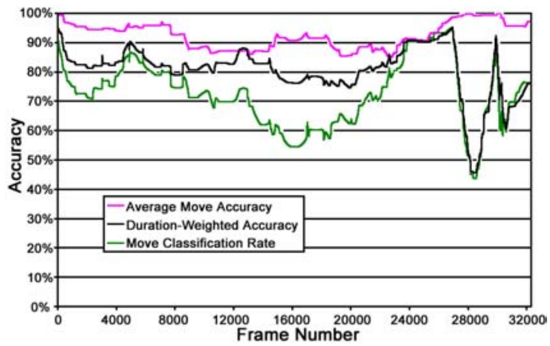

Figure 2. *Camera move classification performance.*

Clearly our approach to cut detection is effective and accurate enough for professional needs. However, although the performance of the move classifier is encouraging (given the difficulty of the trial) it could not be considered as an indication that the system is presently ready for unattended use (an area of our ongoing work). However, in the semi-automated context of *SALSA*, where user input is a component of log creation, this accuracy level is acceptable as any errors can be corrected during the entering of other shot information. Although not ideal, this level of accuracy does still indicate that substantial time savings can be made given the system is correct a significant majority of the time. Preliminary experiments (below) support this claim.

3.2 Annotation System

The description of shot framings and basic content using Hollywood nomenclature can be broken down into a few keys terms that can describe the vast majority of cases. For example, common framings are described by Katz[19] as 'close-up', 'close', 'medium' and 'wide' shots, with modifiers – such as 'extreme', 'tight', 'loose', etc. – used to further refine the description. Likewise, grouping content is often characterised in the same way though the use of 'single', 'two-shot', 'three-shot', 'group shot' and 'crowd shot'. As a result it should be possible to create a stenographic model of input so that users do not need to repeatedly type these descriptions.

SALSA uses dedicated keys to represent the most common classifications (as listed above) as well as a standard keyboard input system to enable unconstrained descriptions of higher-level semantic content. Figure 3. shows the current configuration.

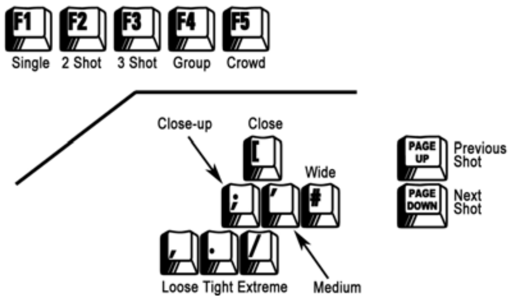

Figure 3: *Key mappings.*

These specific keys were chosen to enable an easy two-handed entry approach without the use of shift, alt or control keys, minimizing crossover and enabling easy movement for fast text entry. The optimal design for the layout has yet to be determined as usability tests are ongoing. However, it is already apparent from preliminary experiments that the stenographic model provides an appreciable time savings over straight keyboard entry alone.

3.2.1 Human-Computer Interface

Given *SALSA* is targeted to meet the needs of professional end users, we have designed the interface of the system using a layout and control methodology familiar to this group. The main entry window displays the output from the automatic parsing system in standard industry format, specifying shot number, start time, end time, duration and a breakdown any camera movements, with their respective starts, ends and durations. This log can be appended with descriptive information using the hot key system (described above) as well as with standard keyboard input for entering more detailed information. Three additional windows showing the actual start frame, end frame and the full running shot (with progress bar) are also utilised. This gives the user both quick and detailed references from which to generate higher-level semantic information. The current implementation is still not highly refined but is adequate for testing purposes. Sample screenshots can be found in Appendix B. Refinement of the approach is intended in future work.

3.3 Mosaic Generation System

The projective transform estimator used in *ASAP* and *SALSA* can be rerun on shots where the movement is simple, to generate an image mosaic. With the addition of start and end frame borders and the path of frames centres, the shot mosaic provides a closer analogue to a storyboard than a simple keyframe. A green bounding box denotes the start frame, shown in perspective in relation to the scene. A blue line indicates the direction of motion, linking centre points; a straight line would show that the movement was smooth whereas an irregular line would denote shake in the movement. A red bounding box is used to represent the end frame, also in perspective. The mosaic itself is centred on the middle frame of the sequence to minimize the overall distortion. Whether this is the best method for display is unclear and a topic for future work. Figure 4 shows an example mosaic.

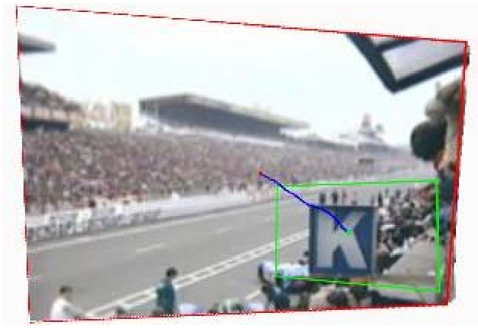

Figure 4: *Sample mosaic of zoom out, pan left.*

The use of mosaics was chosen to provide a succinct, intuitive visual description that enables users to determine all location-based attributes captured by a shot. This is particularly important if there are questions as to the viability of using a particular shot for editing. The indication of perspective does represent a departure from the typical manner of displaying footage content. Indeed, it may require some users to learn to 'see' in a way to which they are unaccustomed. However, our initial trials indicate that this is likely not a major issue and that users begin to see new benefits from the system. For example, if a studio camera tilted up very briefly, a boom microphone could appear in the mosaic even if the incursion lasted for a very short time. Likewise, in many contexts it is immediately possible to identify whether light stands, cables or other equipment are visible without having to review footage. This allows better quality control with minimal time penalty. Trials to date have been quite small so further testing is needed validate this model.

3.4 Log Generation and Output

SALSA uses output from the movement parser to present the data in several forms. These include a shot log that includes common information in standard industry format (e.g., SMPTE time code) such as start point, end point and duration of all shots and all camera movements contained within each shot. Thumbnails of start and end frames are extracted from the source material and rescaled for inclusion. If there is camera movement, these are placed on the left and right, respectively, of the generated mosaic if the predominant move is a tilt or above and beneath the mosaic, respectively, if the predominant move is a pan. A detailed example is shown in Appendix A.

3.5 Database Generation

SALSA creates database objects from both the extracted information and the user input. This enables full random access searching for any technical or semantic attribute, which can provide quick access for archivists and new creative options for editors. For example, we took two shots from the music video *Stargazer*[20] and asked *SALSA* to find the best sequence from a different roll of footage that could be spliced between them, accurately matching the speed of motion of the first shot (a tracking pan left) at its beginning, and that of the second shot (a tilt down) at its end, thus 'bridging' the two fluidly. The result (with dissolves automatically inserted between the shots) is summarized in Figure 5, which shows every fifth frame of the output sequence. As manually generated footage logs typically do not describe the precise *rate* of camera movement, creating a comparable sequence using traditional methods would be time consuming. Matching motions would not only have to be located, but visually compared to ensure the desired smooth editing flow. The ease and speed with which *SALSA* can suggest and create such sequences could prove valuable to practitioners.

Figure 5. *Example of automated shot bridging.*

4. Preliminary Results

To date, we have conducted one trial to test the viability and the basic effectiveness of our *SALSA* approach. This test was by no means exhaustive and simply serves as a means to prove the concept; further testing is clearly needed.

In this trial, an expert editor was asked to log the first 75 shots (~7 minutes) of the film *Le Mans*, twice – first using the system and second using a non-linear editing system with a word processor. This order was chosen to minimize any advantage that might be gained through familiarity with the material; the bias in this trial favours manual entry. Each task was timed to the nearest minute. The subject was asked to characterise each shot fully – including noting principal characters, locations, objects, movements, etc. – as if he were preparing a logging for editing a narrative piece. Note we are not presently including the processing time of the footage as it is an unattended event and this trial was simply to get a sense of the impact on user time requirements.

Using *SALSA* the expert logged the test sequence in 46 minutes. This compares very favourably with the 95 minutes he took when doing the task manually. As predicted, the main time savings appear to come from the automation of logging cuts and camera moves. The stenographic approach to framing classification appears to also have an impact although it was not quantifiable given the limited scope and simple design of this experiment. Although this trial is far from conclusive, we believe the significant time savings obtained does indicate that this approach is highly effective. Larger, more rigorous trials are planned.

5. Conclusions

In this paper we have described a novel method for the semi-automated logging of video and film footage. The application and interrelation of the automated media analysis system, keyboard based annotation system, mosaic generation system, log output system and database generation system were presented. The rationale behind the use of mosaic imagery was described as well as the results of a preliminary trial. Our approach appears to have significant potential although it is recognised that more rigorous tests are needed and that the subsystems need to be further refined. These are areas for future work.

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We would like to thank Zhan Peng for his assistance in recoding the mosaic system to enable the clear labelling of start and end frames as well as facilitating their inclusion into the output system.

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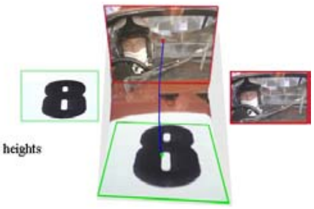
Appendix A: Sample *SALSA* Log

Shot	Start frame	End frame	Start time	End time	Duration	Description
161	25502	25503	17:00:01	17:00:02	0:00:02	Hold
	25504	25611	17:00:03	17:04:10	0:04:08	Tilt up 1.17949 frame heights
	25612	25631	17:04:11	17:05:05	0:00:20	Hold



Starts on tight close up of number 8 on car bonnet tilts to loose close-up of driver

-------------------------------------CUT-----------------------------------

Shot	Start frame	End frame	Start time	End time	Duration	Description
162	25632	25689	17:05:06	17:07:13	0:02:08	Hold

Tight close-up of driver

Appendix B: Sample *SALSA* Screen Shots

```
SHOT 68

ASAP output:
     Start frame  End frame  Start time  End time  Duration  Description
        9488      9602     6:19:12 6:24:01 0:04:15 Hold
        9603      9668     6:24:02 6:26:17 0:02:16 Tilt up          0.294872 frame heights
        9669      9820     6:26:18 6:32:19 0:06:02 Hold
        9821      9824     6:32:20 6:32:23 0:00:04 Occluding object for    4 frames
        9825      9843     6:32:24 6:33:17 0:00:19 Hold
        9844      10063    6:33:18 6:42:12 0:08:20 Pan right        1.54755 frame widths
      ^ 10005     10006    6:40:04 6:40:05 0:00:02 Tilt up          0.145299 frame heights
        10064     10078    6:42:13 6:43:02 0:00:15 Hold
        10079     10123    6:43:03 6:44:22 0:01:20 Track
        10124     10173    6:44:23 6:46:22 0:02:00 Pan left         0.291066 frame widths
      ^ 10159     10183    6:46:08 6:47:07 0:01:00 Zoom in          1.2987 scaling (end/sta
        10184     10207    6:47:08 6:48:06 0:00:24 Hold

User annotation:


Medium
driver from previous shot looking inside car, taken through other door, finishes,
gets out, camera follows him as he walks around car, toward back then toward
camera. End with close up on his crotch and watch.
```

```
SHOT 25

ASAP output:
     Start frame  End frame  Start time  End time  Duration  Description
        2475      2538     1:38:24 1:41:12 0:02:14 Tilt up          0.615385 frame heights
        2539      2563     1:41:13 1:42:12 0:01:00 Hold
        2564      2567     1:42:13 1:42:16 0:00:04 Track
        2568      2650     1:42:17 1:45:24 0:03:08 Tilt down        0.376068 frame heights
        2651      2834     1:46:00 1:53:08 0:07:09 Hold
        2835      2879     1:53:09 1:55:03 0:01:20 Tilt up          0.188034 frame heights
        2880      2884     1:55:04 1:55:08 0:00:05 Track
        2885      2960     1:55:09 1:58:09 0:03:01 Tilt down        1.77778 frame heights
        2961      2987     1:58:10 1:59:11 0:01:02 Hold

User annotation:

Single
Close up
of man winding clock, tilt up as he turns and walks to end of trailer,
looks out of window after placing clock on sill, walks back to camera,
tilt down as he reaches into an open suitcase.
```

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A vision-based postproduction tool for footage logging, analysis, and annotation

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Abstract

We report a new method for logging and annotating video footage directed towards the needs of professional postproduction and archivist end users. *SALSA*—Semi-Automated Logging with Semantic Annotation—is a hybrid system that uses automated footage analysis for cut detection and camera movement classification, and a stenographic-like keyboard input system for the logging of higher-level semantic information. Output is presented both in standard printed log form, with the addition of mosaic visual representations of shots, and in a fully searchable database. Experimental comparisons of *SALSA* with conventional hand analysis show a significant increase in the logger's speed with no reduction in accuracy or semantic detail.
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Keywords: Automated media analysis; Content indexing and retrieval; Shot boundary detection; Semantic annotation; Video analysis; Editing systems

1. Introduction

Postproduction personnel and media archivists share a number of common objectives when reviewing footage. Television and film editors look to obtain technical

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aspects—start and end time codes, duration of shots, framing, types of camera or subject movement within shots, etc—in preparation for editing. They also need to understand specific information concerning subject-based content—locations, props, specific actors, and actions, to name but a few. Archivists often require even higher-level semantic information relating to theme, style, and genre. Both groups demand that the information gathered is accurate and presented in a consistent form. This means the use of standard Hollywood nomenclature (e.g., "Medium Two Shot," "Pan Right to Close-up," etc. [1]) to characterize filmmaking attributes as well as semantic descriptions of content (e.g., "Interior Bar—Reeves drunkenly trips on a chair, spilling his drink" for narrative, "Train derailment—diesel locomotive lying on its side being examined by a salvage crew" for documentary, etc.). The goal is to enable quick access to specific shots and sequences without having to revisit the footage.

The task of logging is accomplished using a variety of methods. For years many editors and archivists created hand written logs detailing the specific information required. As computers became more common, this practice was transferred to word processors and spreadsheets. Presently, non-linear editing systems (NLEs), such as Avid *Xpress* and Adobe *Premiere*, include simple tools for footage acquisition that provide means to note the start and end frame of a shot as well as text boxes in which additional descriptive information can be entered. Bespoke logging tools, such as Imagine Product's *The Executive Producer* [2] and Virage's *VideoLogger* [3], enable logging to take place on any computer system, not just a dedicated NLE. Both NLE-based tools and bespoke loggers provide VCR-like controls to facilitate footage review with keyboard input for annotation. Basic automated cut detection functionality has started to appear in commercial 'pro-sumer' level postproduction tools. However, these systems do not have the frame-accuracy required by industry professionals so there has been no implementation of this technology in higher-end equipment (as of this writing). Despite the evolution of these tools the logging task remains labour intensive.

For the past several years there has been a significant amount of work undertaken to create fully automated video indexing and media analysis systems. Although techniques have advanced and technologies have matured we are still a long way from having a computer adequately and accurately characterize the full content of a film or video. Indeed, research into the extraction of high-level semantic information is very much in its infancy. There are, however, certain footage attributes that can be obtained reliably and consistently, including shot boundary location and descriptions of camera movement. The automated extraction of this information could be of great benefit and timesavings to practitioners yet such technology has barely been implemented in professional systems. Little has been written concerning how best to meet the present needs of these end-users whilst fully automated technologies evolve.

We have developed *SALSA*—a *Semi-Automated Logging with Semantic Annotation* program—to apply state-of-the-art automated content analysis to postproduction and archiving. *SALSA* is a hybrid system that combines an automated footage analysis system, to extract technical information from source material, with a streamlined text-based annotation input system based in part on stenographic models of interaction. Output consists of a combination of a conventional log form, utilizing time code and text annotation, with mosaic representations of each shot in addition to start and end frame thumbnails to provided a concise but complete print reference. A database is also automatically generated that enables direct searches by keywords, descriptions and other criteria. The objective is to enable faster, more accurate logging than is possible through current means.

2. Previous work

There have been numerous studies into automated media analysis. Shot boundary detection is arguably the oldest of these, starting with Syler's work looking at the differences between video frames in 1965 [4]. Since then, a wide range of methods have been developed and compared. Boreczky and Rowe [5] have examined techniques involving the use of global greyscale histograms (with and without twin-comparison thresholding), region greyscale histograms, motion-compensated pixel differencing and DCT-coefficient differencing. Lienhart [6] has looked at methods involving colour histogram differencing, edge change ratio analysis, pixel intensity comparison through standard deviation, and contrast change. Gargi et al. [7] expanded this scope by examining colour histograms in multiple colour spaces and looking at the effect of different colour space representations. Many researchers have also looked at shot boundary detection in the compressed domain (as typified by Sethi and Patel [8]). Other approaches include the use of block-based motion estimation (such as by Porter [9]), block likelihood ratios (shown in Dugad et al. [10]) and affine transforms (notably Bouthemy et al. [11]). Some of these studies ([6], for example) have reported methods that can yield high levels of accuracy (over 95%) with minimal false detection. Although such results may be viewed with suspicion due to insufficient testing methods (see [12] for a detailed critique) it is evident that high levels of reliability can be achieved with certain methods on many types of footage.

Camera movement classification has been studied less widely. Patel and Sethi [8] and Boreczky and Wilcox [13] expanded on their boundary detection work to extract camera motion in the compressed domain. Tan et al. [14] also used compressed video, but performed higher-level analysis. Bouthemy et al. [11] investigated camera motion classification through the use of affine transforms. It is this approach that is most closely related to the methods reported here.

Research into semi-automated editing tools is much more limited. Girgensohn et al. [15] developed *Hitchcock*, which assists in the editing of home video, automating some tasks related to shot choice, clip duration and suitable in/out points. *Hitchcock*, in part, acts as a domain expert (i.e., director) and thus takes some creative control away from the user. As a result, it is not suitable (nor is it intended) for industry use as it has a very narrow set of criteria as to what represents "good filmmaking."

Few studies have been conducted into the specific needs of postproduction and archivist end-users although Mateer [12] does provide a detailed description of important considerations of automated systems targeted for these groups.

SALSA, the system introduced in Section 3, draws on prior work in the estimation of projective transforms. There has been extensive research into projective transform estimation, particularly as applied to the generation of mosaics. These include significant contributions by Szeliski [16], Mann and Picard [17], Peleg and Herman [18], and Davis [19]. The book edited by Benosman and Kang [20] provides comprehensive coverage that includes both mosaicing algorithms and applications. In *SALSA*, however, estimated projective transforms are used for shot change detection and motion analysis as well as mosaicing. There is no prior example of an estimator being used across these applications in an integrated way.

3. Method: *SALSA*

The automation of logging for archiving or postproduction represents the final aim of automated media analysis. As discussed in Section 1, such a system is still a long way off, so *SALSA* is designed to exploit the robust technologies that now exist to streamline and speed up the process. Used in conjunction with some user input, automated parsing is harnessed to enable timesavings with no loss in logging accuracy.

SALSA consists of three main components: (1) an automated shot boundary and camera movement parser, which organizes the footage for presentation in (2), a user interface providing fast keyboard-based semantic mark-up for (3), an output processor, which generates mosaic visualizations, a semantic log, and a machine-readable database. Fig. 1 shows the flow of video data through the system.

3.1. Parsing system

The first major component of *SALSA* was initially developed as a stand-alone automated shot analysis program—*ASAP* [21]. *ASAP* provides the initial parse of the video data that structures user interaction with the log, as well as the motion parameters for mosaic visualizations. It is therefore essential that it be reliable and accurate. Consequently, we describe in this section not only the operation of *ASAP* but also the results of experiments that test its performance on real footage. *ASAP* consists of a frame-by-frame camera motion estimator applied both with and without temporal pre-filtering. A movement parser then connects inter-frame movements into strings and applies syntactic rules to distinguish different types of movement.

3.1.1. Camera motion estimator

We use a fast, high-accuracy, projective transform estimator developed for image mosaicing, and registration in augmented reality [22].

The estimator's first stage is a reliable translational estimate that provides tolerance to noise, illumination change, and small object movement within the scene. The estimator builds an image pyramid then does a wide area full-search match at the highest (i.e., smallest size) level. For every displacement up to half the image size, it determines the overlapping (matching) region and calculates the mean difference

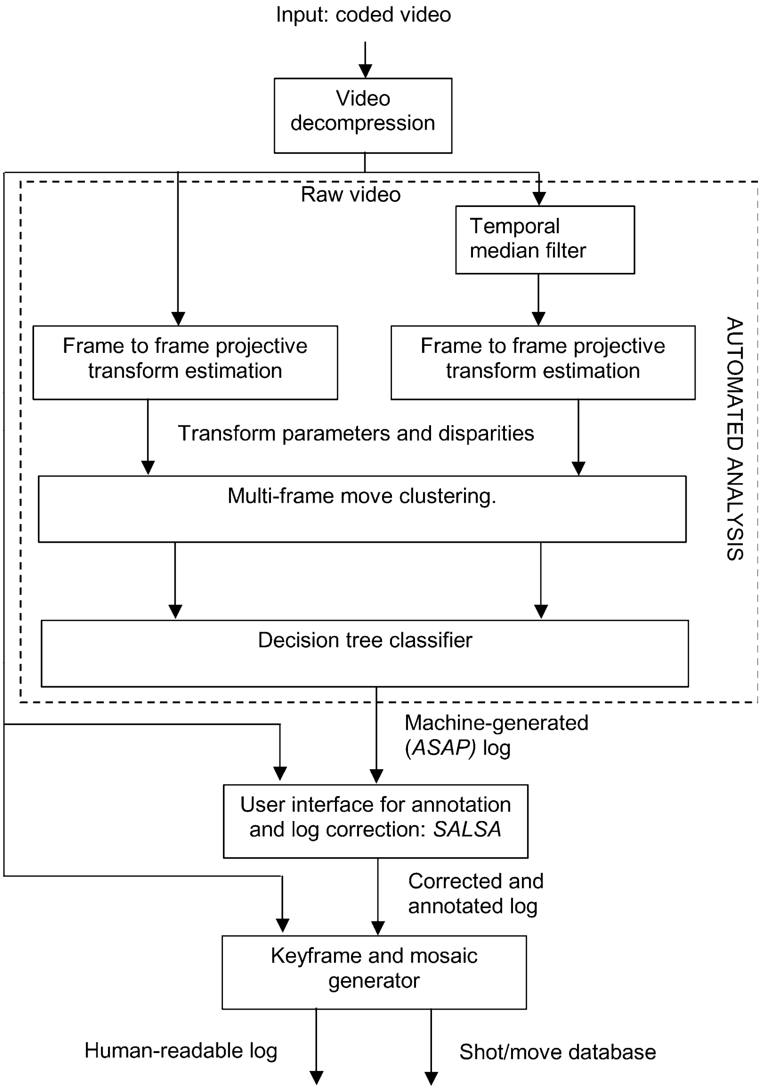


Fig. 1. Block diagram.

between the two images in this region. The mean is subtracted from each individual pel difference before summing up all the absolute values of differences in the overlapping region. The minimum mean disparity value provides the first estimate of translation at the highest level of the pyramid. This value is then projected down the pyramid, where it is refined level-by-level using a gradient descent algorithm. The difference in means of overlapping areas is also projected down and maintained in the search at each level. At the final (bottom) level of the pyramid, a full-resolution block the size of the overlapping area is used.

Because the translational stage begins with a wide area full search it matches accurately over a wide range. The continuous adjustment for the mean of the overlap region provides protection against global level change. This mean adjustment is carried forward to stage 2 of the estimator so that it too is resilient to changes in overall luminance level.

The second stage of the estimator is a generate-and-test optimization procedure. The estimator uses a mesh or grid of coordinates for which candidate transform values are calculated and which then sample the two images. A disparity value is computed from a weighted sum of the absolute differences in sample values. The weighting attenuates high absolute differences to limit the effect of localized moving objects.

The grid of samples may be square or quincunx. No prefiltering is used in either image, so at a local level, sample matches are subject to aliasing effects. But the mesh is not intended as a scaled image representation. Rather it is a way to distribute effectively random samplers over the candidate transformation's range and domain. The sample spacing is uniform, which is convenient for fast transform calculation. There is no relationship between image structure and where the sample mesh happens to fall, so clearly it is possible to be unlucky and miss useful image features. The estimator relies on distributing enough samples through the image as a whole that this is unlikely to matter. In practice, all meshes finer than 1 in 16 image samples have comparable performance. The spacing is the only parameter of the method and varying from 1 in 16 to 1 in 100 trades accuracy for speed.

The weighted sum of absolute differences over the sample mesh is used as the criterion function for optimization by the Nelder–Mead simplex method [23]. This method is not the linear programming simplex but a general unconstrained optimization technique. Its only other application to image correspondence analysis of which the authors are aware is [24], where it was used for estimating the translational motion of square blocks.

The Nelder–Mead simplex requires the maintenance of nine candidate transforms and their iterative adjustment. Each candidate transform is a particular set of the eight projective transform parameters and therefore corresponds to a point in eight-dimensional parameter space. These nine points form the vertices of the simplex. Geometrically, the simplex method involves changing the shape of this hypersolid by systematic movement of the vertices towards the minimum, until they are close enough together to meet a termination condition.

The simplex method is sometimes regarded as inefficient because its exploration of directions in multi-dimensional space is guided by "accidental" configurations of simplex vertices rather than local gradient near the current search point. Yet this indeterminacy appears to work well in shifting the simplex out of local minima. Because of the structure of pictures, local optimization minima occur near the global minimum. Once the "catchment area" of a local minimum has been reached by a gradient descent algorithm, that minimum will quickly be returned as the true minimum. In contrast, the simplex method continues to explore other possibilities as its vertices draw together.

A second benefit of simplex is that the initialization of vertices can be done systematically, according to the expected variation in each of the dimensions. The estimator does this by setting up the vertices one-by-one by orthogonal one-dimensional searches, with directions and step sizes derived from a prior analysis of many video samples. That is, the directions in which the simplex is initially constructed are chosen to shape it to explore the most common transforms encountered in practice. Each 1D search ends when the vertex and its predecessor span a good 1D minimum.

Finally, if the initialization values are particularly bad for a given case, the simplex changes shape to move quickly towards better vertices. In doing so, it grows in size, automatically lengthening the search time, but ensuring that, once values in the vicinity of the minimum are found, the simplex will converge slowly enough to avoid false minima.

Once a minimum has been found it is possible to restart the simplex with noisy values as a check for a false minimum. In a large number of tests this has yielded an improved result in less than 0.5% of cases. The method therefore runs the simplex only once.

In comparison tests with other projective transform estimators, the simplex-adapted mesh method performs as well as the state of the art but up to 30 times faster than its competitors. This estimator has been used for object-based video analysis and coding [25], but *ASAP* only uses the output of eight perspective transform parameters, along with a single measure of disparity, for input to the movement parser. At maximum accuracy the global perspective estimation algorithm used processes a pair of 720×560 frames in about 1.6 s on a 2 GHz Pentium IV.

3.1.2. Temporal filter

The motion estimator is applied directly to the raw video input and to a temporally filtered version of the input. We use a 15-tap temporal median filter that attenuates the effect of temporary scene occlusions. This allows the movement parser to disambiguate between genuine cuts and gross image changes caused by fast-moving foreground objects.

3.1.3. Movement parser

The first stage of the movement parser clusters consistent movements over consecutive frames into tentative zooms, pans, and tilts. It also detects cuts. If the estimated projective transform between two frames yields a significant final disparity, its parameters are examined for consistency with the temporally filtered information, and if inconsistent, a cut is declared. Pans and tilts are easily detected from translation parameters, and zooms from a combination of the scale/rotation matrix entries in the perspective transform. It is also possible to detect and quantify camera roll, though this is such an uncommon movement that we do not parse it.

Having divided the stream of camera movements provisionally into zooms, pans and tilts (which may happen in parallel), the parser applies a second level of analysis. If zooms are of sufficient magnitude, they are accepted as fundamental motions and subsume any other kind of movement. For pans and tilts, the parser examines the series of tentative movements in the shot, and infers that the movement is one of three types: (i) a fundamental pan or tilt, which is a consistent movement in a particular trajectory, (ii) tracking, where the camera appears to be following a moving object, (iii) jitter. The last of these is ultimately classified as part of a 'hold', along with any genuinely stationary camera shots. The motion estimator is able to correct for jitter with motion stabilization if necessary. Throughout the two stages of analysis, the parser follows a tree of classification decisions that have been derived empirically through experimentation on a wide range of video data.

3.1.4. Cut detection and move classification accuracy

Automated and semi-automated footage analysis tools ultimately intended for professional use must be tested with a wide range of footage representing both typical and extreme conditions. There have been many trials to date that have reportedly yielded significant results. However, even the most extensive studies, including those taking advantage of the highly laudable TRECVid initiative [26], may be challenged for failing to consider the wide range of physical and aesthetic attributes that can affect automated analysis. The impact of genre, acquisition formats and creative techniques, such as fast-paced montage, jump cuts, graphic match cuts, swish pans, snap zooms, and racking focus, is rarely considered in depth. Our contention is that performance cannot be adequately analysed without a clearly principled basis for choosing sample sets, including a formal understanding of the cinematic style employed by the programme makers [12], if a system is to ultimately be applied in a real-world setting. As a result, we have chosen specific footage to more fully and accurately test our systems in a real-world context.

3.1.4.1. Test footage employed. Reviewing recognized technical and critical cinema texts [1,27,28] as well as drawing on professional filmmaking expertise we chose source footage from the 1970 film *Le Mans* specifically due to its directorial and editorial style. The section tested encompasses the first 290 shots (32,229 frames) after the head title sequence. It consists of a mix of location Cinema Verité hand-held footage and conventionally staged narrative production. Editing builds from a slow, expository pace and to a very fast montage of shots reaching a visual climax in which the duration of some shots is very short (<4 frames). In addition, there are several instances of intentional jump and graphic match cuts. There is a wide range of shot types with many complex compositional elements, including significant subject occlusion, complex relative motion, and fast motion of both subject and camera. Taken as a whole, this footage represents a very significant challenge for automated analysis.

We have, of course, tested *ASAP* on other sources, from classic black-and-white footage to a contemporary music video [29]. But these are far less varied and demanding than *Le Mans*. Furthermore, we were unable to test a comparison method on black-and-white video, so report here results only for *Le Mans*.

3.1.4.2. Experimental method. An AVI file and an identical set of JPEG stills were generated from a NTSC video master of the 290 shot test sequence. A hand log of the test footage was created using industry-standard criteria to characterize start/

end times, shot type and camera movements, all with frame accurate precision. This was then converted to a simple text file using abbreviations for moves (e.g., L for Pan Left, etc.) to enable automated scoring.

3.1.4.3. Cut detection. Media professionals require shot boundary detection to be truly frame accurate. As such common measures of *Precision* and *Recall* are not best suited for this analysis. Straightforward measurement is possible in terms of missed and erroneously flagged cuts. However, any cut that is not frame accurate should be counted as two mistakes: a completely missed cut, plus an additional false cut. We measure overall accuracy as given by

$$\text{Accuracy} = 1 - N_{\text{missed}}/N_{\text{true}} - N_{\text{false}}/(N_{\text{true}} - N_{\text{missed}} + N_{\text{false}}).$$

To compare *ASAP* against established methods we obtained a copy of Lienhart's *CutDet* [30] to directly gauge relative performance in cut detection using a well-studied and reportedly highly effective approach. Several trials were run using different thresholds to determine optimal settings and compare areas of strength and weakness in both systems (see Fig. 2).

With a temporal filter setting of 5 or higher, *ASAP* correctly detects over 90% of cuts for the test footage. For this data set, the optimal setting is 7, with cut detection accuracy of 95.9% overall. This compares favourably with *CutDet*'s best result of 85.2% at a threshold of 0.275. It is recognized that this version of *CutDet* cannot be modified to attempt the detection of shots with a duration of fewer than six frames, as occurs in shots 254–271. Discounting that section of the test set *ASAP* still outperforms *CutDet* by nearly 4%, significant in a professional end-user context. Examining the areas where the systems failed it is clear that *ASAP* is much better able to cope with occlusion, failing in only one instance. *ASAP* also correctly parsed all four graphic match cuts whereas *CutDet* was only able to detect two. Neither system was able to parse the two one-frame jump cuts. This is important as the detec-

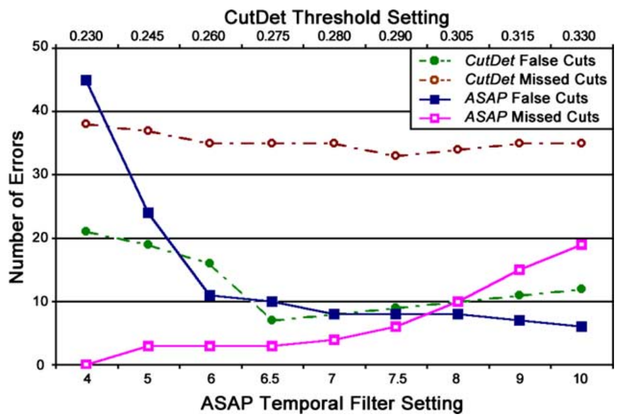


Fig. 2. Cut detection performance.

tion of drop frames is vital to editors and thus warrants further investigation. Overall results indicate that *ASAP* is highly effective.

3.1.4.4. Camera move categorization. Locating the exact start frame of a camera move is desirable although in practice edits are rarely made using the precise start and end points of the movement. For evaluation purposes, however, it is important to judge a system based on its absolute performance.

Camera move characterization and camera move frame accuracy were analysed using a programme that took *ASAP*'s output and compared it to the expert's hand log. At present, *ASAP* cannot parse translating camera shots (e.g., dolly, crane, Steadicam, etc.) and so was penalized for this. The performance scores were calculated based on the following criteria:

- A move was considered *correctly classified* if *ASAP* identified a move with extents that overlapped with a move of the same type in the hand log. *ASAP*'s other moves were categorized as *false*, and the hand log's other moves were categorized *missed*. The *Classification Rate* per shot is the number of correctly classified moves divided by the total of correct, false and missed moves.
- A correctly classified move was assessed for frame-accuracy. The *move accuracy* was defined as the proportion of the time that the hand log and *ASAP*'s log both identified the move as happening, divided by the total extent of time from when either log identified the move starting, to when either log identified it as ending. The *average move accuracy* gives the accuracy performance of all recognized moves within a shot.
- *Duration-weighted accuracy* measures the proportion of frames within a shot where *ASAP* and the hand log report the same movement in progress (or both report a static hold) divided by the total number of frames in the shot.

The first two metrics evaluate the parsing independent of move durations. They, respectively, assess the syntactical correctness of the *ASAP* log and the precision of the transitions between one move (or hold) and another. The third metric emphasizes the amount of time that *ASAP* is right (or wrong), so that long moves have more weight than short moves. Which of these metrics is more appropriate is application dependent. We therefore present results for all. Fig. 3 summarizes *ASAP*'s performance using a windowed average of ± 15 shots.

Overall *ASAP* correctly identified 71.3% of camera moves within the shots, including complex camerawork with multi-directional movement (e.g., a zoom in that pans left and tilts down). There were two areas where parsing is less accurate—one where heavy occlusion adversely affected accuracy and another in which the very short duration of shots, coupled with the small scale of camera movement in two shots that are cut between several times, caused errors (discounting these two repeating shots alone raises overall accuracy by nearly 5%). When *ASAP* correctly classified a camera move, it detected start and end points with an overall average move accuracy of nearly 95%. As an absolute measure this is a remarkable result.

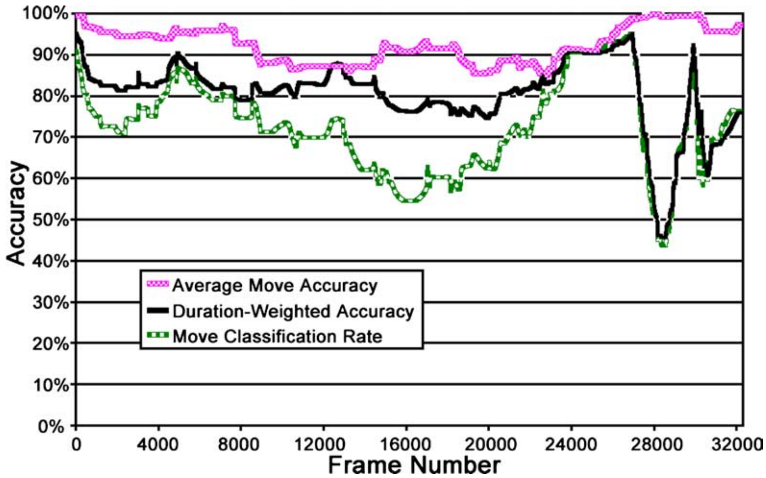


Fig. 3. Camera move classification performance.

ASAP is most accurate in charting start and end times of moves where there were low levels of subject motion or highly controlled movements (i.e., camera on a tripod in controlled conditions). Instances of handheld shots, multiple subject motion, and particularly occlusion are more difficult for the system although it is quite robust and able to detect severe moves such as snap zooms.

In examining other sequences that posed problems, we identified several conditions that likely require a system to have a more formal model of visual perception. Camera moves that keep the subject static within frame as the subject physically moves can fail if the background does not have a clear pattern or texture (such as a clear sky or unmarked road). Likewise *ASAP* can have trouble distinguishing the direction of camera movement in shots where the dominant movement is not objectively clear. We believe that such errors are not unique to our perspective estimation approach but apply to other non-intelligent methods as well.

Clearly the *ASAP* approach to fully automated cut detection is effective and meets the professional requirement of frame accuracy. However, although the performance of the move classifier is encouraging (given the complexity of the test footage) it could not be considered as an indication that the system is presently ready for unattended use. In the semi-automated context of *SALSA*, where user input is a component of log creation, this accuracy level is acceptable as any errors can be corrected during the entering of other shot information. Although not ideal, this level of accuracy indicates that substantial timesavings can be made given the system is correct a significant majority of the time. Logging experiments (Section 4) support this claim.

3.2. Annotation system

The description of shot framings and basic content using Hollywood nomenclature can be broken down into a few key terms that can describe the vast

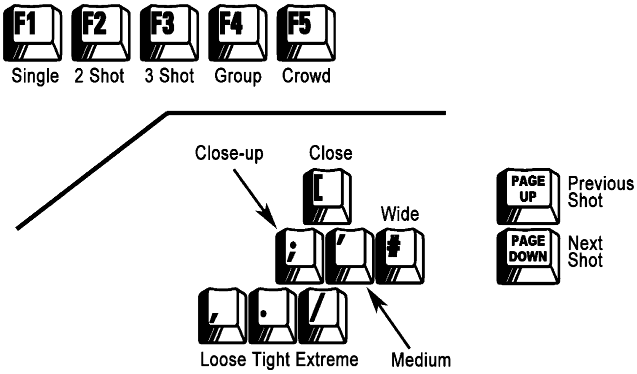


Fig. 4. Key mappings.

majority of cases. For example, common framings are described by Katz [1] as 'close-up,' 'close,' 'medium,' and 'wide' shots, with modifiers—such as 'extreme,' 'tight,' 'loose,' etc.—used to further refine the description. Likewise, grouping content is often characterized in the same way though the use of 'single,' 'two-shot,' 'three-shot,' 'group shot,' and 'crowd shot'. As a result it is possible to create a stenographic model of input so that users do not need to repeatedly type these descriptions.

SALSA uses dedicated keys to represent the most common classifications (as listed above). In addition, users can configure 'hot keys' to provide quick entry of information specific to their needs. A standard keyboard input system enables unconstrained descriptions of higher-level semantic content to also be included. Fig. 4 shows the current configuration.

These specific keys were chosen to enable an easy two-handed entry approach without the use of shift, alt or control keys, minimizing crossover, and enabling easy movement for fast text entry. The optimal design for the layout has yet to be determined as usability tests are ongoing. However, it is already apparent from logging experiments that the stenographic model provides appreciable timesavings over straight keyboard entry alone.

3.2.1. User interface

Given *SALSA* is targeted to meet the needs of professional end users, we have designed the interface of the system using a layout and control methodology familiar to this group. The main entry window displays the output from the automatic parsing system in standard industry format, specifying shot number, start time, end time, duration, and a breakdown any camera movements, with their respective starts, ends, and durations. This log can be appended with descriptive information using the hot key system (described above) as well as with standard keyboard input for entering more detailed information. Three additional windows showing the actual start frame, end frame and the full running shot (with progress bar) are also utilized. This gives the user both quick and detailed references from which to generate higher-level semantic information. Sample screenshots can be found in Figs. 5

Fig. 5. Sample *SALSA* screen shot.

and 6. The current implementation is not fully developed but is adequate for testing purposes.

3.3. Output processor

Postproduction and archivist end-users require footage logs and content descriptions to be available in several forms, depending on the specific task required. *SALSA* has been designed to provide maximum flexibility whilst ensuring all data are presented clearly, succinctly, and with immediate availability. The output processor consists of three key components: a mosaic generation system, a print log generation system, and a database generation and management system.

3.3.1. Mosaic generation system

The projective transform estimator used in *ASAP* can be rerun on shots where the movement is unidirectional to generate an image mosaic within *SALSA*. The mosaic is simply the union of frames in the sequence warped according to their cumulative projective transforms relative to the middle frame. With the addition of start and end frame borders and the path of frames centres, the shot mosaic provides a closer analogue to a storyboard than a simple keyframe. A green bounding box denotes the start frame, shown in perspective in relation to the scene. A blue line indicates the direction of motion, linking centre points; a straight line would show that the movement was smooth whereas an irregular line would denote shake in the movement. A

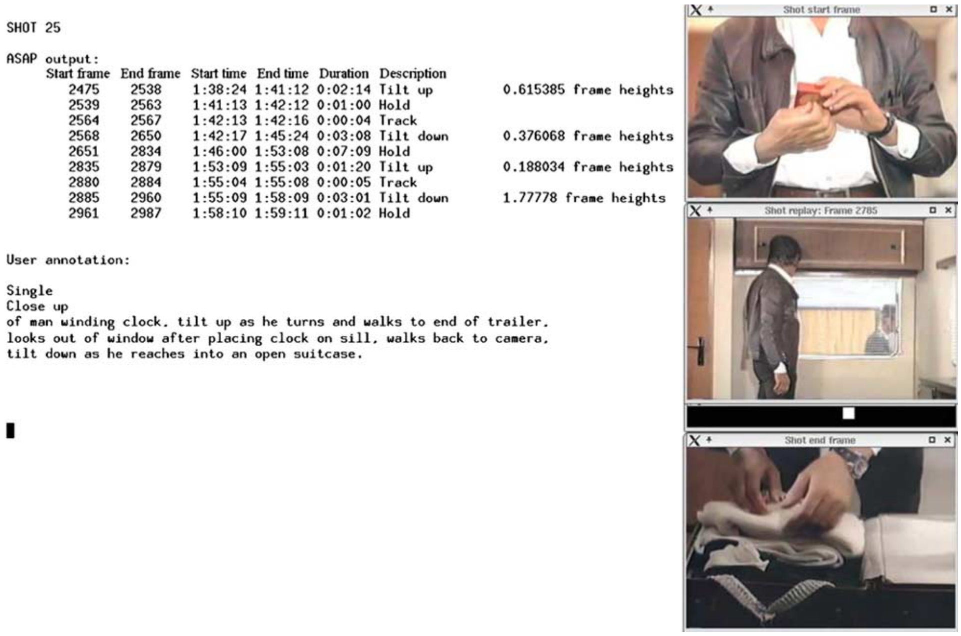


Fig. 6. Sample *SALSA* screen shot.

red bounding box is used to represent the end frame, also in perspective. The mosaic itself is centred on the middle frame of the sequence to minimize the overall distortion. Whether this is the best method for display is unclear and a topic for future work. Fig. 7 shows an example mosaic.

The use of mosaics was chosen to provide a succinct, intuitive visual description that enables users to determine all location-based attributes captured by a shot. This is particularly important if there are questions as to the viability of using a particular shot for editing. The indication of perspective does represent a departure from the typical manner of displaying footage content. Indeed, it may require some users to learn to 'see' in a way to which they are unaccustomed. However, our initial trials indicate that this is likely not a major issue and that users begin to see new benefits from the system. For example, if a studio camera tilted up very briefly, a boom microphone could appear in the mosaic even if the incursion lasted for a few frames. Likewise, in many contexts it is immediately possible to identify whether light stands, cables or other equipment are visible without having to review footage. This allows better quality control with minimal time penalty. Trials to date have been limited so further testing is needed validate this model.

3.3.2. Log generation and output

SALSA uses output from the movement parser to present the data in several forms. These include a shot log that includes common information in standard industry format (e.g., SMPTE time code) such as start point, end point, and duration of all shots and all camera movements contained within each shot. Thumbnails of

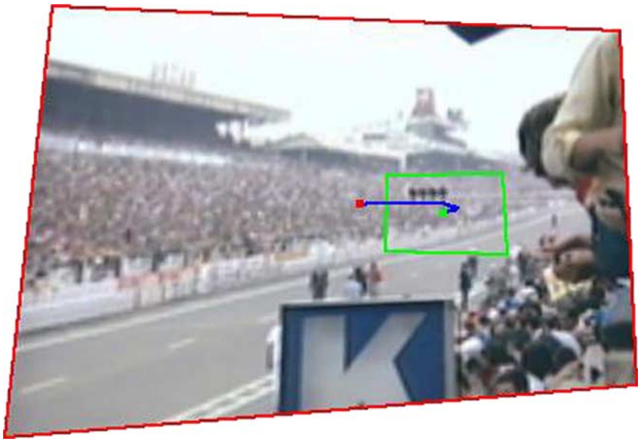
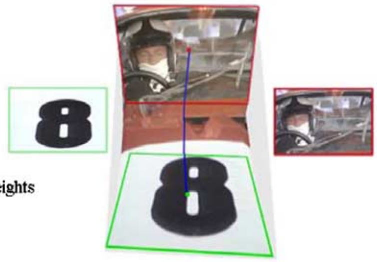


Fig. 7. Sample mosaic of zoom out, pan left.

Shot	Start frame	End frame	Start time	End time	Duration	Description
161	25502	25503	17:00:01	17:00:02	0:00:02	Hold
	25504	25611	17:00:03	17:04:10	0:04:08	Tilt up 1.17949 frame heights
	25612	25631	17:04:11	17:05:05	0:00:20	Hold



Starts on tight close up of number 8 on car bonnet tilts to loose close-up of driver

-------------------------------------CUT-----------------------------------

162	25632	25689	17:05:06	17:07:13	0:02:08	Hold

Tight close-up of driver

Fig. 8. Sample *SALSA* finished log output.

start and end frames are extracted from the source material and rescaled for inclusion. If there is camera movement, these are placed on the left and right, respectively, of the generated mosaic if the predominant move is a tilt or above and beneath the mosaic, respectively, if the predominant move is a pan. A detailed example is shown in Fig. 8.

3.3.3. Database generation and management

SALSA creates database objects from both the extracted information and the user input. This enables full random access searching for any technical or semantic attribute, which can provide quick access for archivists and new creative options for edi-

Fig. 9. Bridging shot example.

tors. For example, we took two shots from the music video *Stargazer* [28] and asked *SALSA* to find the best sequence from a different roll of footage that could be spliced between them, accurately matching the speed of motion of the first shot (a tracking pan left) at its beginning, and that of the second shot (a tilt down) at its end, thus 'bridging' the two fluidly. The result (with dissolves automatically inserted between the shots) is summarized in Fig. 9, which shows every fifth frame of the output sequence. As manually generated footage logs typically do not describe the precise *rate* of camera movement, creating a comparable sequence using traditional methods would be time consuming. Matching motions would not only have to be located, but visually compared to ensure the desired smooth editing flow. The ease and speed with which *SALSA* can suggest and create such sequences could prove valuable to practitioners.

4. Evaluating *SALSA*

To date, we have conducted two small trials to test the viability and the basic effectiveness of our *SALSA* approach.

In the first trial, an expert editor was asked to log the first 75 shots (approximately 7 min) of the film *Le Mans*, twice—first using *SALSA* and second using a non-linear editing system with a word processor. This order was chosen to minimize any advantage that might be gained through familiarity with the material; the bias in this trial favours manual entry. Each task was timed to the nearest minute. The subject was asked to characterize each shot fully—including noting principal characters, locations, objects, movements, etc.—as if he were preparing a log for editing a narrative piece. Note we are not presently including the processing time of the footage as it is an unattended event. Using *SALSA*, the expert logged the test sequence in 46 min; manual logging took 95 min. The second trial involved the same methodology as above but used footage from scene four of Eisenstein's *Battleship Potemkin* (the famous *Odessa Steps* sequence). The scene contains 238 shots and has a duration of just over 10 min. Manually logging the footage took the expert 250 min; with *SALSA* the time was 117 min. In both trials all errors in *SALSA*'s automatic cut detection and move classification were corrected by the user manually during the annotation process. A side-by-side comparison of logs generated with and without the use of *SALSA* showed no apparent differences in the type or level of detail of annotations. Both sets of logs were essentially equivalent in content.

From these limited trials it is clear that the *SALSA* approach has strong potential. In both cases the timesavings were in excess of 50% with no loss in log detail or accuracy and we believe this number can be increased through additional development of the user interface. As predicted, the main gain in efficiency appears to come from the automation of logging cuts and camera moves, even with the user having to correct any parsing errors manually. The stenographic approach to framing classification appears to also have an impact although it was not quantifiable given the limited scope and simple design of these experiments. It was noted that additional dedicated keys for other content descriptions could enhance the logging process. Likewise, automated matching of like angles and continuing shots could further reduce the manual time required.

5. Conclusions

In this paper, we have described a novel method for the semi-automated logging of video and film footage. The application and interrelation of the automated media analysis system, keyboard based annotation system, mosaic generation system, log output system, and database generation system were presented. The rationale behind the use of mosaic imagery was described as well as the results of a user trial. Our approach appears to have significant potential although it is recognized that more extensive testing is needed.

Areas for future work include the conducting of formal needs analyses of a range of archivists and editing professionals to guide the refinement of the user interface. Significant system testing, using a wide variety of footage, will enable us to further improve the automated analysis and detection subsystems. In addition, we will look to incorporate new types of semantic parsing to expand the functionality of the system.

Acknowledgment

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AUTOMATED DESCRIPTION OF FILM AND VIDEO SHOT COMPOSITIONAL CHARACTERISTICS

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Abstract

We report a new method for automatically describing the compositional characteristics of film and video footage through the use of face detection, a novel pose estimation approach and a compositional interpretation system. Preliminary trials using short excerpts of two television programs, and scored using a rigorous user-centric measure, are presented. Results indicate that the system can provide significant time savings in archive annotation and postproduction logging tasks.

1 Introduction

A clear description of the characteristics of film or video content is required for many types of indexing tasks. Textual summaries are important in a variety of contexts – to facilitate database searches, to enable the cataloguing of film archives and to streamline the media postproduction process. Whilst the specific requirements of these different groups often involve information unique to a particular task, there are several areas where common descriptions can be used.

The film industry has a long-established vocabulary for describing certain aspects of visual content that is commonly understood and well suited to many visual indexing tasks. *Composition* refers to the positional information of different elements contained within the picture area. It is broken down into specific categories that describe particular aspects of the composition. *Framing* refers to the how large key elements of the picture (i.e., the subject) are within the picture area. This is noted by terms that indicate the relative view of the shot such as *close-up*, *medium* or *wide*. Qualifiers, such as *tight*, *loose* and *full* are sometimes added to give further precision to the description. Using Katz' definitions [14], common framings are abbreviated as follows:

- ECU = Extreme Close-Up
- MCU = Medium Close-Up
- FCU = Full Close-Up
- WCU = Wide Close-Up
- CS = Close Shot
- MCS = Medium Close Shot
- MS = Medium Shot
- MFS = Medium Full Shot
- FS = Full Shot
- MWS = Medium Wide Shot
- WS = Wide Shot
- EWS = Extreme Wide Shot

Figure 1 shows examples of different framings.

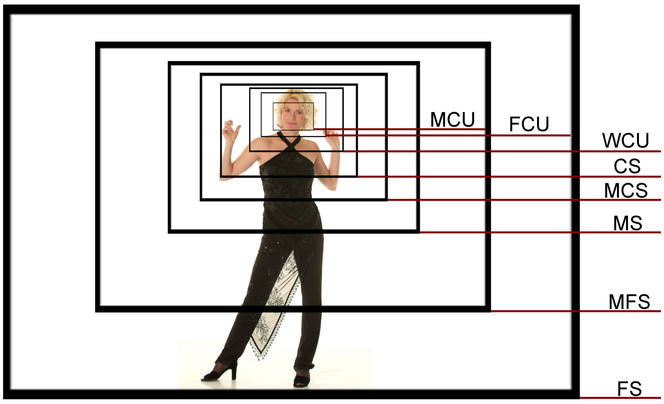


Figure 1: Shot Framings based on Katz' definitions

Grouping denotes the number of subjects present within a particular composition. These are simple numeric measures such as *single* for one subject, *two-shot* for two, etc. The terms are most commonly used to describe shots with people present. For clarity, specific counts rarely extend beyond four (e.g., a *four-shot*), with the terms *group shot* and *crowd shot* often used to denote larger numbers of subjects. Groupings are abbreviated numerically within a framing description, such as M3S for medium three shot, etc.

The third aspect of filmic descriptions involves the relative position of subjects within the shot. This is noted from the camera (or frame) perspective – e.g., *camera right* or *frame left*, etc. Expanding on that simple idea, the final element of the summary involves the orientation of subjects, again anchored to the camera or frame view – e.g., *subject frame right looking frame left*, etc. Together, these four elements provide succinct details of composition.

For the purposes of this project we differentiate between the terms *looking* and *facing*. We use the term *facing* to indicate the orientation of the head – angled to the left, central or angled to the right. We define *looking* as the direction of gaze (or *eye-line*, in film industry nomenclature) as indicated by the position of the eyes. This distinction is important as it is possible for a person to face left whilst looking right. Our system does not currently employ gaze detection and thus we presently only interpret the basic direction that people are facing. Figures 2 and 3 show examples with full descriptions using these definitions.

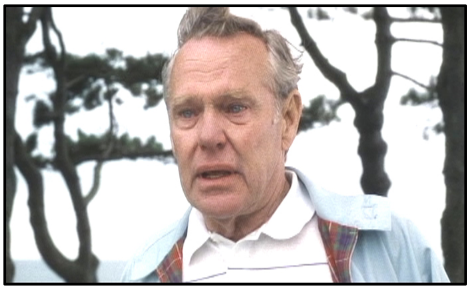


Figure 2: Single close shot of man centre frame, facing left

Figure 3: Over-the-shoulder medium three shot, past General, frame right facing left, to Colonel, frame left facing right, and Major, centre frame facing centre

Although classifying footage content in this manner is straightforward, it is quite time-consuming. There are many situations, particularly in the cataloguing of formerly lost film archives containing millions of feet of footage, where manual classification is not viable.

Techniques for automatic textual summarization could be highly beneficial to many different groups. In addition, the information extracted could be used to enhance the creation of visual summarizations as well.

We propose novel methods for the automated characterisation of shot content based on this film industry vocabulary. This paper details the application of existing face detection techniques in conjunction with a new pose estimation and semantic classification system to create accurate, automated descriptions of basic compositional information.

2 Prior work

For the past several years there has been a significant amount of work undertaken to create fully automated video indexing and content analysis systems. Research in this area began in the mid-1960s with Seyler's analysis of differences between video frames [1]. Subsequent exploration has developed methods of scene change detection (a comparison of commonly used cut detection techniques can be found in [2], a more recent approach is discussed in [3]) and automated analysis of camera work (such as [4] and our own work [5]). Methods for the extraction of semantic content information from footage (including [6-8]) have also been developed.

As of this writing there is little research directly related to the extraction of compositional information. Kumano et al. [9] propose methods for automatically describing some shot framings, however, they rely on predictive analysis of editing styles limited to one genre of television programme. Hauptmann et al. [10, 11] have developed a "people detector" as part of their Informedia system that does detect the relative size and orientation of faces within shot but the information is used to facilitate different types of semantic extraction and not for direction summarization of compositional attributes.

There are many film texts that discuss the nature of film industry vocabulary (such as [12-14]). The terminology used can vary somewhat from region to region although the content of the descriptions is universal. To ensure consistency we use descriptions listed in Katz [14], which is widely acknowledged as a key reference work.

There have been various approaches to the problem of face detection. An excellent survey as of 2001 can be found in [15]. In the years following this survey, much further work has taken place with perhaps the most significant being that of Viola and Jones [16]. They present a new approach and set a new standard of speed and accuracy for frontal face detection. There have been a number of efforts to improve on the system of Viola and Jones. These include reducing the training time [17, 18] and introducing different base features [19]. One of the most interesting developments is the work of Li and Zhang [20, 21] in which they describe a multi-view face detector operating on faces from -90 to +90 degrees. The facial direction is determined by the detector.

For the purpose of our classification system, we choose a face detector similar to that of Viola and Jones [16]. These approaches use simple Haar-like features which may be computed extremely quickly. To construct a classifier, the features are combined using AdaBoost [22, 23], a contemporary machine learning algorithm. Groups of features are then used to form a cascade structure. The structure allows the majority of samples to be rejected very quickly. The result is a detector which operates at 15 frames per second on images of 384 by 288 pixels using a Pentium III 700MHz. The method is equally applicable to both colour and greyscale images.

Methods for determining the orientation of the head of a person (pose) within an image have been widely studied. Geometrical approaches based on the analysis of facial features have been developed by Gee and Cipolla [24] and Horprasert et al. [25]. Others have utilised principle component analysis, such as McKenna [26] who seeks to minimize illumination issues through the use of Gabor Wavelet Transforms. Techniques involving convolutional networks have also been examined, including Osadchy et al. [27] who developed their system for simultaneous face detection and pose interpretation. Wang and Singh [28] provide a useful survey of several methods for pose and other types of human form detection.

3 Methods

The algorithm comprises four distinct stages. In the first stage, a frontal face detector is applied independently to every frame in the shot. The second stage is concerned with processing this data such that it is more amenable to higher level analysis. Pose detection is done in a third stage. The final stage performs the high-level analysis and thereby generates the shot summary.

3.1 Face detection

The detector of Viola and Jones [16] is relatively straightforward to implement, however, training such a detector typically requires weeks of computation. Therefore, we make use of the OpenCV library [29] which provides an implementation of such a classifier together with several configuration files. Each of these files describes a classifier which has been trained in a particular way using a particular data set. One such configuration represents the original scheme of Viola and Jones [16], but we reject this in favour of a classifier trained using gentleboost [30]. This decision was made on the basis several trials on still images and video.

The face detector is a general purpose scheme which operates on a single image. The output of the detector is the size and location of any faces. The system has reportedly been trained on frontal faces, although we note it is surprisingly capable of detecting angled faces, and in some instances near profile views. In these cases, no information is offered regarding the direction of the face, unlike the multi-view scheme of Li and Zhang [21] or Osadchy et al. [27].

3.2 Face data processing

For each frame, the face detector generates a series of face locations indicating the coordinates and size of any detected faces. Depending on the image content, a false positive or two may be found, but these rarely have the same persistence over several frames as a true positive. Conversely, genuine faces are missed in some frames, or are occasionally missed altogether. Therefore, this stage of the system can be regarded as an application-specific means of improving the output of a generic face detector. Ideally, a custom-built face detector with integrated tracking should be used in our application.

The stage essentially comprises temporal filtering and interpolation, with the objective being to remove as many false positives as possible, and construct sequences of faces with as few discontinuities as possible. An additional stage is introduced before this main function to deal with overlapped faces.

3.2.1 Overlap face removal

This simple heuristic was introduced after examining the output of the face detector for a number of shots. It serves to remove some false positives, typically where two faces are detected within the region of one person's true face. The smaller face is eliminated, although some overlap can be tolerated.

3.2.2 Temporal filtering

This provides the main process by which false positives are removed. At the start of this process, a new face set is constructed, hereafter named the processed set. This is initially empty. A routine searches the complete data set (from the face detector) and builds sequences of faces by finding similarly sized and positioned faces in adjacent frames. If a sequence is longer than some minimum length, then it is deemed to be a genuine face and is transferred to the processed set. A minimum run length of twelve frames was used in our experiments. Typically this would remove all but the most persistent false positives, albeit at the expense of removing some faces which are visible for only a short time.

3.2.3 Interpolation

The interpolation process attempts to join together the face sequences created by the previous step. A sequence may be interrupted for many reasons, such as occlusion or head rotation, or simply face detector error. The interpolation process searches outwards from the start and end of each sequence looking for similarly sized and positioned faces. The original data set is included in this search, along with the processed set. Therefore, faces which did not form part of a sequence in the previous step may still have a chance to transfer to the processed set. The search distance is limited to 20 frames to avoid inferring the presence of a face long after it has disappeared from the frame. Sequences may be interpolated up to the start and end of the shot, provided these boundaries fall within the search distance. All interpolated faces are marked as such, so that further processing does not assume these face locations are accurate.

3.3 Pose estimation

For the purpose of our classification scheme we introduce a simple but novel pose estimator which can be used in conjunction with almost any frontal face detector. The only constraint on the detector is that it must provide the coordinates of the face centre (approximately on the bridge of the nose) and a value indicating the size of the face. The OpenCV detector meets these requirements.

The principle of our method follows. By using the face information noted above, a circle may be drawn around the face, centred on the nose. If the circle is appropriately sized, there will be one or two regions at the sides of the circle which represent either the background or the subject's hair. When the subject is looking directly towards the camera, these regions will tend to be of roughly similar size. As the face turns to one side, the region on that side of the face becomes larger. The direction of the face can therefore be estimated by comparing the size of the left and right regions as illustrated in Figure 4

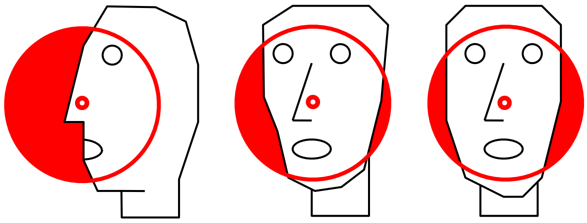


Figure 4: Principle of pose estimation

In practise, it is non-trivial to accurately ascertain which pels lie within these non-face regions. The method we have adopted is simple, although we have found it provides reasonable performance within the context of our application.

The average colour of the nine pels at the centre of the face is calculated and converted to YUV colour space. Each pel within the left and right halves of the bounding circle is then tested. The UV distance from the reference colour is computed, and pels which fall outside some threshold are added to the corresponding tally of non-face pels. The face direction is then determined by comparing the totals on either side. A magnitude can be found by division of the totals. In our application, this information is later quantised into three directions: left, right and ahead.

3.4 Compositional interpretation

The shot is split into segments to facilitate the high level analysis. Each segment comprises a series of frames with the same number of faces. A simple heuristic is applied before the main processing, in this case to help reduce the number of segments. A person is assumed to be in the background if the average size of their face is less than half that of the largest face. Since background faces are not part of the main composition they may be removed with little consequence. It was observed that this heuristic also helps to remove some persistent false positives.

A single segment which best represents the shot is then chosen for full analysis. The choice is dependent on the complexity of the shot which is determined by the number of segments and the way in which the face count varies. For complex shots, a reduced level of information is offered. In these cases it is far more difficult to accurately summarise the shot, particularly via the analysis of only one segment.

During the segment analysis, the shot grouping is determined according to the number of faces. The framing is categorised based on the size and position of the faces relative to the frame boundaries. The location of the subjects is implicit in the face detector output, and is included in the summary. The novel scheme for pose estimation is applied to determine the direction in which a subject is looking and any head movement. This information is combined into a brief textual summary.

3.5 Non-face analysis

Shot boundary detection, camera motion parsing and occluding object handling are provided by *ASAP* [31]. To these we have added a mechanism to recognize when a particular shot is a continuation of one seen previously. This allows the addition of "Same angle as shot…" lines in the automatically-generated log, which earlier versions of *ASAP* lacked.

The mechanism for recognizing a continuation is as follows:

- Frames close to the end of each shot are compared with frames close to the beginning of each subsequent shot.
- In each case the frames are judged to match when a chrominance-weighted mean error distance is less than a threshold.
- The weighting is equivalent to Euclidean distance in a colour principal components space. I.e. the (R,G,B) values of each pel are transformed to (Y,C_1,C_2), then the values of each component are scaled to give approximately equal variances. The RMS error between the two frames in this transformed space is then calculated and compared against the threshold.
- The threshold is set empirically by processing a training set and choosing the highest value that yields no false positives. (The assumption is that falsely ascribing a continuation is more costly than missing one.)

4 Results

4.1 Pose estimator

749 images of faces with a diverse range of poses, expressions and backgrounds, where the automatic face detector correctly located the face, were hand-coded with respect to pose. Only the three directions Left, Middle and Right, were used and the human logger was required to make their own judgement about where the transitions between Left and Middle and between Middle and Right occurred. The same frames were then classified by our pose estimator, to yield the results shown in table 1.

2,550 frames of a video, each identified as containing a single face by the face detector, were independently hand-coded with respect to pose. This footage included some shots where multiple frames would be likely to have the same classification, but also many shots in which there was significant head movement and change in framing. The results for this test are shown in table 2.

Human Classification	Automatic Pose Estimator Classification		
	L	M	R
L	214	24	22
M	87	47	83
R	20	25	227

Table 1: Matrix of pose detector results on diverse set of faces in varied backgrounds.

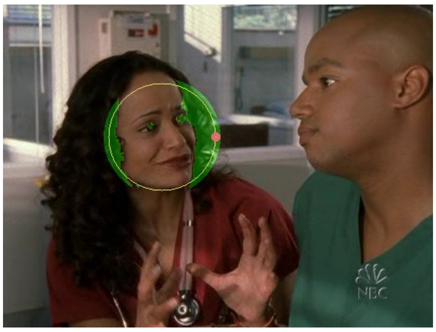
Human Classification	Automatic Pose Estimator Classification		
	L	M	R
L	1392	20	85
M	80	78	105
R	11	14	765

Table 2: Matrix of pose detector results for frames from a soap opera video

Table 1 shows agreement between the automatic pose estimator and human judgement on about 65% of faces, while table 2 shows agreement for about 88% of the time on the test footage. The difference is due to the diversity of the first test set compared to the relatively easily interpreted film language of the second set. In both cases the human logger tended to count more faces as frontal than the pose estimator. This is partly a matter of calibration: note that the detector was not designed to equalize L/M and M/L misclassifications, nor R/M and M/R misclassifications. Rather it was designed to yield results that generate good "facing direction" results in the final logs. Clearly there are also outright misclassifications. These errors were mostly due to scenarios where the background is close in colour to the face, or the lighting is heavily coloured, or very low intensity. The direction data are often rather noisy, and temporal filtering is used to help in this respect. As a result of this, fast and/or subtle movements are not detected.

Figure 5 shows three examples of the pose estimator working on one type of footage. Figure 5(a) and 5(b) illustrate examples where the technique works very well. In Figure 5(c) the estimator indicates the wrong direction.

(a)



(b)

(c)

Figure 5: Examples from pose estimator in action

4.2 Compositional interpretation

In order to quantify the performance of the system as a whole we have used an "edit distance" measure. This was developed to allow systematic comparison of the costs of mistakes in framing, position and pose, given that a grouping mistake (number of people in the shot) affects all of these.

The edit distance is based on a model of footage logging where each of {framing, grouping, person_position, person_pose} is an equivalence class of alternatives, each of which can be set, reset or modified by a single data entry. For example, to encode a typical two-shot with such a logging system would require six entries: framing, grouping (two-shot), person1_position, person1_pose, person2_position, person2_pose. The manual logging cost of such a shot is therefore 6. The edit distance of a shot that has been automatically logged is the number of corrections that would be required to repair any errors. Thus, if the two-shot were incorrectly parsed as a single (one-shot) but the framing, and position and pose of the detected person were correct, then three corrections would be required to repair the damage: one to convert one-shot to two-shot, one for person2_position and one for person2_pose. The edit distance cost for this mistake is therefore 3. In instances where the system detects a number of elements incorrectly and misses others, the edit distance is calculated as the number of corrections required to add the missed data plus one for deleting all incorrect information.

Table 3 shows a small part of the edit distance log for a particular 3-minute clip from a soap opera

Shot	Total Shot Elements	Correct Detections	Incorrect Detections	Edit Distance
1	1	0	0	1
2	4	4	0	0
3	4	3	1	2
4	4	3	1	2
5	4	0	0	4
6	5	3	1	3
7	4	0	0	4
8	4	3	1	2
9	4	3	1	2

Table 3: Sample system performance on soap opera excerpt

The *Total Shot Elements* column represents the cost of generating the log manually from scratch whereas the *Edit Distance* column shows the number of corrections to the automatic log that would be required.

Film experts occasionally have difficultly determining precisely which framing description corresponds to a particular shot. For example if a framing is a bit looser than a wide close-up but a bit tighter than a close shot, either term can be correct. Because of this ambiguity we do not penalize the system if it interprets the framing as either the next bigger or next small size. However, we do consider any other framing inaccuracies to be wholly incorrect.

The edit distance is a severe measure of performance because it penalizes all errors, even when the difference is slight. Anecdotally testers reported that the automatically generated logs often appeared as good as the manual logs even when the edit distance was non-zero.

To test the system we had an editing professional create a ground truth log for two short clips from television programmes – one soap opera and one situation comedy – with a total combined running time of approximately 6 minutes and 30 seconds (9,750 frames). The footage was processed by the system and compared to the ground truth logs using the system described above. The average manual log keystrokes and correction edit distances for the two pieces of footage are shown in table 4. A side-by-side comparison of the system output with the ground truth for the comedy sequence can be found in the appendix.

	Soap Opera	Comedy
Log Entries Required	260	232
Corrections Required	159	118
Savings in Effort	38.8%	49.1%
Savings (excluding compound dolly moves)	42.3%	55.5%

Table 4: Sample system performance on test footage

The system's performance is dependent, in large part, on the success of the face detector employed, As a result, it performs well on shots with small groupings and relatively close framings. In the soap opera clip, the system was unable to detect any faces in 17 of the 54 shots thus it was heavily penalised in our scoring system. In the instances where the face detector did find one or more faces, the system produced a saving of over 60%, indicating that improvements to the face detector should be explored.

The other key area where the system struggles is the interpretation of shots with multiple re-framings, such as compound dolly moves (such as shot 28 described in the appendix). In these cases, the system cannot adapt to the more than one change in framing and thus cannot fully interpret changes in shot.

In spite of these shortcomings our preliminary results indicate that the approach has merit and can be of benefit to certain user groups, such as archivists and postproduction personnel, where even small time savings can be important. Used in conjunction with semi-automated annotation tools, such as SALSA [32], the techniques described can result in significantly increased efficiency.

4 Conclusions

We have proposed methods for the automated extraction of compositional information from film and video footage through the use of a face detector in conjunction with a novel pose detector and composition interpreter. Preliminary results indicate that the system can be effective on certain types of shots but that there are limitations stemming from the quality of the face detector employed. In the context of a semi-automated application where incremental timesavings can be beneficial, the system shows great promise. Future work will involve refinement of the system as well as more extensive testing on a broad range of film and video footage.

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Appendix: Manual/automated log comparison

Shot	Manual log	Automated log

1	M2S JD frame L facing R, Kelso frame R facing R, Kelso turns L and moves L	`MC2S`
		`* subject frame L (later R) facing frame R`
		`* subject frame R (later L) facing frame R`

2	M2FS JD frame C facing R, Kelso frame R facing L, PAN L as Kelso moves L and exits L, JD frame C turns L and facing L	`MS, subject frame C facing frame R, then L, then R`
		`Turns into CS`
		`Background person(s) in shot`

3	M2FS (slight high angle) Carla frame L facing R, Turk frame C facing R	`MC2S`
		`* subject frame L facing frame R`
		`* subject frame R facing frame L`

4	(same angle as 2)
	MFS JD frame R facing L, moves into MCS frame C still facing L
		`(same angle as 2)`
		`MS, subject frame R facing frame L`
		`Turns into CS`

5	CS Turk frame C facing R (Carla on L edge of frame, two people out of focus in BG)	`WCU, subject frame C facing frame R`

6	MW car in flames, DOLLY R to MFS Turk turns R toward camera frame R facing down L, turns quickly L away from camera, turns R toward camera facing down C, facing L briefly then facing down C	`Complex shot`
		`Likely to be (dominantly) a 1-shot`
		`Starts off MF framing`

7	(same angle as 4) MCS JD frame C facing L, turns R slightly, facing C	`CS, subject frame C facing frame L, then R, then L`

8	(same angle as 3)
	M2FS (slight high angle) Carla frame L facing R, Turk frame R facing up L (OTS JD just on right edge of frame)
		`(same angle as 3)`
		`MC2S`
		`* subject frame L facing frame R`
		`* subject frame R facing frame L`

9	(same angle as 7) MCS JD frame R facing L	`(same angle as 4)` `WCU, subject frame C facing frame R, then L`
10	(same angle as 5) CS Turk frame C facing C	`WCU, subject frame C facing frame L`
11	MC2S Carla frame L facing L, turns R facing R, Turk frame R facing L, turns L away from camera	`CS, subject frame L facing frame L, then R`
12	MC2S Carla frame L facing R profile, Turk frame R facing L	`CS, subject frame R facing frame L`
13	(same angle as 9) MCS JD frame C facing L	`(same angle as 9)` `CS, subject frame C facing frame L`
14	(same angle as 11) MC2S Carla frame L facing R, Turk frame R facing L profile, Carla turns L facing down L, turns R facing R	`CS, subject frame C facing frame R, then L, then R`
15	(same angle as 13) MCS JD frame C facing L	`(same angle as 13)` `CS, subject frame C facing frame L`

16	(same angle as 8)
	M2FS (slight high angle) Carla frame L facing R, Turk frame R facing R, turns L facing L, (OTS JD just on right edge of frame)
		`MC2S`
		`* subject frame L facing frame R`
		`* subject frame R facing frame L`

17	(same angle as 15) MCS JD frame C facing L	(same angle as 15) CS, subject frame C facing frame L
18	MC2S Carla frame L facing R, Turk frame R facing R, turns L then R facing R	FCU, subject frame L facing frame L
19	(same angle as 17) MCS JD frame C facing L, turns R profile, exits R	(same angle as 17)
20	(same angle as 16) M2FS (slight high angle) Carla frame L facing L, Turk frame R facing R, turns L facing L	M2S * subject frame R facing frame R, then L * subject frame L facing frame L
21	MCS JD frame C facing down R, facing R	CS, subject frame C facing frame R, then L, then R
22	(OTS) MFS man in bed frame R facing L, facing up	MCS, subject frame R facing frame L
23	(same angle as 21) MCS JD frame C facing R	(same angle as 21) MCS, subject frame C facing frame L, then R
24	(same angle as 22) (OTS) MFS man in bed frame R facing up L PAN L to MF2S JD frame L turns R quickly facing R, PAN L with JD	CS, subject frame L facing frame L, then R
25	MF2S woman doctor frame L facing R, man in bed frame R facing R, DOLLY IN to (OTS) M2S, man in bed facing C	M2S * subject frame L facing frame R * subject frame R facing frame R, then L
26	MCS JD frame C facing L (OTS woman doctor, other man in bed in far BG facing up L)	MCS, subject frame C facing frame L
27	(same angle as 25) M2S woman doctor frame L turns facing R, man in bed frame R facing L	(same angle as 25) MCS, subject frame R facing frame L
28	MF2S woman doctor frame L back to camera turns R facing R profile, JD frame R facing L profile, turns R facing L, DOLLY BACK as they walk, woman doctor looks mainly R, turns L to hand clipboard to passing nurse, turns R, JD facing mainly C, CAMERA MOVES BEHIND them as they move R into elevator and turn to face camera, JD frame L facing R, woman doctor frame R facing L, JD turns and moves L to press button facing L, then moves back turns R facing R	Complex shot Likely to be (dominantly) a 2-shot Starts off MC framing Background person(s) in shot
29	MFS Perry enters frame C facing L, DOLLY BACK in MF2S, JD follows frame R facing R, turns facing C, CAMERA STOPS in MC2S Perry frame L facing down L, JD frame R facing mainly C, Perry tilts head up pauses then turns R facing away from camera, JD sings facing C, DOLLY IN slightly at end	M2S * subject frame R * subject frame L facing C Background person(s) in shot
30	(OTS) MCS Perry frame C facing R (people out of focus in BG)	CS, subject frame C facing frame L, then R
31	M2S Perry frame L facing R profile, JD frame R facing L profile (Carla moves through them exits bottom frame left), Perry turns L facing C moves toward camera	M2S * subject frame R facing frame L * subject frame L facing frame R Background person(s) in shot
32	(OTS) MCS Perry frame L facing R, turns R away from camera moves L	CS, subject frame L facing frame R
33	(same angle as 31) MS JD frame R facing L, turns R facing C, DOLLY BACK to FS frame C	MCS, subject frame R facing frame L, then C, then R Turns into MFS

34	DOLLY BACK as Carla and Perry walk from R into MF2S, Carla frame L facing R, Perry frame R turns facing C, Carla turns L facing mainly C, after a bit Carla turns R facing R, Perry turns L facing L, Carla turns L facing C, Perry turns R facing C	Complex shot Likely to be (dominantly) a 2-shot Starts off M framing

Digital Cinematography: Evolution of Craft or Revolution in Production?

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Digital Cinematography: Evolution of Craft or Revolution in Production?

JOHN MATEER

THE DEBATE CONCERNING THE IMPACT of the introduction of digital technologies into the filmmaking process and the emergence of digital cinema has been raging for well over a decade. "Evolutionists," as exemplified by John Belton's 2002 article "Digital Cinema: A False Revolution," view new technology and associated methodologies as a natural progression consistent with other technical advancements in cinema (100). "Revolutionists," including Ganz and Khatib, argue that these technologies have not only irrevocably altered filmmaking practice but have fundamentally changed the nature of cinematic storytelling (and thus the viewer experience) as well (Ganz and Khatib 21). What is interesting to note in both Belton's article and Ganz and Khatib's article is that there is a presupposition that the relevant technological evolution had plateaued at the time of writing such that the question of the impact of digital technologies on cinema could effectively be answered. Yet it can be argued that the most significant advancements in filmmaking technology have occurred since these articles were written. Recently released camera systems such as the Red One and Arri Alexa are claimed to have created a brave new world of data-centric production. A recent interview in *Variety* with Michael Cioni, owner of Light Iron Digital, a postproduction facility catering specifically to data-centric production, sums this up: "You can't make film smaller. You can't make 35mm be 8K resolution no matter what you do. You can't have a [film] camera be four pounds. You can't fit a 400-foot magazine in a smaller space. It can't improve at the rate Moore's Law says we can predict technical improvements [in digital systems]" (qtd. in Cohen).

No longer does a camera department require light-tight temperature-controlled spaces to load camera magazines or store reels of film. Workstations with multiple RAID arrays and linear tape backup systems have taken their place. Dailies, so called because of the time it took to develop the film and create one-light prints to check the quality and aesthetics of a day's shoot, now take mere minutes to create, no longer requiring the specialist skills of a photochemical lab. But for all of this change, has the process of filmmaking been fundamentally altered? Is this truly a new era in which the cinematographer has become more of a data-capture specialist than a visual artist? Or do these advances in camera systems simply represent the latest chapter in the evolution of filmmaking as Belton originally argued? This article sets out to explore these questions by looking at the craft of cinematography for current mainstream production and how it has been affected by technological innovation.[1]

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What Is a Cinematographer?

Cinematography is an art-form but at the same time it's a craft, and it is definitely a combination of the two . . . You have to light, you have to compose and you have to create movement. Those are the three elements of cinematography.

—Owen Roizman (qtd. in Fauer 1: 234)

Roizman's definition arguably represents the most common view of cinematography. Cinematographers work with a director to develop a visual means of interpreting the story. In narrative film, this process typically includes the breaking down of scripts first by acts, then by scenes, and finally by dramatic beats. At each stage, primary and secondary themes are interpreted in terms of tone and desired audience response. From this, details of setting and basic production design begin to emerge, leading to a definition of a visual style. For the director, this serves as the backbone of the production bible, providing a framework for more detailed dramatic analysis. For the cinematographer, it represents the beginning of a blueprint to enable physical production to realize the look of the piece. As the process continues, some form of visualization usually takes place. Working methodologies can differ significantly from project to project and director to director, with the cinematographer's control over visuals ranging anywhere from being a slave to dictated camera positions (such as Hitchcock's reputedly definitive storyboarding or the tight requirements of visual effects–based work) to holding nearly free reign over position, composition, and even blocking (as in Woody Allen projects). Irrespective of the amount of creative freedom granted, the cinematographer will ultimately determine the position of lighting sources and the quality of that light (e.g., color, hardness of shadows, and opacity) to achieve the desired dramatic objectives.

The lesser-known side of the cinematographer's role is more mundane but no less important. Commercial film and television productions are expensive, so it is imperative that principal photography be successful. For the cinematographer, this means that light levels need to be calculated precisely to ensure proper reproduction and exposure within the latitude of the recording medium. Film stocks and electronic image sensors vary in their sensitivity to light and ability to reproduce certain visual spectra, so understanding the technical attributes of these is vital not only for production but for also ensuring that image quality is suitable for the postproduction process and mastering. Related to this, the cinematographer must be certain that the recording medium has sufficient robustness to cope with shooting conditions—be they dust, moisture, or vibration—which can affect recording. These conditions also dictate which specific camera systems and accessories are needed to enable shooting, which in turn can affect the cameras' mobility and the viability of complex shots. All of these logistical considerations must be considered with respect to the time it will take to prepare and shoot and, most importantly to producers, with respect to the overall cost. The modern professional cinematographer is part artist, part scientist, and part businessperson, and technology has always been a key tool in supporting his or her ability to fulfill all three roles.

The Role of Film

Film stock has been revered as the gold standard for feature film and narrative broadcast-television projects for decades. Modern-day stocks are very sensitive and can handle a significant range of brightness within one frame (known as "latitude" measured in f-stops). Film is also remarkably durable, which is a prime consideration for cinematographers, studio executives, and archivists alike. But for all of its strengths, film is far from a perfect recording medium. Because it is a physical system, the duration of shots is directly linked to the length of the strip of film itself. Film relies on photochemical reaction to capture light, so a chemical process is required to render images in a finished form. This means that specialist equipment must be used to process the negative and print the footage. As a light-sensitive material, stock must be kept in controlled conditions prior to exposure and development (Kodak). Because of their mechanical nature, film cameras must be continually checked for light-tightness and cleanliness as well as calibrated for physical registration to ensure the film is accurately and securely stopped for each frame of exposure. Professional film cameras are expensive, and this, coupled with the cost of the film stock itself and secondary processing, means that shooting with film can be costly, particularly in comparison to other types of image recording.

The Evolution of Digital Motion Pictures

Although digital recording of moving images first began to appear in the 1970s, it was not seen as viable for any type of commercial work until the mid-1980s ("Grass Valley"). The television industry began to embrace these technologies once it was shown that digital cameras could outperform their tube-based predecessors and that savings could be made with a digital workflow.[2] However, from a cinematographic perspective, even the newest systems of that time were woefully lacking in their technical capabilities. Standard-definition digital video has too low a resolution (about 0.4 megapixels), too little latitude (about six to eight f-stops compared with film's thirteen to fourteen), and insufficient color depth, making it unsuitable for anything beyond stylized low-budget cinema work. Although initial digital systems did provide freedom for small independent filmmakers, the technology was not yet developed enough to support mainstream filmmaking. Studios have long had strict requirements with regard to image quality and thus a conservative approach to new technologies.

In the late 1990s, Sony and Panavision engaged in a formal collaboration to explore how digital video technology might be utilized for film-style production. The first system emerging from this collaboration was the Sony HDW-F900 24p camera, which recorded to a new type of tape deck known as HDCAM (Kalley). Both components evolved from Sony's broadcast television systems, with the camera utilizing charge-coupled device (CCD) sensors to record images. For the first time, a digital camera could offer resolution approaching 16mm film stocks, with improved latitude and color fidelity. Likewise, the adaptation of traditional cinema lenses from Panavision allowed optical characteristics such as depth of field to be controllable in a way similar to the control granted by film cameras. Despite the advances, take-up of this new system was initially limited. This changed when George Lucas decided that he wanted a completely digital workflow for *Star Wars Episode II: Attack of the Clones* ("Sony and Panavision about to Deliver"). For that picture, Sony and Panavision refined their systems, ultimately leading to the commercial introduction of HDCAM SR in 2003, which represented a significant enhancement to HDCAM. The success of the film showed the industry that digital high-definition (HD) recording technologies were approaching the color fidelity and latitude of film.

At the same time, the digital intermediate (DI) process—where film negatives are scanned into digital form for editing, compositing, and picture finishing—was becoming standard practice in Hollywood. By the time HDCAM came onto the market, the notion of working in a completely digital postproduction environment, though not universally embraced, was becoming understood and accepted. The ability to copy or alter digital data an infinite number of times without any degradation or loss in quality demonstrated the advantages that digital systems could provide. HD digital video systems have a resolution of 1,920 × 1,080, which is not appreciably less than 2K (2048 × 1556), which is common for DI. This meant that workflows established through the evolution of the DI process could be adapted to HD material. As a result, the introduction of these new HD systems into the production pipeline represented a logical evolution in the application of digital technologies to the filmmaking process.

From an "on set" perspective, working with HD systems does not differ radically from standard film or television production methodologies and represents a hybrid of the two. The "look" of the project is effectively burned in to the tape recording—that is to say it cannot be fundamentally altered—in the same way it would be in film. Exposure is still determined based on the dramatic requirements of the scene, with limitations in latitude and other recording characteristics of the HD system taken into account, as would be the case for film. Unlike film, recorded output of HD systems can be played back on set. Aside from confirmation that recording has been successful, there is little difference between this and video assist systems. From a camera assistant's perspective, focus pulls and other during-shot activities are completely unchanged. Off set, cans and reels of film are replaced with magnetic tape cassettes, but the rules of storing and cataloguing footage are similar, again borrowing from TV workflows. The only significant handling difference is that tape is reusable, so it is vital that camera assistants ensure that recording tabs are switched off, so that tapes are not accidentally recorded over. From a practice perspective, it is evident that shooting with HD, though somewhat different from film, does not represent a new paradigm but the amalgamation of existing technique, albeit with additional considerations related to the technology. According to Victor Nelli Jr., "[m]ost of the procedure is the same. The equipment is much harder to troubleshoot. It no longer is a piece of film passing by a hole. There are so many things to the HD format. [Crew] do need to be up to date" (qtd. in Rogers).

Sony was by no means the only manufacturer to develop digital camera systems targeted at high-end production during this period. Panasonic and Thomson (the latter drawing on expertise from its acquisition of Technicolor in 2000) also created systems based on CCD imaging sensors; the VariCam and Viper are still used for television and feature film work, though neither is viewed by the industry as definitive. From a financial perspective, the costs associated with these systems—both the costs of procuring the equipment for production and the associated postproduction costs—are not appreciably lower than those of film. Despite straightforward workflows and advances in digital imaging technologies, many veteran cinematographers remained (and some still remain) skeptical as to whether these digital systems could ever truly supplant film. In large part this is due to CCD technology, which has a different look from film. The following remark by Oscar-winning cinematographer Wally Pfister typifies the view: "The range of colors that you can record with the best digital cameras is also a joke when put head-to-head with 35mm negative . . . Why anybody would replace a proven image capture system with vastly inferior technology is beyond my comprehension" (qtd. in Fisher).

Film processes light in a fundamentally different way from CCDs. It records more information in shadow and highlight areas, with less in mid-tones. This nonlinear approach means that it is better able to capture and reproduce detail at extreme areas of brightness. On the other hand, CCDs and other digital systems are designed such that light is processed linearly, giving equal weighting to dark, mid, and bright tones. (A useful discussion of the nature of film log versus the linear processing of video can be found in Wright's *Digital Compositing for Film and Video*, starting on page 385, as well as in Wheeler on page 53.) In order for footage shot with a CCD-based system to look like film, a data transformation process is required to simulate the nonlinear distribution of luminance. Because this effectively means redistributing data and introducing information that was not originally present, artifacts are generated that would not be present in film. Likewise, once light levels reach a certain threshold, all data is capped at that point. If the brightness is greater than the CCD can handle, the signal is "clipped," that portion of the image goes pure white, and all detail is lost. The opposite is true with dark areas going to pure black ("crushed"). Negative film is much more forgiving at extreme ranges of brightness. It too can clip whites or crush blacks, but the change is usually much less pronounced. Other differences, such as the look of visual noise (e.g., chrominance or luminance artifacts compared to film grain) and the grid-based nature of CCD sensors, mean that a true film look can only ever be approximated through this type of technology.

The Advent of Digital Cinema

The emergence of digital cinema is arguably linked to technological advancements in image reproduction systems in parallel with significant increases in performance and decreases in costs for computer systems. The two are related in that high-quality image data requires significant storage space as well as computer processing capability to render finished footage. Cinematographically, advances in CMOS (complementary metal-oxide semiconductor) imaging technology have enabled a more efficient path to an all-digital workflow. CMOS sensors can respond more rapidly to light than CCDs, and they also have the benefit of requiring less external processing of the raw digital data. Although both of these imaging sensors started development at roughly the same time (the late 1960s), it was not until comparatively recently that CMOS technology matured to a point where its image reproduction capability reached that of CCD ("CCD vs. CMOS"). Three CCD chips are typically used—one each to capture red, green, and blue picture data—but only one CMOS chip is required to capture full-color information. This means that CMOS sensors work in a manner that more closely resembles film. Indeed, one of the major early shortcomings of CMOS technology when used in cameras was its slow shuttering, such that fast-moving vertical objects in a frame could appear distorted—the dreaded "rolling shutter" effect that also plagued early film-camera systems (as exemplified by Lartigue's classic 1913 photo, *Car Trip*). Wheeler gives a good overview of the technical aspects of digital cinema systems in his book *High Definition Cinematography* (43).

In 2005, seeing the emerging take-up of HD systems to replace film for television projects, Arri was the first of the traditional film camera manufacturers to utilize a CMOS chip for a "digital film" camera. The D20 represented a middle ground between film and HD video systems. The active recording area of its CMOS sensor was equivalent to super 35mm film, so it had similar optical characteristics to film systems (in areas such as depth of field, for example). It also featured a resolution of 2,880 × 2,160 pixels, which is approximately the same as 2K film scans for digital intermediate. Operationally, the D20 had an adjustable mechanical shutter just as Arri film cameras do, and many of the accessories and basic components of Arri's cameras were directly compatible with the D20. In Filmstream mode, the recorded data was captured in logarithmic form, mimicking the way film responds to light. This data output would be transferred either to tape (using HDCAM SR) or to proprietary data cartridges. The data itself was handled using methods not unlike those for scanned film in DI workflows. However, production and post with the D20 was cumbersome. Given that there were comparatively few D20s in the field, no clear consensus emerged regarding workflows. This led to a view among cinematographers (and producers) that the D20 was best utilized only in specific situations that lent themselves to digital production, such as stylized looks (as in Guy Ritchie's *RocknRolla*, shot by David Higgs) or visual effects work (as in the ferryboat fire sequence shot by Sam Nicholson for ABC's *Grey's Anatomy*). Indeed, at the time Arri itself conceded this point in its publicity, looking at digital not as a replacement for film but as simply another supporting tool. Bill Lovell, digital camera project manager for Arri, stated, "Film will continue to be the preferred acquisition format when its benefits are paramount, but if digital is the tool for the job, then we have a camera here for you to do it" (qtd. in "ASC Technology").

At roughly the same time, a start-up company also launched, proclaiming that they would "[change] the face of the motion picture industry" ("Red History"). Red Digital Cinema was founded by businessman Jim Jannard, a keen amateur photographer and film buff who was dismayed by the high cost and technical conservatism of industry film and HD camera systems and thought he could do better. Rather than develop cameras from a classical cinematography perspective, Jannard drew inspiration from the data-centric design of the then-emerging DSLR systems. He assembled a team of electronics experts to develop a CMOS chip that could effectively duplicate how film reacts to light but could be packaged in such a way that postproduction could be accomplished using commonly available computer desktop tools such as Apple's Final Cut Pro. From the start, Jannard and his followers proclaimed this to be a revolution, and the company structure reflects this. Red Digital Cinema's Ted Schilowitz, known as the "Leader of the Rebellion," explains:

> The company does not work in a normal hierarchy . . . There are some really brilliant people that work on the team that don't fit into the normal convention of who you might think would build a camera . . . [We envisioned] a 4K future that would be affordable, logical and accessible for a lot of people, and a lot of people were highly sceptical . . . ("HD Expo")

The first commercial Red system, Red One, was released in 2007. Although technologically it was not radically different from the Arri D20, a number of key differences did represent a shift from conventional film and HD systems. The CMOS chip developed by Red, Mysterium, had a full resolution of over 4K, which was significantly larger than Arri's and was the largest commonly available imager format made (similar to Super 35mm film). Likewise, the chip had extended latitude and sensitivity similar to mid-level film stocks. Rather than using tape recorders or bespoke data cartridges, the Red One could record to commonly available CompactFlash cards and portable hard drives. This reliance on established data technologies ensured that production and postproduction support could be accomplished through time-tested IT methods. A very low price point for the camera body itself ($17,500 on release) meant that the overall cost for a Red system was significantly less than HD systems and a fraction of the cost of a film system.

To give an example, the following table details the costs of a one-week shoot in Los Angeles for a total of ten hours of footage (including videotape-based dailies) shot using different systems (prices are from a survey of Los Angeles suppliers conducted in August 2011).[3]

Chart 1: Cost Comparison for One-Week Shoot in Los Angeles for Ten Hours of Footage

	Arri 435 ES (35mm film)	**Sony SRW-9000 (HD video)**	**Arri Alexa (digital cinema)**	**Red One (digital cinema)**
Package Rental Cost (based on three-day charge)	$8,145	$9,360	$8,610	$6,360
Recording Media	$24,920 (Kodak 5260)	$900 (HDCAM SR tape)	$0 (included)	$0 (included)
Processing	$4,800 (0.12/ft)	$0	$0	$0
Duplication/Backup	$0	$1,900 ($100/hr + tape)	$300 ($100/hr)	$300 ($100/hr)
Telecine/DataCine (supervised, for dailies)	$6,750 ($225/hr)	$6,750 ($225/hr)	$6,750 ($225/hr)	$6,750 ($225/hr)
Total	**$44,615**	**$18,910**	**$15,660**	**$13,410**

At first the industry was highly skeptical. Wild claims of increased performance and low cost ran rife at trade shows, but Jannard was canny in promoting his new systems to filmmakers he knew to be tech-savvy. Peter Jackson became the first "name" director to shoot with a Red. A self-proclaimed early adopter of new filmmaking technologies, he heard about the development of the Red One and expressed his interest in the company. In preparation for NAB 2007, the annual trade show of the National Association of Broadcasters, Jannard asked Jackson if he would be interested in making a short film as a demonstration (reportedly on an unpaid basis). Intrigued by the system, Jackson agreed and created *Crossing the Line*, a twelve-minute period World War I drama, in only two weeks ("Ready for Takeoff"). The film was well received at NAB, and the industry took notice, with other established directors, including Steven Soderbergh, soon looking to try the new camera. Given such directors' clout within the business, the system gained legitimacy, and industry take-up began. Producers became particularly enamored of Red because they could see the financial advantages of the system.

By 2010, more than 9,000 Red One systems had been sold. To put this in perspective, Sony produced approximately 2,500 CineAlta F900s (and variants) between 2002 and 2010, so Red's market penetration was truly remarkable for a specialist professional system. Mainstream feature films, including *Ché* (parts 1 and 2, both shot by Soderbergh), *The Book of Eli* (Don Burgess), and *The Social Network* (Jeff Cronenweth), as well as US network television series such as *Southland* (NBC), *Leverage* (TNT), and *Sanctuary* (Syfy), demonstrated the viability of Red to the Hollywood studios.

This did not go unnoticed by Arri, which launched Alexa in 2010 in response. Alexa has a very similar architecture and workflow to the Red One but a more filmic image quality. Not to be outdone, Red introduced a new 5K camera, the Epic, in 2011. Which camera is the more effective tool is a matter of debate—Reds are more affordable; Alexa has greater image reproduction capability—but there is no disputing that Arri, with its rich and comparatively conservative history in the development of film cameras, has recognized and embraced the notion that digital cinema represents the future of acquisition. As noted by Michael Cioni, digital has now surpassed film as the recording medium of choice for mainstream film and television production (Cohen).

New Digital Cinema Technologies and the Cinematographic Process

Even with the significant technological advances that Red and Alexa represent, the core tasks of cinematography have remained unchanged. Lens choice, shot composition, and means of facilitating camera movement are still the same. The relationship between the exposure index of the recording medium, the aperture setting, the exposure time, and the required level of illumination is also unaltered. Lighting design still needs to consider the latitude of medium as well as the dramatic requirements of the scene. That is not to say that there are not operational differences.

By definition, digital cinema production systems are data-centric. Recorded images are nothing more than computer files, so they must be handled using IT procedures, similar to other digital data. This has led to the creation of new roles for on-set production such as the digital imaging technician (DIT). The DIT's chief responsibility is to ensure the integrity of the data (i.e., to confirm that the recordings are correct) as well as to archive it to ensure that there are reliable backups in case of loss or corruption of the original recording media. In the film realm, these would have been the duties of the clapper/loader. He or she would have been responsible for loading film magazines, storing and cataloguing exposed reels, and maintaining the camera components. Now the focus of this role is centered on shooting tasks—marking actor positions, recording camera notes, and so on—allowing the DIT to handle most technical camera matters.

Changes in the cinematographic process lie in the nature of exposure and recording. Unlike film or tape, exposure for Red or Alexa is not "burned in" to the medium. As a result, so long as brightness falls within the recording range of the image sensor, the captured data can be altered without any loss in quality. In other words, if a shot appears to be overexposed to the naked eye, but distinct data is present for all areas in the shot (i.e., the brightest parts are not just one shade of white but actually consist of a subtle range of tonalities), the brightness can be changed in postproduction to provide correct exposure. Setting exposure for these systems is about capturing as much data as possible rather than creating the exact look per se. That is not to say that differences in contrast between areas within a shot are ignored, but rather, in order to give the maximum amount of control over the image in grading, the cinematographer purposefully exposes the image using as much of the exposure range as possible without clipping white highlights even if the "look" of the shot is intended to be moody and dark. By creating a rich data set—akin to a "thick negative" in film—the cinematographer is able to utilize the entire dynamic range of the camera. However, this approach means that control over the final look of the image now rests with the grader of the project. It has always been the case that color timers could alter color balance and brightness of film footage, but the nature of data-centric image capture is such that much more extreme and fundamental changes can be made.

Following is an example of a properly exposed shot from a Red One using the "thick negative" model. Shadow areas are purposefully overexposed to preserve detail: the histogram at the bottom represents the amount of data captured at different brightness levels.

Photo 1: Red One footage pre-grade.

Left represents pure black and right pure white, with the height representing the amount of picture with that level of brightness per color channel. Note that none of the data goes to either extreme, so that as much of the image information is recorded as possible. In the finished, graded image, the exposure has been manipulated digitally such that it is now correct. The contrast has been increased and brightness extended to enhance the dynamic range of the image.

To many cinematographers, the notion that someone in postproduction has final control over the look of their work is untenable and threatens their art. Mark Sawicki's remarks typify this view:

> Unfortunately, after a century of cinema the art of cinematography is threatened by the rush of technological change and the ease of digital capture. . . . Highly sensitive sensor chips that can shoot by starlight have brought about the erroneous conclusion by some producers that you don't need to light anymore as if the art of lighting amounts to merely obtaining an exposure. . . . Camerawork is so much more than so called "product acquisition."

Yet others, even those with traditional backgrounds, have recognized the imaging power that digital cinema systems can provide irrespective of protocol. Vilmos Zigmond says, for example, "After seeing *The Girl with the Dragon Tattoo* shot on the new Red Epic camera . . . the only thing I could think was that this looked like it was shot on 65mm film or with an IMAX camera. The latitude and detail was incredible. I was so impressed that I will be shooting my next feature on Epic" (qtd. in Jannard).

It is clear that the cinematographer's role has evolved with the introduction of digital cinema

Photo 2: Red One footage post-grade.

systems but does this represent a fundamental change in the role?

Conclusion: Revolution or Evolution?

Revolutionists, as described by Kirsner in his discussion of "innovators" (5), claim that the rise of digital technologies, including Red and Alexa, represents a fundamental change in feature film production. No longer are individual, discrete frames recorded to a frame of film or specific location on a magnetic tape. Now, image data generated by the camera is captured using traditional computer hardware. As mentioned earlier, this meant the establishment of a new DIT role and changed the responsibilities of the clapper/loader. Likewise, postproduction has seen the introduction of data wranglers, who take the raw data and convert it into the different formats required for different stages of postproduction—for example, small QuickTime files for off-line editing, DPX files for visual effects and grading work, and so on. The tremendous quantity of data means that new methods of asset management have had to be developed to catalogue and index footage to ensure easy access. Because the entire program is digital, editing and grading are no longer tied to specialist equipment or facilities. Shows can be edited, graded, and even finished on laptop computers, representing a freedom in working that has never been seen before. Likewise, digital content is easily repurposed from one platform to the next. Platform variants for DVDs, Blu-Ray, mobile phones, and other devices can be created directly and at low cost. The availability of professional-caliber equipment at a greatly reduced cost has meant that barriers to entry have been lifted.[4] Greater access to equipment has enabled independent filmmaking to flourish. The last argument put forth is simply that of commerce. All major equipment manufacturers—Arri, Panavision, Sony, Panasonic, and others—have modified or developed new designs based on technologies and methodologies used by a previously unknown start-up company. To many, Red has indeed fulfilled its promise of revolution.

Evolutionists counter that although there are new roles associated with production and post using new digital cinema systems, the fundamental aspects of cinematography—script interpretation, visualization, lighting design and planning, lens choice, camera movement, and so on—have remained virtually unchanged. Roles have adapted as technology has developed, but this has been an evolutionary process. Systems used in the creation of motion pictures have been emerging and changing for well over a century: hand-cranked cameras gave way to motorized systems; film stocks grew in gauge and sensitivity; color systems were introduced, developed, and refined, as was sound; wide-screen formats have come and gone in a wide range of aspect ratios; and the list goes on. It could be said that the only constant in feature film production is change. As such, digital cinema technologies simply represent the latest development, and there are bound to be others. The editing process is effectively unchanged as well, driven by the need to juxtapose shots as a story requires. New technologies and associated techniques make this easier and more efficient, but the editor's role is the same. Indeed, even the digital intermediate process evolved through the application of new technologies to existing postproduction techniques (namely, the replacing of physical optical printers with a digital counterpart).

For viewers, it is impossible to distinguish between films that utilize a DI process and those that do not. As Bill Pope notes, "[t]he point is, [DI] looks great and it's indistinguishable from film" (qtd. in "*Spider-Man 2* Set to Deliver"). The all-digital nature of the DI process is directly analogous to the all-digital production pipeline involved with cameras such as Red and Alexa. If the viewer cannot see a difference between movies shot on film and those shot digitally, how can the use of a digital technology be considered revolutionary? Of course, film-based, HD video–based, and digital cinema–based programs have different looks because each process introduces a different type of artifact into the recording. But this is arguably no different from variations in the grain patterns or color characteristics of standard film stocks.

Throughout the history of cinema, there have often been alternative platforms for showcasing film content—from audio soundtracks adapted for radio to versions cut for TV broadcast to videotape for videocassette distribution. This is nothing new. To evolutionists, the bottom line is that the essence of the filmmaking and film-watching experiences is unchanged, and thus, digital cinematography is simply yet another landmark in the evolution of cinema.

Much of the innovation with regard to film production and delivery systems has historically been driven by commerce. Producers and studios have always sought to create products attractive to the market in such as way as to maximize profit. In this sense, the evolution and take-up of digital camera systems is similar to the arrival of sound. As Douglas Gomery describes it, the adoption of sound technology was driven by economic benefit to the studios (1). For a period, limitations in the emerging technologies and related production methods had a negative effect on the presentation of story, but these issues were resolved fairly quickly, resulting in a greater number of higher-profile (and higher-budget) projects moving to sound. The slow take-up of the first HD and digital camera systems for mainstream filmmaking, leading to the current reliance on digital camera systems for network television and big-budget features (e.g., *Pirates of the Caribbean: On Stranger Tides*, budgeted at roughly $250 million and shot solely on Red Epic), mimics this. The effect of the introduction of digital camera systems in production has been far less obvious to the viewer, but the impact on the business of film is arguably the same. Hollywood studios are conservative by nature to ensure profitability. Thus, production methods have evolved with new technologies rather than completely changing when new systems are available. The mainstream cinematographer's role may be slightly different with the advent of digital technologies, but the importance of cinematographers' work to Hollywood's bottom line means that the role has not been (nor could it be) radically altered.

Kirsner explores the development of feature film technologies from the silent era to the present day just prior to the take-up of digital cinema systems. He categorizes industry attitudes and perceptions into three camps—innovators, those who adopt new technology and push it to its limits; preservationists, those who cling doggedly to established tried-and-true systems; and sideline sitters, those who will wait for a consensus to form once a new technology stabilizes (5). He demonstrates how these camps reappear on a cyclical basis as new systems are developed. Digital cinema can be viewed in the same light. Underpinning Kirsner's thesis is the idea that movies themselves have not fundamentally changed; the nature of cinema, the relationship between the screen and the audience, has evolved but is essentially the same. The same arguably can be said about cinematography and the cinematographic process.

The tools of the cinematographer have changed, and methods have been adapted accordingly, but fundamentally, the role is still centered on the creation of images through the understanding of light, optics, and story. Gabriel Bernstein sums up the introduction of digital tools to the cinematographic process nicely:

> I think cinematography will continue to be what it is. . . . For us, it will remain a discussion about lighting ratios, controlling our contrast ratios, our faces, trying to get enough detail in the shadow areas and trying to get enough detail in the highlights. For us, the art and technique of cinematography will continue. Our palette will still be there. Maybe our colors will change, but the film look will continue. Cinematography has not essentially changed in 100 years and it's not going to change. It is the process of artistry that will evolve. (qtd. in Fauer 2: 25)

NOTES

1. This article was completed in August 2012.
2. "Workflow" refers to the step-by-step process

of acquiring and manipulating picture and/or sound to create a motion picture (e.g., shooting, recording, editing, grading, mastering). In a digital context, this may require the use of specific file formats, software, and/or hardware systems at different stages. Not all systems are compatible, and thus, designing workflows is an important component of the technical side of filmmaking.

3. Data for the cost-comparison table was gathered on a like-for-like basis of production packages from established Los Angeles vendors that have a history of supporting commercial projects. Quotes for the Arri camera package were obtained from Otto Nemenz, and quotes for the other three packages came from Abel Cine. Lab and consumable prices are an average based on quotes from Los Angeles suppliers. All data was compiled in August 2011.

4. It is common for Red camera packages to be rented at heavily discounted rates that are significantly lower than those given for other camera systems. This, plus the ability to conduct postproduction on personal computer systems with comparatively inexpensive software such as Final Cut Pro Studio, represents a landmark shift in the accessibility of true theatrical-grade production tools for low-budget independent filmmakers.

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Perceptions of broadcast and film media practitioners in UK higher education

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Abstract

With a growing emphasis on employability and commercial relevance, universities are increasingly involving practitioners in delivery to add perceived value and credibility to their film and television courses. Likewise, film education researchers, including Bergala (2016), see significant value in practitioner involvement in teaching. Yet, from both the academic and industry sides, this integration has been questioned and challenged, resulting in a long-standing discussion of the 'theory/practice divide'. Through analysis of two formal surveys conducted in 2012 and 2014, involving 131 respondents from 64 UK higher education institutions, this paper reports on the perceptions of broadcast television and film practitioners working in academia. It also briefly considers whether the issues raised have changed since the surveys were completed. Responses suggest that an appreciable number of respondents encountered a mixed or negative reaction from new academic colleagues immediately upon joining their institution, and that this has had a potentially lasting negative impact on their productivity. The data indicate that many media practitioners working in higher education do not feel that they are seen as equal to non-practitioner colleagues, although they do still feel part of the academy as a whole. Respondent institutions were broken down by type, and there is statistically significant evidence of perceptions of systematic disadvantaging of media practitioners across all types of UK academic institutions, although Arts-focused universities were seen most favourably. This suggests that, despite the UK government's increased emphasis on teaching and employability, and new commercially focused research funding initiatives, higher education institutions need to do more to redress the perception of a theory/practice divide.

Keywords: academic life; theory/practice divide; conditions of practice; media practitioners in education; film education

Introduction

The importance of the involvement of practitioners in media education has been touted since the emergence of formalized cinema, with Lev Kuleshov being but one of a number of early proponents of the integration of theory and practice in the early 1920s (Petric, 1974). Indeed, many pioneers in the development of film theory, such as Vsevolod Pudovkin and Sergei Eisenstein of the Soviet school, and Louis Delluc and Jean Epstein of the French Impressionist movement, were also seminal film-makers. Within current theoretical debates concerning the fundamental nature of film education, as exemplified (and arguably prompted) by Bergala's *The Cinema Hypothesis* (2016), the making of films is seen to be as potentially important as analysis in understanding the film medium. Bergala argues that 'The two approaches require and nourish each other' (BFI Southbank, 2017), and the involvement of practitioners is seen as a key

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component in this process. On a commercial level, the creative industries, including film and television, are playing a significant economic role, currently contributing over £90 billion per year to the British economy alone (Clark in DCMS and BEIS, 2018). With the government's growing emphasis on employability and commercial impact, universities are increasingly employing practitioners to add perceived value and credibility to their programmes. Yet, from both academic and industry sides, this integration has been questioned and challenged, resulting in a long-standing discussion of the 'theory/practice divide'. Indeed, at times this division has been truly combative, as the feud between the noted Australian media historian Keith Windschuttle and lauded practitioner-academic John Hartley in the 1990s illustrates (Crook, 2015).

In 2001, as a film and television industry veteran of more than 15 years at the time, I decided to accept an academic position to assist in the development of a new undergraduate programme that involved production. This proved to be successful to the point that I was then asked to be a founding member of a new media-focused department three years later. On the face of it, my participation in both endeavours would suggest that I was accepted as an equal member of the academy despite previously having an industry-only background. However, both my initial appointment and subsequent involvement in the development of a department were met with scepticism (and even contempt) by some academic colleagues. There was also scepticism from industry contacts, who felt that my involvement in academia meant that I had left industry – this in spite of my continuing professional activity and fostering of mutually beneficial academic–industry links. In his article, 'Theory for practice: Ceci n'est pas l'épistémologie', Brian Winston (2011: 193) echoes my own feelings: 'For a practice teacher, making one's own way in the academy on the basis of one's professional qualifications alone is … hard. Continuing to work as a media professional can count for little.'

My experience in academia over the past 18 years led me to wonder whether it was unique, or perhaps particular to my institution, and whether others who entered academia from industry had similar experiences. It also raised the question of whether it might be possible to begin to more formally describe or even quantify the theory/practice divide beyond the theoretical analyses of Bell (2004, 2006), Petrie (2011) or the various scholars in Clive Myer's (2011) seminal compendium *Critical Cinema.*

Previous research into the involvement of practitioners in media education has tended to be limited in scope or focused on specific aspects of the practitioner-academic experience, rather than considering the role as a whole. Bergala (2016) sees the film-maker in an idealized form as 'artist', and is unashamedly anti-Hollywood, effectively ignoring (if not discounting) the current widespread involvement of mainstream commercial film and television practitioners in teaching. Other film education researchers, including Chambers (2018), Bachmann and Zahn (2018) and Aidelman and Colell (2018), consider different ways that film-makers have been (or can be) involved in the delivery of film education programmes, but do not consider actual practitioner experiences in the process in any significant depth.

Bell (2004) considers his own experience as a film-maker entering the academy in his analysis of the theory/practice divide. He argues that an institutional emphasis on traditional research outputs coupled with a vocational view of media training has served to widen this divide for practitioners working in the academy. Although it provides some very interesting insight, it is primarily a personal commentary. In his later work, Bell (2006) explores more broadly this seemingly contentious relationship between practice and research, an important aspect of the academic role, but only one part of the academic experience.

Petrie (2011) provides a highly detailed account of how the theory/practice divide has manifested itself in film education, considered at a historical institution-focused level rather than at a personal one. In Myer's (2011) edited volume, the theory/practice divide is examined from a range of perspectives. Of these, Winston's (2011) relates most closely to the questions concerning the experiences of practitioners working in the academy, where he describes his observations of the combative relationship between 'the theory people' and 'the practice teachers', and then considers ways in which theory and practice can be seen as complementary in educating film-makers.

Of the work most directly related to the focus of this article, Parmar (2010) interviewed five active industry professionals seconded to the Bournemouth University Media School as 'teacher-practitioners'. Despite the comparatively small number of participants, this study yielded some interesting insight into differences in expectations of industry professionals entering the academy, as well as their experiences in assimilating into the academic community. Parmar (ibid.) observed that industry professionals often have inaccurate preconceptions about universities, for example that equipment is out of date, and that academics are 'out of touch' with industry practice, but also reported that this group saw benefits of working in the academy, including the ability to work with talented students, which enabled them to reflect on their own practice and develop. However, the way in which academia operates was often seen as slow and bureaucratic when compared with industry. Her conclusion was that experiences were, on balance, more positive than negative for her subject group.

Clews and Mallinder (2010) carried out a broad survey into how the creative industries and higher education (HE) institutions have interacted, and the role of teacher-practitioners in those collaborations. While their study was larger in scale, including interviews with 120 practitioners working with approximately 75 HE institutions across a range of creative disciplines, it was not specifically focused on the experiences of media practitioners entering and working in the academy, but rather on outlining the types of collaborations (placements, industry liaisons and so on) and quantifying the number of departments that employ teacher-practitioners (around 85 per cent, with the majority employed as guest speakers or part-time lecturers).

Ashton (2013) considered the professional identity of media practitioners working in education, and how this can be affected by the need to balance teaching and professional media practice. While his analysis provides some strong insight into the practitioner's experience in the academy, like Parmar's (2010) work, the emphasis of Ashton's (2013) article is to consider how the practitioner-academic's industry experience can help media students gain a sense of identity as 'cultural workers' rather than exploring the challenges encountered by practitioners in academia.

To date, there has not been a large-scale survey of those most directly involved in the theory/practice debate – media practitioners working in higher education. This paper aims to fill that gap by systematically assessing the views and experiences of broadcast television and film practitioners working in UK academia ('film' in this context referring to narrative and non-fiction feature film but not corporate or short-form commercial film-making). It details the results of surveys conducted in 2012 and 2014, then briefly considers whether the issues raised have changed or been addressed as of the start of 2019.

Methods

Two online surveys were conducted, the first in 2012 and the second in 2014. To recruit appropriate participants for this study, a list of HE-level media production undergraduate and postgraduate programmes on offer in the United Kingdom was compiled using information from publicly available sources, including the Universities and Colleges Admissions Service (UCAS), Creative Skillset (now known as ScreenSkills, the UK government initiative that supports focused education to enhance the talent base for media industries) and FindAMasters. At this initial stage of the research, all types of media production programmes were considered. Each programme was then examined through the website of the host institution to determine the backgrounds of staff involved in delivery. Individual biographies were reviewed, with any listed staff members whose background suggested they had paid media industry experience being added to a list of candidate subjects. This provided a subject pool of 215 possible participants from 47 institutions for the 2012 survey, with an expanded search in 2014 yielding an additional 200 for a total subject pool of 415 candidates from 64 institutions across all media production-related disciplines who were directly contacted. Referrals to colleagues were also encouraged, so, while the actual reach of the survey is unknown, it is reasonable to surmise that the list collated represents a substantial sample of the film and television practitioners working in UK higher education at the time the surveys were conducted.

Surveys ran from August to October in 2012 and from June to August in 2014. The surveys were administered through SurveyMonkey, and consisted of a series of multiple-choice questions with text boxes for comments. The 2012 and 2014 surveys are identical apart from an additional section in 2014 designed to evaluate any changes in circumstances or opinions from those participants who had completed the 2012 survey. As the study was conducted completely anonymously, there was no direct way to link responses between the two surveys, but participants were asked if they had completed the survey previously. In both surveys, the option of entering a draw for a £50 voucher was offered as an incentive to help generate interest in the study. Analysis of the data provided by the surveys was completed using analytical tools within SurveyMonkey and Excel.

For the purposes of this paper, the term 'practitioner' is used to mean a media practitioner who has worked in the film and/or television industry on a paid basis in either a creative or technical capacity; 'non-practitioner' is used in reference to an academic who has not worked in these industries and entered work in the academy through a traditional route (for example, advanced degree, research associate position). To preserve anonymity, individual participants are referred to by the number assigned to them by the SurveyMonkey system. The type of HE institution with which respondents are associated will be shown in parentheses when this is relevant to the discussion.

Results

The 2012 survey resulted in 100 respondents, while the 2014 survey had 150 respondents overall, 13 of whom indicated that they also completed the first survey. This resulted in an overall sample size of 237 individual participants from all media production disciplines across the two surveys – a response rate of 57 per cent based on the numbers originally contacted via email, although there may have been some respondents from outside this group. For the purposes of this study, participants were filtered so that only those who declared having predominantly worked in broadcast television or feature film production were included. This resulted in 65 discrete respondents from 2012 and 66 from 2014 for a total sample size of 131 for this study.

Participant backgrounds

The majority of the 131 respondents (89 per cent) had worked in the film and television industry for more than ten years, with only 5 per cent having five or fewer years of experience; 92 per cent stated that they had worked in broadcast television and 50 per cent in feature film; 40 per cent overall reported working in both disciplines.

In terms of time spent working in HE, 43 per cent had worked in academia for more than ten years, 34 per cent between five and ten years, and the remaining 23 per cent for less than five years. None had worked for less than one year (that is, no new appointees responded). Of respondents, 94 per cent indicated that they were not the first practitioner hired by their academic department.

Of respondents, 87 per cent reported that they worked for only one institution, with the remainder being employed by two or more simultaneously. A majority of participants (61 per cent) stated that they were full-time staff with teaching, research and administrative duties, 20 per cent were on full-time teaching-only contracts and 19 per cent were on part-time contracts; 95 per cent of respondents stated that they teach at undergraduate level, 68 per cent at master's level, and 23 per cent reported that they were involved in PhD supervision.

For this paper, distinguishing between different types of institutions is important in order to determine whether certain institutional attributes (such as age, and whether the university started as a college or polytechnic) or priorities (such as research or vocational training) have had an impact on the experience of their practitioner-academic staff.

The types of institutions in the UK in which the participants were employed are grouped according to mission, as follows:

- Million+ (The Association for Modern Universities) is comprised mainly of 'new universities', including university colleges that were given university status after 1992 (for example, Bournemouth, Edinburgh Napier, Staffordshire, Sunderland). Former polytechnics have also been included in this grouping although some institutions may not formally be members of the Million+ group. These institutions are typically viewed as having more of a teaching emphasis, with less academic time dedicated to research.
- The University Alliance is comprised of a range of newer universities with a stated objective to prepare students for careers in industry and prioritize links with relevant companies. Members include Lincoln, Portsmouth, Salford, South Wales and Teesside. Research is undertaken in these universities, although industry-focused teaching is seen as a priority.
- Arts-focused institutions include general arts universities such as Arts University Bournemouth, Ravensbourne and the University for the Creative Arts, as well as dedicated media schools such as the London Film School, and the National Film and Television School. Teaching relevant to industry is the primary focus here, with few staff members engaging in traditional research.
- Russell Group universities (such as Bristol, Cambridge, Edinburgh, Oxford, Warwick and York) are highly research-intensive and receive the majority of UK government research funding. These are often regarded as 'top-tier' institutions, with particularly high standards for staff performance.
- The 1994 Group was a collection of smaller universities (for example, Goldsmiths, Royal Holloway and Sussex) where research was also seen as a major focus alongside teaching. It was disbanded in 2013 after the first survey was completed, and thus the designation has been retained for the purposes of this study. A

number of these institutions joined the Russell Group shortly before or after the dissolution.

The results by institutional type are shown in Figure 1, indicating that the majority of respondents were from institutions with a teaching and vocational focus, with only 16 per cent of respondents being from those with more of a research mission (that is, Russell Group and 1994 Group).

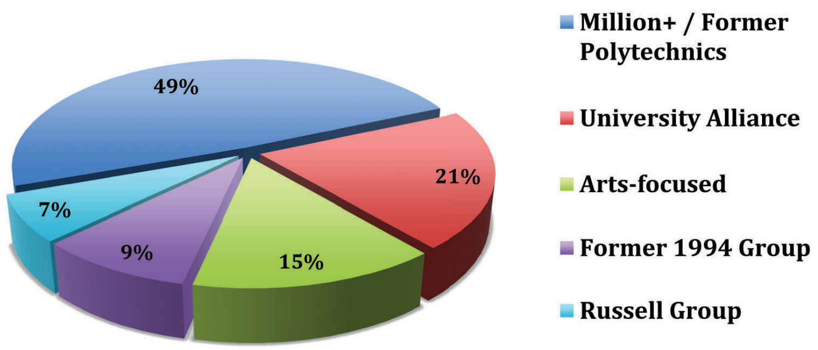

Figure 1: Results by type of academic institution

Entering the academy

Participants were given a range of choices for why they entered academia, as well as the option to add their own. These were presented randomly to each participant to avoid biasing responses, and more than one option could be chosen. The results are shown in Figure 2.

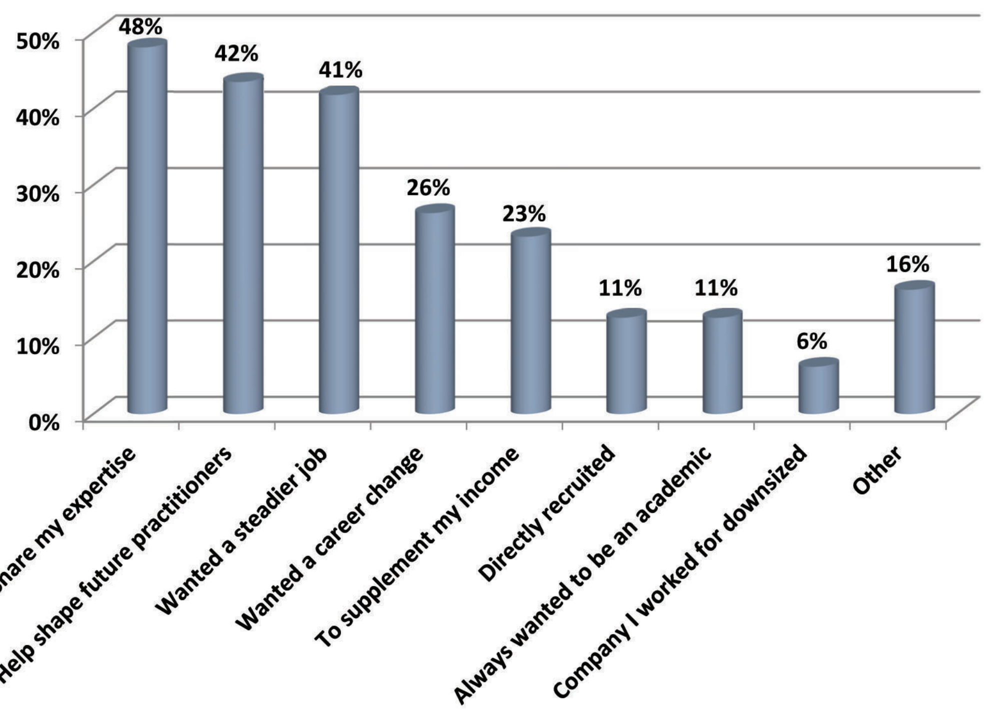

Figure 2: Reasons for entering academia

Participant impressions of how they were viewed within their institutions

When asked about the initial reaction from non-practitioner colleagues upon their appointment, most but not all said they were welcomed warmly, as shown in Figure 3.

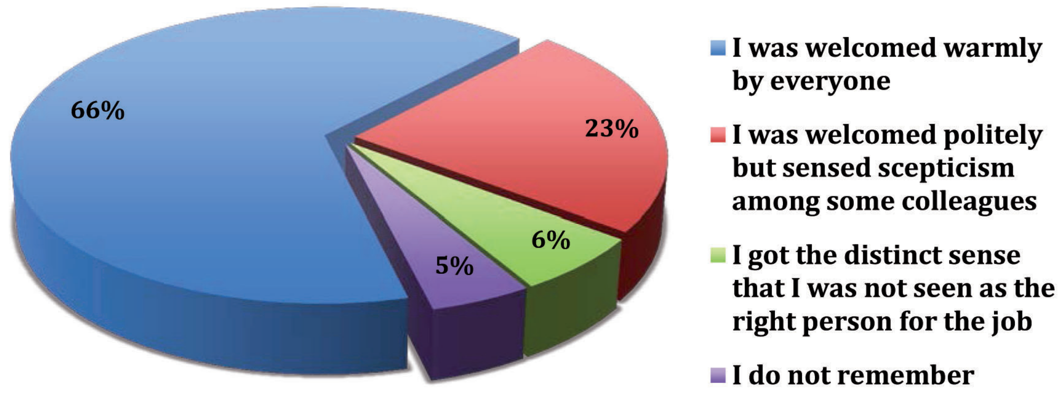

Figure 3: Initial reactions of non-practitioner colleagues

Participants were also asked about their perception of how they felt they were viewed by non-practitioner colleagues in their institutions, and results are shown in Figure 4.

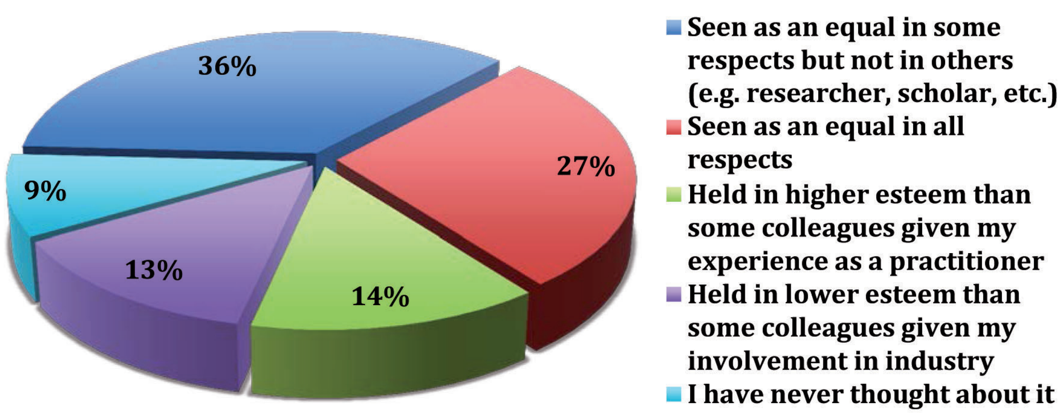

Figure 4: Views of non-practitioner colleagues

To gain insight into the possible reasons for any perception of inequality, participants were asked whether they felt their institutions valued staff on 'teaching only' or 'teaching and scholarship' contracts as highly as those who had research as part of their job description. In response, only 19 per cent felt that they were valued equally, whereas 55 per cent felt that they were not; 26 per cent had no opinion or indicated that this was not relevant to their institution. When asked whether they themselves felt staff on teaching-only or teaching and research contracts make an equal contribution to their institutions, 59 per cent said that they did and 15 per cent stated that they did not, with 26 per cent expressing no opinion.

When asked whether they felt part of the academic community, 69 per cent responded that they did, with 31 per cent stating that they did not. Some 64 per cent of participants felt that the staff make-up of their department had a 'good balance of practitioners and non-practitioners', while 33 per cent argued that there should be more practitioners on staff, and 3 per cent stated that there should be more non-practitioners in their department. All but one respondent stated that they felt the involvement of media practitioners in teaching enhances the student experience.

Respondents were able to comment on all of the questions for this section. These responses are explored in the 'Analysis and discussion' section below.

Research activity

Despite the fact that most respondents were from institutions with a teaching and vocational focus, and irrespective of the type of academic contract held, 74 per cent of participants claimed to be research-active – three-quarters of those reported this as part of their academic job and a quarter as an independent activity. Of the remaining participants, 16 per cent stated that they intend to undertake research at some point, while 10 per cent did not expect to conduct any form of research.

There are several types of activities undertaken as research, outlined below:

- 'Research by Practice' refers to both media-based works that are contextualized for academic dissemination, and commissioned industry work that is accepted by the respondent's academic institution as formal research. This is discussed in greater detail below.
- 'Traditional Scholarly' refers to work based on literature and academic research, such as that published in film studies, educational or other 'traditional' academic journals.
- 'Knowledge Transfer' refers specifically to research conducted as part of a formal Knowledge Transfer Partnership scheme (for example, through Innovate UK/ Technology Strategy Board) between the respondent's academic institution and a commercial partner.
- 'Traditional Scientific' refers to technically based research, such as software or systems development, as published in mathematics or engineering journals.
- 'Commercially Funded' research refers to work funded solely by a commercial entity for commercial use.

The types of research undertaken by participants are shown in Figure 5.

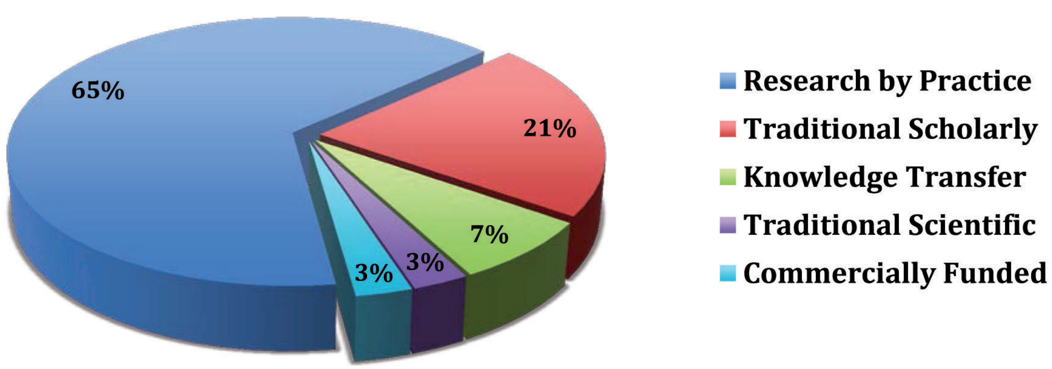

Figure 5: Primary type of research conducted

Participants were asked how they perceived their research to be valued by their institution. This was specifically to try to ascertain whether research undertaken by practitioners is seen differently to that conducted by more traditional academics. While

36 per cent stated that they felt their research work was seen to be equal to other types of research, 48 per cent said that it was perceived as less important. Only 3 per cent felt that it was regarded as more important, with 13 per cent being unsure. Of those engaged in Research by Practice, 60 per cent of respondents reported that they did not feel this type of research was well understood by their academic institution.

Involvement with industry while working in the academy

Alongside working in HE, 65 per cent of participants were still active in industry, either on a directly paid or indirectly paid basis (where commercial activity is directly linked to research). Of those, 75 per cent responded that they had to alter their work in industry around their academic commitments, and 52 per cent stated that their academic institution did not make any adjustments to enable them to undertake industry work.

Industry-active respondents were asked how they felt they were viewed by their media industry colleagues, given their work in academia. Results are shown in Figure 6.

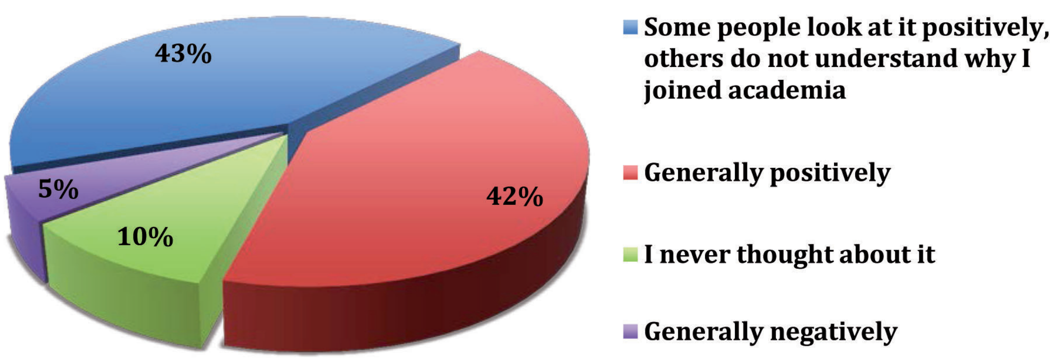

Figure 6: Viewed by industry colleagues

Of the 35 per cent who responded that they were no longer active in industry, 61 per cent reported that academic work took too much time, 26 per cent responded that they could not get suitable or consistent work, 17 per cent stated that changes in the film and television industry made it less attractive to continue with commercial work, and 17 per cent noted that they had accomplished what they wanted in industry (respondents were able to choose more than one option).

Participants were invited to comment, and their responses are discussed further in the 'Analysis and discussion' section below.

Future plans

A small majority of respondents (53 per cent) stated that they planned to continue working in both academia and industry, 22 per cent expected to leave industry completely, while 8 per cent were looking to leave academia to return to industry; 17 per cent were unsure.

Two additional questions were posed in the 2014 survey. The first followed up on the preceding question to determine whether the participants' plans had changed during their time in academia. While 55 per cent stated that they had not, 29 respondents (45 per cent) said that they had. Reasons given are shown in Figure 7. Note that some 'Other' responses actually indicated available answer options and so were combined with those.

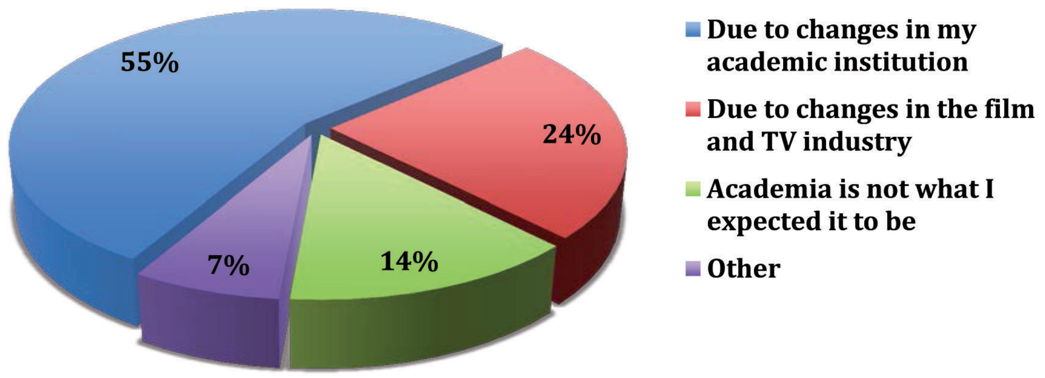

Figure 7: Reasons for change in future plans

The second additional question in the 2014 survey looked at whether or not respondents had changed institutions during their academic career – 57 per cent had not. Of the 32 participants (43 per cent) who had moved academic institution, the reasons given are shown in Figure 8.

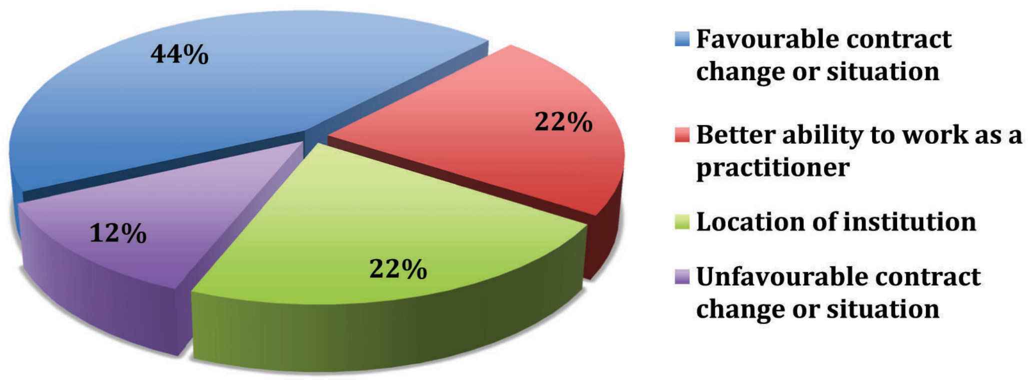

Figure 8: Main reasons for changing HE institution

Analysis and discussion

The main results of the surveys are analysed and discussed in this section. This includes free-text responses at the end of both surveys that allowed participants to add general comments; 26 per cent (34 people) did so, many leaving lengthy entries that give insights into the experiences of media practitioners in their institutions.

Entering the academy

From the surveys it is clear that the media practitioners who participated entered academia for two main reasons, broadly speaking:

1) Economic – 54 per cent of all respondents selected 'to have a steadier job', 'supplement their income' and/or 'the company I worked for downsized or went out of business'.
2) Altruistic – 59 per cent of all respondents selected 'to share professional expertise' and/or 'shape the next generation of practitioners'.

The first point is telling, and may be indicative of changes and new demands in industry that have forced practitioners to reconsider their career trajectories, as discussed by Dex *et al.* (2000) and Hesmondhalgh and Baker (2010). Also, while Clews and Mallinder (2010) found that a majority of practitioners in their survey of creative industries were employed part time, 80 per cent of respondents to this study were on full-time contracts, which may again indicate increased instability in the film and television industries. These quotes are indicative of a number of respondents' views:

> I reached a point, as a district reporter working from home, at which I felt the diminishing professional rewards no longer helped me cope with the stresses of my job; and at 50, I could not see a way to progress within the BBC. (Respondent 3347191577)

> [I] needed a career which was not as erratic as working in television – better work/life balance with family life. (Respondent 3323998097)

> If you have children it is very difficult for both yourself and your partner to maintain a career in the industry. (Respondent 3329162357)

The last comment hints at the issues many women working in the creative industries face. Dent (2016) explores this in detail, highlighting ongoing issues and complexities surrounding the nature of inequality in the media industry. It is beyond the scope of this article to explore these in detail, but they are certainly worthy of further investigation in consideration of the practitioner-academic experience.

The altruistic nature of the second reason given for entering HE (sharing expertise), coupled with comments made by several respondents, suggests that many practitioners entering the academy may have a somewhat idealistic view of academia, seeing it as being less constrictive than industry and allowing greater creative flexibility:

> [I] wanted freedom to pursue my own creative projects rather than work on someone else's. (Respondent 1940989196)

> [I] wanted to make film work freed up from the treadmill of making I was on at the BBC. In the last 10 years I've made work for BBC Radio/TV but at my own pace and projects I choose or nurture myself. (Respondent 1934540539)

> I wanted to be able to put the work that I had done so far into some sort of academic framework in order to move forward. (Respondent 3322319460)

However, actual experiences within the academy were often reported to be different than expected, which has the potential to impact on the ability of practitioners entering academia to assimilate, thus ultimately affecting motivation and performance.

Participant impressions of how they were viewed within their institutions

Responses suggest that an appreciable number of respondents encountered a mixed or negative reaction from new academic colleagues immediately upon joining their institution. While 66 per cent of participants overall responded that they were 'welcomed warmly' when they first met their academic colleagues, nearly 30 per cent either 'sensed scepticism among some colleagues' or 'got the distinct sense that non-practitioner colleagues did not feel [they were] the right person for the job'; there was little difference between the responses from 2012 and 2014 (27 per cent and 31 per cent respectively for these choices). Perceptions of participants in specific types of institutions are shown in Table 1 (removing those who answered 'Don't remember').

Table 1: Percentage of respondents receiving a positive welcome by institution type

Institution type	Respondents % *(number)*
Arts-focused	94 *(16 of 17)*
Russell Group	78 *(7 of 9)*
University Alliance	73 *(19 of 26)*
Million+	65 *(39 of 60)*
Former 1994 Group	36 *(4 of 11)*

The values above vary appreciably between institution types, and there is a statistically significant difference from what would be expected by chance (chi-square=11.5, p=0.02). It would appear that Arts-focused universities have been more welcoming of practitioners than other types of institutions, and Former 1994 Group members less so. Considering the work of Petrie and Stoneman (2014), this may be explained by the fact that art schools were among the first to offer film production courses, and have traditionally seen practice as a key element of research across all artistic disciplines.

The finding that nearly 30 per cent of respondents perceived a negative 'welcome' is remarkable given that there is ample research (for example, Ashforth, 2000) indicating that organizations typically try to be attractive and welcoming to new employees, thus creating a 'honeymoon period' (Boswell *et al.*, 2005). Not only are negative experiences at such an early stage dispiriting, but established research into the impact of organizational socialization suggests that these respondents may immediately have been disadvantaged in their ability to undertake their responsibilities effectively, if the perception of a lack of collegial support was experienced from the start (Feldman, 1981; Jokisaari and Nurmi, 2009; Lodahl and Kejner, 1965; Vroom, 1962). As Feldman (1981: 314) notes:

> At the encounter stage, initiation to the task and initiation to the group will be correlated … many recruits report feeling that until such time as they became friendly with co-workers and could trust them, they could not find out information that was essential to doing their jobs well.

Table 2: Percentage of respondents receiving a positive reception from non-practitioner colleagues by institution type

Institution type	Respondents % *(number)*
Arts-focused	88 *(14 of 16)*
University Alliance	46 *(12 of 26)*
Million+	40 *(21 of 53)*
Russell Group	33 *(3 of 9)*
Former 1994 Group	33 *(4 of 12)*

While a majority of respondents felt that there was an initially positive reception in their academic institutions, the data suggest that many media practitioners working in HE do not feel that they are seen as equal to non-practitioner colleagues, as shown in Table 2. As with the perception of 'welcome', there appears to be a clear relationship between the type of institution and the participants' views of how they were valued by non-practitioner colleagues, with the vast majority of those in Arts-focused institutions reporting positive experiences compared with less than half across all other types (chi-square=13.3, p=0.01).

More than half of all respondents overall reported that they were either 'seen as equal in some respects but not others' or 'held in lower esteem'. The comments below are indicative of the frustration that several participants expressed about this:

> As I don't do trad[itional] research I am definitely looked down on, and it is very hard to maintain morale. (Respondent 3369057913 (Russell Group))

> There is still, sadly, in some quarters a sense that a practitioner who has not undertaken formal research is akin to a monkey pushing a button. (Respondent 2017339242 (Million+))

> Non-practitioners have the time to develop research interests and publications which allows them to develop their careers within the institution and elsewhere, while those teaching practice are stuck as teachers. (Respondent 2016843263 (Million+))

> Although I am a bona fide academic in terms of degrees, certificates, etc. I have had a constant battle to get the same terms and conditions as others without professional qualifications. (Respondent 1954715118 (Million+))

> There remains a persistent habit by our HoD [head of department] to characterize academics with production experience as 'professionals' and quite distinct from academics. It is a false distinction. (Respondent 1954700730 (Russell Group))

> It's taken longer to get promotion and although there are equal numbers of practitioners there is one professor of practice as against 5 or 6 theory colleagues. (Respondent 1934341183 (Former 1994 Group))

It is interesting to note the fall-off in positive perception between the initial 'welcome' and subsequent perception of how much respondents felt valued by colleagues, as shown in Table 3.

Table 3: Change in positive perception from 'welcome' to 'views of non-practitioner colleagues' by institution type

Institution type	**Change % *(detail)***
Russell Group	–45 *(78% to 33%)*
University Alliance	–27 *(73% to 46%)*
Million+	–25 *(65% to 40%)*
Arts-focused	–6 *(94% to 88%)*
Former 1994 Group	–3 *(36% to 33%)*

This fall-off may be due in part to institutional demands based on a traditional view of the academic role – the Russell Group in particular has historically placed significant value on intensive traditional research – which does not appear to align well with the 'Research by Practice' that the majority of practitioner-academics undertake (discussed in the 'Research activity' section below). This appears to be consistent with the tension that Bell (2006: 85) observes, 'the notion that creative practice itself – with its enthusiasms and confusions, expressivity and sheer immanence – could be the crucible for a process of systematic research investigation, remains a harder sell within the wider academic community.'

Comments suggest that some of the frustration appears to be due to requirements for staff at some institutions to have higher-level academic qualifications, primarily PhDs, for certain types of roles:

> We have a serious problem in recruiting suitable academic staff as the university will only consider applicants who have a PhD. However, this is not valued by the students as much as industry experience. Even the willingness to undertake a PhD is no longer acceptable to the HR department. (Respondent 3347201018 (Million+))

> Here there is a clear understanding that practitioners are needed, but this is not understood at university level where they insist that all new staff have PhDs (I got in under the wire). This is because they are more interested in their own academic cred[ibility] than the needs of the students. The only way to rise up the pay scale is to get academic qualifications – length of service in the industry is not considered equally valuable. (Respondent 1944580834 (Million+))

> There is a major issue facing our university and possibly others in requiring us to recruit only staff who have PhDs. This has prevented us from taking the appropriate people recently. (Respondent 1934983484 (Million+))

> The university keeps going on about PhDs and doesn't mention industry awards, etc. (Respondent 1955468867 (University Alliance))

Interestingly, there is also evidence of similar judgements that some practitioners have made towards non-practitioner colleagues, suggesting that some do not value traditional academic skills:

> I don't believe there is any point in having non-practitioners teaching practice-based media skills. There is no way to keep up with current practice otherwise. Film theory is fine with pure academics, but not practice. The challenge is to actually get the time to continue to practise once you are in academia because the structure of such does not realize that the practice is necessary in order to properly teach. (Respondent 1934230802 (Million+))

> Non-practitioner colleagues are either sceptical of practitioners' lack of pedagogic rigor, or feel insecure teaching a practice they do not have first hand experience of. (Respondent 1940562240 (University Alliance))

> I am both practitioner and traditional scholar, and am perceived by practitioner colleagues as 'inferior' in practice, when in fact have a very similar profile to them but with extra academic experience. (Respondent 1942226482 (University Alliance))

> I don't actually respect much of the research my academic colleagues undertake, I feel it is indulgent and has little impact – at times it appears to be the same notions rehashed to fill conferences with outputs. (Respondent 2022666615 (Million+))

The apparent lack of respect suggested by these comments, from both academic and practitioner sides, is consistent with Winston's (2011: 195) observations, where he states, 'For practice teachers caught in such a position of enforced inferiority, a defensive hostility is a quite natural, and in my view, an excusable reaction.'

However, despite a significant number of participants expressing that they felt they were seen as unequal to non-practitioner colleagues, almost 70 per cent stated that they did feel they were part of the academic community – effectively bona fide academics (shown in Table 4).

Table 4: Percentage of respondents who felt part of the academic community by institution type

Institution type	**Respondents % *(number)***
Former 1994 Group	83 *(10 of 12)*
University Alliance	74 *(20 of 27)*
Arts-focused	72 *(13 of 18)*
Million+	67 *(42 of 63)*
Russell Group	44 *(4 of 9)*

There is no statistically significant difference between the type of institution for this question (chi-square=4.3, p=0.37), although responses from Russell Group participants are worthy of further investigation, given that it is the only institution type where fewer than half felt part of the academic community (although the small sample size limits the robustness of this finding).

Comments for this question offer few specifics about the possible contradiction between perceptions of acceptance and feeling part of the academic community, although support from fellow practitioner-academics and embracing a perception that they were non-traditional academics may be factors:

> [Yes, but] only because we have a lot of practitioners. (Respondent 3346385003 (University Alliance))

> Yes – although I'd never describe myself as an academic. I am professor of practice – which means I am a professor through the body of work I have made. I feel uncomfortable using the phrase academic. I am one – but do not use it! (Respondent 1934540539 (University Alliance))

> [Yes,] I feel part of my workplace community but the word academic doesn't really mean much to me. (Respondent 2017339242 (Million+))

> [Yes, but] it's a struggle. Old attitudes about the inherent superiority of theory/practice persist – not through malice by any stretch, but because research in these areas are more easily recognized and rewarded. Hence the professoriat, for example, is made up entirely of theory/history people. (Respondent 1954700730 (Russell Group))

Research activity

As noted above, nearly three-quarters of respondents stated that they were research-active, the majority of which (just under two-thirds) having been engaged in 'Research by Practice' in some form; 60 per cent felt that this type of research was not understood by their institution:

> There is no understanding of what is involved in the creative process and no value put on this, only on REF-ability [Research Excellence Framework]. (Respondent 2017545344 (University Alliance))

> It's a question of language ... I write for a human audience. I am not a scientist. My reflections are not academic enough. The institution has a problem with this. (Respondent 1935532935 (Million+))

> … it is very hard to try and get institutions to see actual commissions as research. (Respondent 3326267613 (University Alliance))

> It is not valued as equivalent to published peer-reviewed output – even when it is seen by millions of viewers! (Respondent 2022666615 (Million+))

These comments and others suggest that there has been a possible lack of communication between institutions and practitioner staff regarding the specific needs and uses of research outputs in the academy. The language used by several respondents indicates that some have a divergent view of what constitutes academic research, a view that is consistent with Nelson's (2013: 23–47) observations of 'practitioners moving to practitioner-researchers'. This divergence may well be a factor in the shift from the predominantly positive perception at 'welcome' to the increasingly negative perception of how practitioner-academics were viewed by non-practitioner colleagues (apart from those at Arts-focused institutions) discussed earlier.

The last quotation above is of particular note, given the increasing importance of 'impact' in the measurement of the 'value' of research, as exemplified by the specific mention of these in the Research Excellence Framework (REF, 2014) as well as on Research Councils UK funding application forms. Given that part of 'impact' is to raise awareness or effect change based on the reach of a work, the comments suggest that there needs to be more focused dialogue between institutions and their practitioner-academics to ensure that mutually beneficial opportunities are not being missed, particularly since broadcast television and feature film projects can reach significant audiences.

Bell (2006: 90) observed that 'research councils like the AHRC remain nervous about funding creative practice projects such as films … where the "research value added" component cannot be delineated from the vehicle of the creative practice and evaluated as a separate deliverable'. However, it appears that funding council and government views may have begun to change. Both Barnard's feature documentary *The Arbor* (2010) and Oppenheimer's *The Act of Killing* (2012) received production funding from the Arts and Humanities Research Council. More significantly, the AHRC's recent Creative Economy Programme (AHRC, 2017–18) was specifically devised to enable academic–industry collaborations to enhance commercial project development, where success is to be measured in commercial rather than academic terms. Indeed, while details of REF 2021 are still to be confirmed, a recently commissioned report suggests that Research England is likely to use the indicators of 'engagement', 'mentions in non-academic documents and the media', 'employment' and 'financial figures' in assessments of REF case study submissions (Parks *et al.*, 2018). These measures would appear to align more readily with those used to assess the success of commercial film or television works than criteria used in 2014, suggesting greater acceptance of commercial practice methods. However, even with an apparent shift in government perspectives on the role of the academy, the impact of commercial activity within it and the value of industry practice, there is currently no evidence that institutional policies or the perceptions of the practitioner-academics themselves (as articulated by the respondents in this study) are changing as well. This is an area for further investigation.

Considering perceptions of Research by Practice within the various types of institutions, percentages suggest a difference between the views of participants from Arts-focused universities and those from other types (see Table 5). However, these differences did not reach statistical significance, most likely due to the small numbers involved (Fisher's Exact, p=0.20; chi-square, p=0.20). To more fully determine whether there is a significant difference, a larger data set is needed.

Table 5: Percentage engaged in 'Research by Practice' who felt that it is understood by their institution

Institution type	**Respondents % *(number)***
Arts-focused	71 *(5 of 7)*
Former 1994 Group	50 *(2 of 4)*
Million+	46 *(12 of 26)*
University Alliance	33 *(5 of 15)*
Russell Group	0 *(0 of 4)*

Of the 95 respondents who stated that they were research-active, only 29 per cent indicated that they were involved in PhD supervision. This is remarkable, in that this is often seen as an important part of academic research activity (Coate *et al.*, 2001), as well as a common consideration for promotion. Possible reasons as to why this number is lower than expected is another area for future investigation.

Several respondents reported that they felt it was difficult to be a non-research-active academic in their institution. Some expressed this quite strongly:

> 'Teaching only' in a research-led university like this one is clearly regarded as second-class citizenship among academics. (Respondent 1954700730 (Russell Group))

> Life as a non-research academic in a research university is a battle and has worn me down over the years. (Respondent 3369057913 (Russell Group))

> Teaching and research contracts? Wow. (Respondent 3318432409 (Million+))

> We provide 94 per cent of the faculty's income but the REF FTE [full time equivalent] submission was 40 per cent of the workforce, and they generated less than 4 per cent of the faculty's income. Therefore those in the 'teaching ghetto' finance all the others to progress their academic careers, while we are left at a standstill. (Respondent 3324061951 (Million+))

From these comments and others, it is evident that many survey participants perceived a 'class difference' between those engaged in research and those who were not, with the former being viewed more favourably in their institutions. This is consistent with findings of studies such as Burton and Haines (1997), Hannan and Silver (2000) and Taylor (1999) that investigate different aspects of teaching within higher education. Young (2006: 191) is one particularly clear example, where the author states, 'Unanimously, [researchers in this area] report the low status which higher education institutions give to teaching as an activity'.

Involvement with industry

Nearly two-thirds of respondents indicated that they were still active in industry, although three-quarters of those stated that they needed to fit industry work around academic requirements, just over half without any assistance or accommodation from their institution. This has both presented challenges and been a source of frustration:

> To edit a full-length documentary for seven weeks, I have to give up my summer holidays. (Respondent 2022666615 (Million+))

> Sometimes [it is] very hard to juggle a fixed timetable against flexible/ expanding media projects. (Respondent 1971374170 (University Alliance))

> Projects take much longer as a result of the academic workload, and usually take place in summer. (Respondent 1940591317 (Million+))

> I have only been shooting 3 weeks per year – which isn't even my full allocation of research days, but all I can muster. I need to do more to be satisfied in my work. (Respondent 1934230802 (Million+))

> It's easier to get a sabbatical to write a chapter than shoot a feature film or make a documentary. Ironic, seeing as a film could provide students with valuable experience, enhancing learning and employability. Film-making is a team experience, writing a chapter isn't. (Respondent 3318173860 (Million+))

There was no measurable difference between the type of institution and the likelihood of a participant being active in industry (chi-square=2.2, p=0.71). However, there was a marked difference between types of institutions in the level of accommodation of professional practice, with Russell Group and Million+ universities being seen as the least supportive of this type of activity, as shown in Table 6 (chi-square=19.6, p=0.0006).

Table 6: Percentage whose institution made adjustments to accommodate practice

Institution type	**Respondents % *(number)***
Former 1994 Group	88 *(7 of 8)*
University Alliance	82 *(14 of 17)*
Arts-focused	43 *(6 of 14)*
Million+	32 *(12 of 38)*
Russell Group	17 *(1 of 6)*

From the results, it is reasonable to infer that, if practice were seen as an important component of department activities, institutions would go to greater lengths to ensure such activity could be readily accommodated, as they do for traditional research. It should be noted that some institutions have actively supported academic–industry collaborations in the production of commercial media projects involving their staff, including Research by Practice, but those experiences have been mixed – see Mateer (2018) for a detailed review of feature films created in this manner.

Comments from some participants also suggest that engaging with industry can introduce compromises in other areas of work for the academy:

> I have been allowed to take on broadcast work as the experience is seen to be valuable, but I have to fit that around commitments and have taken unpaid leave to do so. You can't make films and teach – the teaching suffers inevitably. (Respondent 1938855447 (Million+))

> Overly heavy teaching workloads have meant that I have turned down far more production work than I've been able to accept – some of it highly relevant to my core research interests. (Respondent 1954700730 (Russell Group))

> It is a struggle to balance both priorities – shifting timetables and working for two institutions compounds this problem. (Respondent 3323998097 (Arts-focused))

Of the 35 per cent of participants who were no longer involved with industry, the time required by academic work was seen as the major factor by just over 60 per cent. This comment is indicative:

> Getting work in the industry is a full-time job, and you have to be available immediately. It's simply not viable with an academic schedule. (Respondent 3329162357 (Former 1994 Group))

Industry views of working in academia

As noted above, respondents indicated that perceptions of their work in academia by industry colleagues was fairly evenly split, skewing slightly negative. There was no measurable difference based on institutional affiliation. This suggests that the reputations or rankings of institutions have not been greatly considered by those working in media industries.

Interestingly, comments were quite polarized. Several respondents who had received negative perceptions reacted quite strongly:

> The phrase 'Those who can, do, and those who can't, teach' is regularly used in my company. (Respondent 3329472720 (Million+))

> It isn't counted in the industry, 'you are out!' (Respondent 1955468867 (University Alliance))

> They are two separate worlds with two separate languages and ways of understanding. (Respondent 3347201018 (Million+))

> Once you leave the industry you are very quickly forgotten especially in a very competitive role such as Director. (Respondent 3329162357 (Former 1994 Group))

Some in industry appear to view practitioner involvement in academia very positively:

> They think it must be amazing! (Respondent 3369057913 (Russell Group))

> There are an awful lot of people out there in the industry, particularly the older ones, who envy me … (Respondent 1944580834 (Million+))

> Usually impressed that I have taken this step. Older colleagues often want to do the same. (Respondent 3324231042 (Arts-focused))

A few participants were more circumspect, and indicated the conflicted feelings many practitioners working in academia appear to feel. This quotation sums those up:

> It's not as simple as that ... my industry colleagues have a romantic notion of film schools. And they have a very positive attitude towards me doing this job ... but when they get involved in stuff that I do they are as shocked as I am. Particularly with assessment and the modular nature of the courses ... and are surprised by the talent of students and dedication of staff working in this environment. Good work is made despite the institution ... so views of industry colleagues are mixed. (Respondent 1935532935 (Million+))

Future plans

Just over half of respondents indicated that they intended to continue to work in both academia and industry. Given the challenges and negative feelings many participants expressed towards working in the academy, it would seem that this is an interesting contradiction. However, comments suggest that many were choosing to stay involved with academia for practical reasons:

> I doubt this is a matter of choice for most people but necessity. I doubt if anyone can afford to have a career plan these days. (Respondent 1938855447 (Million+))

> The hours, the flexibility and the steady work in academia make it very hard to leave when you have a young family to support. (Respondent 3369057913 (Russell Group))

> If the industry provided a stable career I would prefer to work in industry for all or part of my time but I am attracted to academia by the illusory possibilities of professional practice and practice-based research. (Respondent 1934983484 (Million+))

> I am finding working as an academic so time consuming that I find it hard to do any practice. However, I don't anticipate that in this market it would make financial sense to leave academia to support myself in the industry again. (Respondent 1934230802 (Million+))

A few expressed resignation about an inability to return to industry at a level meaningful to them. This comment is indicative:

> It is a one-way process and as the creative industry is fundamentally ageist it is unlikely I would gain a senior managerial role back in the industry equivalent to my role at the university. (Respondent 2022666615 (Million+))

Those who did indicate that they planned to leave academia entirely expressed strong dissatisfaction with the academy. These comments are reflective of the sentiments of this group:

> Education has become very unpleasant and difficult for any intellectual pursuit, or real teaching. (Respondent 1942226482 (University Alliance))

> I would like to have ticked the box ... to continue working in both the industry and academia ... but the nature of institutional academia makes

> that impossible – the majority of work I have as an academic has very little to do with film-making or teaching film-making, it leaves me little time for the things that are important. This has been a big shock to me. (Respondent 1935532935 (Million+))

> It's crucial that we have media practitioners in this area, but also that we have staff who understand the often Kafkaesque workings of an HE institution. For this reason staff on PT [part-time] teaching-only contracts who still work in the industry have a huge part to play and should be given more respect and acknowledgement. (Respondent 1935483006 (Million+))

Conclusions

I undertook this study initially with the arguably selfish objective of seeing whether the experiences of film and television practitioners working in UK higher education were similar to my own. Results from the survey conducted in 2012 were striking, so I undertook a follow-up survey in 2014, both to validate the findings of the first survey and to gain additional insight into the issues reported. The high response rate for the surveys and the strong sentiments expressed by the participants suggest that not only were my mixed experiences in the academy common but also that they represent direct evidence of the continued impact of the theory/practice divide. The surveys show that many practitioner-academics perceive a 'two-tier' system in which their experience and expertise from working in industry is not fully valued by the academy despite its relevance to furthering institutional teaching objectives, particularly enhancing employability. The perception of those undertaking Research by Practice was that it is still often seen as inferior to more traditional forms of research. Yet, changes in industry and a belief in the relative security of academia have led many practitioner-academics to put up with what several have reported to be unfair treatment. Likewise, HE institutions have not seemed to recognize the impact of negative staff interactions and their effect on staff productivity. Participant comments suggest that they felt the relationship between the academy and practitioner-academics was not likely to change.

It has been four years since the last survey was completed, which raises the question of whether the situation for film and television practitioner-academics is any different today. To answer this question fully requires updated information from the practitioner-academics themselves but there are some indicators that suggest that the institutional rigidity participants noted may be beginning to change, mainly due to a range of economic pressures. The notion of a 'triple helix' – the increasingly interdependent relationship between government, industry and academia first discussed by Etzkowitz and Leydesdorff (1995) two decades ago – appears to be materializing rapidly. Along with the government's reductionist emphasis on 'employability' and 'value' in education, research funding structures for supporting higher education are changing, with new requirements to demonstrate economic benefit. Central to this is commercial engagement, as exemplified by an expansion in the range of Knowledge Transfer Partnerships supported by Innovate UK, particularly in the arts, and major initiatives such as the AHRC's Creative Economy Programme (discussed in the 'Research activity' section above). Related to this, models of Research by Practice are becoming more clearly formalized and increasingly recognized, not only by the government (for REF 2021, as discussed above) but also within the academy through the establishment of championing bodies such as PRAG-UK (n.d.). At institutional level, industry engagement has begun to be formalized by some universities. One example is the University of York, where the role of Pro-Vice-Chancellor for Partnerships and

Knowledge Exchange was recently established alongside a new university committee dedicated to industrial engagement that runs in parallel to the university's research committee. This suggests a significant institutional commitment to embracing the commercial sector, considering it on an equal footing with traditional research. Central to all of these initiatives is the need to bridge academia and industry cultures and harmonize objectives. Practitioner-academics are clearly well suited to this, which would suggest that the bias and systematic disadvantaging that several respondents reported could become less common.

However, these potential shifts in perspective centre predominantly on research, and a significant number of media practitioner-academics are teaching only. Additional performance measures introduced by the government, such as the Teaching Excellence Framework (DfE, 2016), are putting pressure on HE institutions to demonstrate the efficacy of teaching staff, often through the insistence that academics have advanced degrees (usually PhDs), which is a particular concern noted by respondents. Likewise, UK higher education is in an unprecedented state of flux, particularly with ongoing debates about core funding for universities, including changing tuition fees. There are great uncertainties surrounding Brexit that threaten to affect the entire range of institutional activities, the concerns of the University of Warwick highlighted in a *Times Higher Education* article being a prime example (Morgan, 2018). Both the data from the surveys and these current trends seem to support Winston's (2011: 195) contention that the use of practitioners as teachers is (and may remain) a marriage of convenience:

> Why are they hiring people (scandalously unacademic!!) whose only value is the small matter of them knowing how to teach practice on the basis of their own experience? … The despised practitioner is made not more happy with her knowing that without her efforts the finances of the university's media education operation (and the 'area studies' department in which it is often embedded) would collapse. The institution, also understanding this, can be nevertheless ever more adamant that insistence on its traditional ways and 'standards' is justified.

On balance, it would seem that little real progress has been made in redressing the theory/practice divide since Winston wrote his article, although further work is required to determine this more fully. Additional surveys of practitioner-academics, as well as their non-practitioner colleagues and institutional leaders, are needed to try to gain a better understanding of current attitudes towards the academy and the different types of people and activities that now comprise it. I argue that only when universities review their policies, working practices and institutional attitudes towards industry can they truly make the most of what practitioners can offer and begin to close the theory/practice divide, to the benefit of all. The emergence of changing attitudes towards industrial engagement in the academy is certainly welcome. However, based on my experiences, and those of others as reflected in the surveys, it seems there is still a long way to go.

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Notes on the contributor

John Mateer has been working in film and television for more than 30 years, and as an academic for over 18. He recently worked as executive producer on the feature film *The Knife That Killed Me* (UK 2014, Universal Pictures) and as visual effects producer for *Macbeth* (UK 2018, GSP Studios). He was a founding member of the Department of Theatre, Film and Television at the University of York, where he designed (and currently teaches on) four film and television production courses, as well as being heavily involved in the design of the department's bespoke building. He is a graduate of the American Film Institute Conservatory and New York University's Tisch School of the Arts.

Filmography

The Act of Killing (UK/DK/NO 2012, Joshua Oppenheimer)
The Arbor (UK 2010, Clio Barnard)

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A fistful of dollars or the sting? Considering academic–industry collaborations in the production of feature films

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A fistful of dollars or the sting? Considering academic–industry collaborations in the production of feature films

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ABSTRACT

Increasingly universities and film schools are looking for ways to provide richer experiences for students to enhance their employability as well as find ways to make their programmes stand out in a competitive marketplace. Likewise, economic pressure on commercial feature film production companies, particularly independents, is forcing them to consider alternative means of production and new sources of cost-effective project support. This paper looks at the emergence of formal academic–industry collaboration in the creation, production and support of commercial feature films. Looking at a wide range of examples from collaborations worldwide, it considers three basic models: University as film production company with 'soft' investment; University as film production company with 'hard' investment; and University as film production service provider. It is argued that all three models can be viable but that alignment with corporate and institutional objectives, as well as realistic expectations, are essential to success.

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Introduction

Feature film production is big business. In 2016 global box office revenue reached a record high of $38.6 billion (MPAA 2017) with the number of films being commercially released approaching nearly 3000 in 2016 alone (The Numbers, n.d. b). The sector accounts for millions of jobs worldwide and its importance to national economies is regularly acknowledged at government level – cf., Sweney (2017) concerning films positive impact on the UK economy.

Over the past 50 years, there have been an increasing number of university programmes that have aimed to prepare students for working in the film industry.[1] A prime objective of these production-focused courses is to give students a realistic understanding of current professional practice as well as provide them with experience to enhance their ability to break into what is a highly competitive business sector. Work placements and internships have been demonstrated to be effective in meeting these goals (Murakami et al. 2009). Indeed, the offering of these is seen to be a key requirement for obtaining formal course accreditation from bodies such as Creative Skillset (in the UK). However, growing demand for work experience as well as economic pressures

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on production companies has made it increasingly difficult for universities to ensure these opportunities are available to all students. Likewise, a proliferation in the number of film and television production courses worldwide has meant that institutions have increasingly needed to add perceived value and industry relevance to their offerings. In response to both of these pressures, many academic institutions have begun to explore different means of engaging with industry to give students direct experience working on commercial projects. Starting around the turn of the millennium, a number of academic–industry collaborations in support of the production of commercial feature films began to emerge.

This paper explores the evolution of these collaborations in detail. First, the nature of engagement with industry by the academy on a more generic level is considered to provide a context with the emerging partnerships involving the film industry. Then, three common models of collaboration are defined, looking to go beyond the simple idea of a 'production partnership':

(1) University as film production company with 'soft' investment
(2) University as film production company with 'hard' investment
(3) University as film production service provider

A wide range of collaborative projects that culminated in the creation and release of commercial feature films through these different models is discussed. The objective is to show a representative range of the different types of academic–industry collaborations that have taken place with a view to assessing their effectiveness in meeting stakeholder expectations. Analysis of the observations and insights detailed is then undertaken to draw conclusions as to the efficacy, costs and benefits of the different models of academic–industry collaboration for commercial feature film production.

Methodology

In the discussion of models of collaboration, a range of sources of information, compiled from 2008 onward, has been used. Primary sources include on-site visits to specific institutions as well as in-person and e-mail-based interviews with academic and industry personnel involved in relevant collaborations. In some cases contacts were known to the author, in others they were obtained through contact lists from film-focused university organisations including CILECT and NAHEMI; referrals were considered as well. The author was formally involved in the development of the University of York's 'service provider' model and participated in several of the projects discussed on a credited-basis thus has direct first-hand knowledge; information based on this is clearly stated. Secondary sources include information obtained through institutional websites as well as news and trade press. Only projects released on a formal commercial basis – theatrically, direct to DVD, via a commercial online service such as iTunes or Amazon, etc. – as verified by Internet Movie Database Professional (n.d.) or The Numbers (n.d. a) have been included. Financial figures cited are based either on primary source information, data published on institutional sources or from IMDB Pro.[2] A filmography is included that also lists the academic institution involved and main IMDB link.

Models of academic–industry collaboration

Background

Over the past 20 years, universities have been increasingly looked to by government as a means to enhance economic development on a regional and national level through 'technology transfer' – cf. Florida and Cohen (1999). Traditionally this has involved industry working with science and engineering departments where research is often relevant to the development of new technology-driven systems or methods. Rosenberg and Nelson (1994) explore this type of collaboration in detail and note a tension between traditional academic research, which tends to be longer-term, and the more immediate needs of industry. The 'spin-out' model, where a company is formed by a university based on a particular area of research that is relevant to industry, has emerged as a means to address this by facilitating faster and more efficient transfer of knowledge to industry through a bespoke entity. Spin-out companies also represent a vehicle through which universities can monetise intellectual property obtained through research and generate additional revenue. Lockett and Wright (2005) provide a detailed examination of the benefits and challenges of this model.

The notion of 'commercialising' research has been somewhat controversial in the academy. Lee's (1996) extensive survey of US academics showed that while most were in favour of their universities engaging with industry and supporting technology transfer, most were against financial partnerships between the two as this could curtail academic freedom. In considering the notion of the 'entrepreneurial university' and how academics engage with industry, D'Este and Perkmann conclude that:

> … the benefits of university-industry collaboration are best attained by cross-fertilization rather than encouraging academics to become economic entrepreneurs. Collaboration is fruitful when it facilitates or contributes to both industry applications and academic research. (D'Este and Perkmann 2011, 332)

However, D'Este (in his work with Bruneel, D'Este, and Salter 2010) also notes that there can be barriers to such collaborations due to cultural differences between universities and industry in terms of institutional expectations, sharing of intellectual property and operational methods (these findings are relevant to film production-related collaborations as well, which will be explored later). Despite these challenges, there is increasing awareness of the benefits of academic–industry collaboration as noted by PwC (2016) in their report considering public–private partnerships in the United States.

In terms of academic–industry collaboration in the media industries, Holt (2013) considers industry engagement in support of 'screen studies' in a variety of contexts although actual production itself is not considered. The benefits of students experiencing production work in a realistic group setting has been explored in a range of contexts such as core curriculum design, e.g. Pfaff and Wilks (1977) and Sabal (2009), media-specific work placements, e.g. Allen et al. (2012) and Berger, Wardle, and Zezulkova (2013), and integration of the two, cf., Collis (2010). Ashton details other related studies in his consideration of the relationship between higher education and the creative industries labour market (Ashton 2016, 269). However, there is currently no literature that considers collaboration between academia and industry specifically for feature film production either with or without student involvement. This paper seeks to fill that gap.

Benefits of collaboration for media production

The case for collaboration between universities and industry for media production is different to that for the sciences. While there may be some research-derived technologies or methods that could be beneficial to commercial media producers, the majority of benefits are arguably more pragmatic.

Universities can offer industry access to:

(1) Cost-effective facilities and equipment. With the demand for media production-related courses increasing and the cost of equipment falling, many universities now have professional-level facilities rivalling those commonly found in industry.[3]
(2) New funding sources not normally available to industry. For example, in the UK, these include Knowledge Transfer Partnerships supported by Innovate UK and research funding councils as well as production support through grants from the Arts and Humanities Research Council.
(3) Motivated, competent and inexpensive labour through students and recent graduates.
(4) Specialist expertise in the form of academic staff that might otherwise be difficult to source or expensive to secure.

Industry can offer universities:

(1) Additional income including a means to generate revenue from facilities and equipment during 'down time'.
(2) Enhanced student experiences by providing unique access to professionals and 'real world' production opportunities
(3) Enhanced publicity, given the often high-profile nature of film production marketing, benefitting recruitment, demonstrating impact and furthering other university objectives.

University as film production company with 'Soft' investment

This model represents the most common form of academic–industry collaboration for the creation of feature films. Here, the academic institution provides 'soft' support (i.e. no direct financial commitment) through mechanisms such as: allowing staff with relevant expertise to participate in projects, providing use of production equipment or access to specialist facilities and/or enabling the involvement of current students or recent graduates in production on a formalised basis. The use of 'production company' here is to suggest that the projects could not have been undertaken (at least in the form that they were) without the support of the academic institution even though there was no explicit financial investment. Essentially this is akin to a film industry coproduction model with investment 'in-kind'. On the most basic level, this involves institutional support of a member of staff who is central to the creation of a feature film project.

One of the simplest examples is Denial (2016), a $10M US–UK coproduction starring Rachel Weisz, which was lightly supported by Emory University in the US. Here, Deborah Lipstadt, the author of the book on which the film is based, one of the screenwriters and a Professor at Emory, was given time off to participate in the project. The university served as a location for part of the film, students were given basic work experience (primarily as extras) and Russ Krasnoff, the film's producer, held a Masterclass for Emory's film and media students (Williams 2016). In this instance, assistance provided by the university was comparatively minimal yet the project could not have proceeded in the manner it did without its consent given the nature of Lipstadt's involvement. The collaboration was mutually beneficial as the university gained appreciable publicity and the commercial production company gained access to an essential production person as well as a cost-effective location.

More often this model is realised as a type of 'research by practice'. In some instances, particularly in the United Kingdom, these projects can help to fulfil requirements for research outputs although institutional acceptance of this varies (Mateer 2015). Given the goal of commercial release in some form, publicity and student involvement are sometimes seen as higher priorities. In any case, an academic is the principal project driver. While the degree of institutional involvement can vary markedly, it is always seen as essential to the project's creation. Below are various examples based on this approach. All had in-kind support from the academic institution, were funded externally and involved students in production roles:

- High Tide (2015) was directed by Jimmy Hay, a Lecturer at Swansea University in the UK and crowdsource funded. Students reported that their involvement in the project subsequently led to industry work (Swansea University 2015).
- Laurence (2016) was produced by Sharon Teo-Gooding and co-written and co-directed by Richard Endacott, both Associate Professors at the University of Nebraska at Lincoln in the US. A significant number of students were involved in secondary support roles, e.g. key grip, best boy electrician, assistant editor, etc. (University of Nebraska 2017)
- Brown Willy (2016), directed by Associate Lecturer Brett Harvey (Falmouth 2016a), and Wilderness (2017), written by Senior Lecturer Neil Fox (Falmouth 2016b), were both supported by Falmouth University in the UK and had a specific goal of introducing students to professional film production through a 'real world' setting.

There are other instances of 'research by practice' in filmmaking that involve different approaches to production outside of collaborative models.[4]

The model of 'University as Film Production Company with 'Soft' Investment' can also take the shape of a formal course offering in feature film production where the films produced have some form of commercial release. For example, Bath Spa University in the UK and Filmbase in Ireland offer dedicated Masters programmes. These courses typically involve tutors who have industry experience and thus essentially serve as liaisons to facilitate industry access. The academic institution provides infrastructural support in terms of basic equipment, facilities and supervision, with additional production funding coming from external sources often via 'crowdsource' funding. These courses are marketed as a more direct means for graduates to enter the industry. Filmbase's programme, which was originally validated by Staffordshire University and is presently by the University of Western Scotland, is one of the longest running using this model and has supported several films with commercial release including *Keys to the City* (2012), *Light of Day* (2014), Fading Away (2015), Monged (2015), The Randomer (2016) and Writing Home

(2017). Their films *How to be Happy* (2013) and Poison Pen (2014) are particularly notable as they also enjoyed festival success. It is interesting to note that various new programmes focusing on the development of feature film projects, such as those offered by Bournemouth University and Birmingham City University in the UK, are beginning to emerge. It is not yet clear whether projects developed as part of these courses will ultimately be produced in a related manner.

Rather than offering full degree programmes, a number of academic institutions, such as the London Film Academy in the UK and Fairleigh Dickenson University in the US, are offering shorter courses specifically geared toward feature film production. Fairleigh Dickenson's Summer Feature Film programme is particularly notable as it has generated several projects including Favorite Son (2008), Dark Tarot (2014) and Stray 2015) that have had commercial release. Whereas development of the projects at Fairleigh Dickenson and the London Film Academy was driven by academic staff, *Hell at Heathridge* (2013) was developed specifically as part of a course in the School of Journalism and Mass Communication at Kent State University. More than 50 students were involved in developing and producing the project, which was written by a former student and funded via Kickstarter. The goal of the initiative was to 'give students a taste of the real-world film industry' (Kent State University n.d.). Interestingly, despite the project not achieving it crowd-funding objectives, it was still completed although it is unclear whether funding was obtained through other means or whether the scope of the project was reduced.

Some academic programmes that are not specifically dedicated to feature films still facilitate their production on a 'soft' basis. For example, INCINE in Ecuador has supported the transition of students in the final year of their studies to the industry through supporting feature film development through their OUTCINE initiative. Camilo Luzuriaga explains:

> Graduates start developing their feature projects during their fourth and last year of studies. Once they are graduates, a commission of three teachers […] keep track on the developing of the projects, through monthly meetings with the writers and producers of the projects, who have to be necessarily INCINE graduates. We help and support them to send the projects for funding. The project that gets the cash funding receives the OUTCINE support with equipment, transportation, wardrobe, props and other production and post production facilities. (E-mail interview. August 13, 2012)

Distante cercanía, la ley del más vivo (2013) is one example of an INCINE-supported project with international release. In Italy, the Milano Scuola di Cinema e Televisione has also been involved in a similar approach to the development of projects for theatrically released feature films. This involved professional production companies working with recent graduates and current students although specific details were not made available (Bianco, E-mail interview July 6, 2012).

The most complex implementations of the 'University as Film Production Company' involve an intermediary entity that serves as a bridge between the academic and industry partners. The majority of these involve institutional investment (discussed in detail below) but there is one collaboration of note involving 'soft' cost. In the US, the University of Pittsburgh is involved with the commercial production company Two Kids and a Camera through a joint venture known as the Steeltown Film Lab (n.d.), part of the non-profit Steeltown Entertainment Project. This collaboration was driven by industry veteran Carl Kurlander, who is now a Senior Lecturer at the university, and Demetrius Wren a visiting Assistant

Professor and up-and-coming filmmaker. Steeltown Film Lab's first project, *The Rehabilitation of the Hill* (2018), completed principal photography in 2017 and is due for release the following year. As Fike and Dyer (2017) report, the primary goal of the project is to facilitate 'a collaboration that merges film studies with film production' by putting 'students alongside film professionals and talent from the community both in front of and behind the camera. Students assume junior roles in which they learn about costumes, directing, lighting, sound and other aspects of filmmaking.' Wren notes (quoted in Fike and Dyer 2017), 'These kinds of experiences are meant to teach and prepare […] and give people professional credit to open the door to opportunity.' As will be shown in the following section, the collaboration is effectively a fully commercial partnership although it differs from the 'hard investment' model in that it is solely dependent on funding from sources outside of both organisations (primarily public donations).

University as film production company with 'Hard' investment

In this model, the academic institution provides a 'hard' investment (i.e. cash) as well as providing other resources 'in-kind'. Because there is a financial commitment, there is an expectation of return in some form, usually through profit but occasionally this is measured in other ways (e.g. increased institutional awareness, increased recruitment, increased donations, etc.) This also means that the risks to the academic institution are significantly higher than those in the other collaboration models. Often the institution establishes some form of formal commercial entity through which film projects are produced, with industry involvement taking more of a supporting role in areas such as casting, marketing or distribution.

Some implementations of this model are comparatively simple, particularly when feature film production aligns with other institutional objectives. For example, Regent University and Liberty University are both faith-based institutions in the United States that consider the promotion of their beliefs as an important aspect of their activities. Both have invested significant amounts in the creation of commercial feature films involving name Hollywood talent as well as staff and students from their institutions.

In-Lawfully Yours (2016) is a light romantic comedy that stars US television stalwarts Marilu Henner (known for the hit comedy *Taxi*) and Corbin Bernsen (star of *L.A. Law*) and was produced by Regent University reportedly for \$625 K. Mitch Land, Dean of the School of Communication & The Arts, served as the Executive Producer with more than 80 students involved in the project (Regent University 2016). High-profile televangelist Pat Robertson is the CEO of Regent University and promoted the film through his show *The 700 Club*, which airs in 138 countries and claims a viewership of over 300M people (CBN, n.d.). However, despite the high visibility of the project among its target audience and a 'name' cast, the film has grossed just under \$70 K in one year of release (The Numbers, n.d. b).

Liberty University touts *Extraordinary* (2017) as the first 'feature film created by a university film program [released] in movie theaters nationwide.' (Liberty News 2017). The \$2M film is based on the true story of one of Liberty's professors and stars Kirk Cameron, a long-established US TV actor. It screened in 400 US cinemas in September of 2017. The President of Liberty University is Jerry Falwell, another high-profile televangelist. Again, students were involved significantly in production and the project clearly had a secondary objective to raise the profile of Liberty's film school. Whereas Regent's project was intended to serve as more of a crossover project involving religious themes, *Extraordinary* is more specifically evangelically focused. As of this writing no data are available to consider the film's financial performance but, based on the performance of similar titles, it would seem that the film is unlikely to recoup costs. Considering the faith-based nature of both institutions, it would seem that the return on investment from these projects is not being considered strictly in terms of revenue but rather in other ways.

Academic institutions where faith is not an emphasis have also utilised the 'hard investment' production company model for feature film production. The University of Missouri-Columbia in the US (known as MU) has produced a number of projects starting in 2005 through a collaboration between their Computer Science and Film Studies departments that enabled engineering and film students the opportunity to work alongside industry professionals in supporting production roles. The projects utilised postproduction facilities at the university and have been financed in part by MU's Interdisciplinary Innovation Fund (MERIC 2008; Wiese-Fales 2011). Two examples are *Mil Mascaras vs. the Aztec Mummy* (2007) and *Academy of Doom* (2008), 'Lucha Libre' themed films that were produced through MU's Project IT production company and involved Chip Gubera, an instructor in the Computer Science department, as the films' director with Jeff Uhlmann, an Associate Professor of Computer Science, as the writer of both. The projects were co-produced with local professional companies including Osmium Entertainment and Boster Castle, and involved students working in various crew roles. *Mil Mascaras vs. the Aztec Mummy* had a budget of $900 K though the majority of funding came from external sources; financial information for *Academy of Doom* is not available. Both were distributed by Monogram Releasing with limited theatrical and DVD release. MU's most recent project is Aztec Revenge (2015) is a lower budget ($20 K) follow-up film produced by Uhlmann working again with Boster Castle.

Point Park University in the US has sought out academic–industry collaborations specifically to 'expand its cinema and digital arts offerings to a wider array of students who have the desire to forge a career in the entertainment industry' (Point Park University 2014a). In addition to its collaboration with the US cable television network STARZ in producing *The Chair* (Point Park University 2014b), Point Park has produced three feature films including *The Umbrella Man* (2016), which was directed by veteran director Michael Grasso, produced by experienced television producer Philipp Barnett and supported by Point Park staff, students and alumni. While specific budget information is scarce, the film has been reported as 'low budget' and it is possible to speculate that it is roughly consistent with their previous projects Not Cool (2014) and Hollidaysburg (2014), both of which are reported to have budgets of $800 K (IMDB Pro, n.d.). While there is no financial information available for *The Umbrella Man*, both *Not Cool* and *Hollidaysburg* have not performed particularly well with revenue reports of $96 K and $4 K respectively (The Numbers, n.d. a). It is unclear how much production funding comes from the collaboration with STARZ but these figures suggest there are questions surrounding financial viability given the returns are so low.

Arguably the largest and most aggressive approach to the 'University as Production Company' model was attempted by the University of Texas at Austin. Through the creation of a new University of Texas Film Institute (known as UTFI) and a for-profit spin-out company, Burnt Orange Productions, the university planned to produce 'eight to 10 high-quality, low-budget independent feature films during its first three years of operation' (UT News 2003). Interestingly, as a public university UT is not able legally own a for-profit company but was able to circumvent this by establishing the non-profit Communication Foundation as an external bridging body to support for-profit activity (Daily Texan 2013) – the relevance of this is discussed shortly. The scale of the ambition was remarkable:

> Burnt Orange Productions will produce two types of films: co-productions involving third-party financing and outside talent in key creative roles, and in-house productions featuring students and faculty in key creative roles. Co-productions – ranging from $1 to $3 million – will be shot either on film or in digital format and will be marketed and distributed by third-party financing companies. Co-productions will be green-lit based on distribution prospects. Burnt Orange's in-house productions – ranging from $500,000 to $1 million – will be shot in digital format and will be marketed by Burnt Orange Productions. (UT News 2003)

In total, over $3M of private equity financing was raised to cover production and other related costs (Schatz, personal interview, October 29, 2008). Experienced independent film producer and Alive Films founder Carolyn Pfeiffer was brought in to run Burnt Orange. She quickly established a network of UT alumni working in Hollywood, including agents at CAA, to help package and support productions.

The first film to emerge from the initiative was The *Quiet* (2005), starring Hollywood actors Elisha Cuthbert and Edie Falco, with a production budget of $900 K. It involved over 50 UT students and recent graduates with experienced industry crew (often UT alumni) serving in key roles. It was picked up by Sony Pictures Classics and screened at over 300 theatres but only grossed $380 K across all platforms.

Whereas the first project had significant industry involvement, the second, The *Cassidy Kids* (2006) involved relatively unknown actors (including a young Judah Freidlander, before the hit show *30 Rock*) and had students (over 60) serving as crew and undertaking the majority of key roles. Although official budget figures are not available, it is speculated that it was at least $300 K. After limited festival success, it struggled to find distribution and, although it aired on the Independent Film Channel, did not generate any significant revenue (Schatz, personal interview, October 29, 2008).

Schatz described the third project, *Homo Erectus* (2007) as 'more of a project for hire' (Homo Erectus 2007). Budgeted at over $1.1M and directed by Adam Rifkin, best known for Hollywood projects *Mousehunt, Small Soldiers* and *The Chase*, this project was intended to specifically generate revenue for Burnt Orange. The film was picked up by a distributor as a direct-to-DVD project and rebranded as *National Lampoon's Homo Erectus* (to utilise the name recognition of the high-profile humour magazine), which generated a large pre-release order of 220,000 copies. Yet despite this, the film did not perform particularly well and it was speculated that investors would be lucky to recoup their investment. Schatz expressed disappointment with the project saying that it was not worthwhile pedagogically and poorly placed in terms of budget to be cost-effective; it would be the last of the 'big budget' UTFI productions (Homo Erectus 2007).

UTFI produced two more projects. *Elvis and Annabelle* (2007) had the lowest budget to date at $240,000. Although Burnt Orange handled commercial aspects of the film, it did not provide funding. As with the first two projects, over 50 students were involved and there was some 'name' cast, including Joe Mantegna, Mary Steenburgen, Keith Carradine and a young Blake Lively. *Dance with the One* (2010) was produced in a similar way at a comparable level but the cast was almost completely unknown. Neither film was able to secure significant distribution and thus did not generate sufficient revenue for UTFI to be sustainable. Schatz noted that the economic downturn of the late noughties coupled with cuts at the University of Texas meant that UTFI had to be put on hold indefinitely (E-mail interview, September 10, 2010). He speculated the model could work if viable distribution mechanisms were found stating, 'I remain convinced that [academic-industry production collaborations are] something films schools should be pursuing. Although original cable programming may make more sense these days than theatrical features' (Schatz, E-mail interview, September 10, 2010).

A 2013 article in UT's newspaper *The Daily Texan* considering the *Homo Erectus* project, reported that a review of the accounts for the Communications Foundation, the non-profit bridging entity that enabled the university to have financial dealings with Burnt Orange Productions, showed that it 'registered consistent negative balance of more than $760,000 on its tax forms since filmmaking ended' (*Daily Texan* 2013). The article went on to note,

> By writing off its losses, the foundation registered a positive balance on its 2012 tax return of $22,000, but how those funds will be spent and whether or not the organization has any potential as a vehicle for funding at the University of Texas remains to be seen. Should *Homo Erectus* and a filmmaking company described as a 'sinkhole' for private and public money be a part of the mission of higher education? Many students involved directly in the project say 'yes,' because the foundation provided them with valuable learning experience. One student told the Texan, 'The main long-term benefit I received was working with high quality material.' (*Daily Texan* 2013)

Interestingly, despite the well-publicised negative experience of the University of Texas, Chapman University, a private institution based in Southern California, adopted a similar approach to feature film production through the creation of Chapman Filmed Entertainment (CFE) in 2013 (Fernandez 2012). Like Burnt Orange, CFE was set up as a 'launching pad' for students to enter the industry by working alongside professionals on projects with budgets ranging from $250 K to $1M.[5] Although they have publicly stated the ambition to produce four to six films per year, only one – *The Barber* (2014) – has been completed and released. The thriller stars Scott Glenn and includes other name cast but, as with UTFI, crew roles were undertaken by students and alumni. Budget figures are not available but it has been classed as 'low budget' by the trade press. US distribution rights were purchased by ARC Entertainment for 'mid-six figures' (McNary 2014), and revenue figures show income of just under $800 K, which suggests the film has likely come close to recouping costs. Although another project, *Ride Share*, is listed as being in development, there is no information later than 2016 so it is unclear whether CFE is still active in producing films. This is an area for further exploration.

Outside of the United States there have also been various examples of academic institutions creating and investing in feature films with the goal of commercial release. In Israel, the Sam Speigel Film and Television School collaborated with Channel 2 TV for *Miss Entebbe* (2003), which also had funding from the Jerusalem Fund and the Israeli Lottery Fund. All crew members were graduates or current students and equipment was provided by the school. The film played in more than fifty festivals worldwide and won a 'Crystal Bear – Special Mention' award at the Berlin International Film Festival. Yet, despite the significant recognition, the film only generated limited revenue and the school did not recoup the $250 K investment (Shahar, E-mail interview, July 23, 2012).

Sandcastle (2010) was produced by at the Puttnam School of Film at the Lasalle College of the Arts in Singapore. The film had a budget of $330 K and was directed by Junfeng Boo, a recent graduate of the programme. It secured international distribution after being nominated for both the 'Critics Week Grand Prize' and 'Golden Camera Award' at the Cannes Film Festival. Total revenues generated are not available but the school indicated that they were satisfied with the project and were looking to expand the approach:

> We do have [further] ambitions of indeed collaborating in the creation of a commercial project, where the incubator will coproduce a feature film. […] The incubator will secure shares in the film by providing equipment for the production. (Snaer, E-mail interview, September 13, 2012)

In the United Kingdom, the Met Film School has actively engaged with industry through its Met Film Production (MFP) arm since 2007. Jonny Persey, Chief Executive of Met Film notes, 'We pride ourselves on blurring the boundaries between education and industry […] *Town of Runners* is a great example' (E-mail interview, August 18, 2012). *Town of Runners* (2012) originated with an idea that Dan Demissie (then a student) brought to Al Morrow, Head of Documentary for the school, who helped to turn the idea into a feature film that was produced through MFP with the two acting as producers (E-mail interview, August 17, 2012). Although financial information is not available, the film played in numerous festivals internationally. More recently, MFP projects including the documentaries *How to Change the World* (2015), which grossed just over $170 K and *Sour Grapes* (2016), which grossed $25 K (both of which were produced by Morrow) and the comedy *Swimming with Men* (due for completion in 2018), which features British stars including Charlotte Riley, Rupert Graves, Jane Horrocks and comedian Rob Brydon, have been showcased by Met Film School as just a few of the collaborative industry projects produced by MFP that have enabled their students to 'cut their teeth on real industry projects' (Met Film School, n.d.).

The largest of the international initiatives appears to be the collaboration between Australia's Griffith Film School and Visionquest for *Bullets for the Dead* (2015). This project was facilitated through Live Lab, the commercial arm of Griffith that was founded in 2010 that also includes industry-standard production facilities (Live Lab, n.d.). The adventure comedy had a budget of $2M and secured distribution through GSP Studios International, who had previous involvement with academic–industry feature film collaborations (detailed below). There is no revenue data available presently but Griffith has seen the collaboration as a success:

> We are now Australia's largest film school and […] we want to give our students the opportunity to work on long-form films and open up opportunities for industry collaboration. […] Film schools have a vital role to play in preparing students to take on these roles [and collaborations with industry are part of that]. (Herman van Eyken, Head of Griffith Film School, in Crossen 2016)

It is evident that investment into production companies by academic institutions to facilitate collaborations with the film industry carries an appreciable level of uncertainty and risk. Yet, as some of the examples above show, these relationships can be beneficial if the objectives of those involved are well aligned to the likely outcomes.

University as film production service provider

In this model of academic–industry collaboration, the commercial partner initiates, funds and drives the project with the university partner only providing logistical or infrastructural support. Typically this involves the industry production company using university equipment or facilities in support of production or postproduction. Industry personnel serve in key roles with student involvement generally limited to shorter-term crew positions or work placements. If the resources needed by the commercial partner have already been procured by the academic institution to support other activities (e.g. teaching or research), this model represents the lowest risk as access can be controlled so that commercial activities only take place in quiet periods. From a university perspective, this arrangement can be a means to enhance the student experience through access to 'real world' projects, not to mention generating revenue from equipment that might otherwise sit idle. Given the significant investment many institutions have made in their departments (as noted above), this prospect can be highly attractive. However, culture clashes and differing expectations between partners can mean that enabling this type of collaboration is not always straightforward.

Because of the highly variable nature involved with this type of partnership and, in some instances, a need to preserve confidentiality, gaining a true picture of how many institutions are involved in a 'service provider' model and obtaining specific project information is challenging. Below are three examples of different types of engagement that are felt to be indicative of workings and challenges associated with this form of collaboration.

The National Film and Television School in the UK has been actively involved in these types of joint ventures ('JVs') for a number of years and has seen this as vital to its students. Citing commercial sensitivities, they were unable to share specific project or collaborator information but did note that:

> … some JV's are one offs while others last several years […] We are running between 5 and 10 JVs each year. In general they are extra-curricular and are aimed at very recent grads as well as final year students. They are not done for profit at all […] but to give students industry credits and experience they can put on their CV's. […] The underlying business model for most of the JVs is we put up the facilities and crew and the commercial partner puts up the cash budget. (Powell, E-mail interview, August 31, 2012)

In some instances the 'service provider' model can involve investment from the academic partner if the expenditure can be seen to have other benefits. An extreme example of this is the partnership between Carnegie-Mellon University (CMU) and 31st Street Studios in Pittsburgh, Pennsylvania. CMU has had a history of engagement with Hollywood studios dating back to the late 1990s, when Randy Pausch and Don Marinelli established the Entertainment Technology Center (ETC), a new department at the university focused on advanced interactive games (Pausch and Marinelli 2007); Pausch had been a consultant for Walt Disney Imagineering Research & Development, a Disney studios subsidiary, since 1996 (Pausch 2011). In 2012, Marinelli brokered a deal with local Pittsburgh film studio 31st Street Studios and Paramount On-Location whereby CMU would commit a significant investment (believed to be seven figures) into purchasing a Knight Vision motion capture system (D. Davidson, personal interview, July 11, 2012). Knight Vision was originally developed to support production of James Cameron's *Avatar* and this was to be the only such system on the US East Coast. Specifics are scarce, but it is understood that the deal was structured such that CMU was to receive a percentage of all revenue generated from 31st Studios renting out the system, with the investment being recouped over several years (D. Davidson, personal interview, July 11, 2012). One of the driving factors was an opportunity spotted with the production of *Avatar 2*, which was seen as likely using all Knight Vision capacity thus driving clients to Pittsburgh to do production with the system (Schooley 2012). CMU's objective was to have students (all on Masters courses in ETC) trained in the operation of the system then have them work on projects coming into the studio. Initially this was to be on an ad-hoc basis although the ultimate objective was to have these placements integrated into the curriculum (D. Davidson, personal interview, July 11, 2012). The collaboration was touted as enabling 'The best film and video production facility for movies outside of Southern California' (Rodgers 2012). However, 31st Street Studios encountered financial difficulties and the deal was put on hold in 2013; by 2016, it was facing foreclosure (Van Osdol 2016). As of this writing, the studio has survived and is continuing business although there is no evidence of the ETC collaboration. It is unclear whether CMU lost any of its investment.

In contrast to Carnegie-Mellon's highly ambitious, high-profile attempt at a 'service provider' model, film industry collaborations at the University of York in the UK have been much more low key yet enabled support of a significant number of commercial film projects.[6] The first project, *The Christmas Miracle of Jonathan Toomey* (2007), produced by Bauer-Martinez for MGM Studios and starring Joely Richardson and Tom Berenger, came to the university almost by accident. Kit Monkman, Visual Effects Supervisor for the film, approached the author of this article whom he had known as part of a regional creative network. Monkman had been tasked with creating composites for a small number of 'blue screen' shots for the film and was looking for students to support creation of the required scenes as well as office space for the team. The author, then a lecturer in the Department of Electronics, identified a team of five students for Monkman and his associate Tom Wexler to train, and also arranged facilities on the university's Science Park (University of York 2006). Seeing the quality of work produced by the students, the producers were impressed and the 'handful' of shots became 40,000 frames of compositing work. The project was deemed a success: students gained invaluable paid work experience (two went directly to VFX jobs in London), the University gained good publicity and the production company saved money while not sacrificing quality.

The benefits of that collaboration were noted during the development of York's new Department of Theatre, Film and Television (TFTV). Part of the funding for the department came from the European Regional Development Fund. Conditions of this funding stipulated that the department had to facilitate a number a business 'assists', supporting local companies to add value to the regional economy. Considering the collaboration for *The Christmas Miracle of Jonathan Toomey* and several other factors, the university took the view that the ERDF requirements could be met by providing production and post-production support to film and television projects. This required increased investment in high-end equipment and facilities in keeping with industry needs; however, it was also felt that there would be a 'trickle down effect' as students would benefit from access to both industry-standard equipment and professionals through live projects.

TFTV opened its new building in late 2010 and created a 'commercial arm', Heslington Studios (HS), soon after to provide production and postproduction support to commercial clients (University of York 2012a). It was envisioned that this support would involve student work placements and, in some instances, paid crew positions wherever possible. HS supported a range of broadcast clients, including sound mixing for the BBC series *In the Club* and *The Syndicate* as well as postproduction support for Channel 4′s *Location, Location, Location*, but its main client was Green Screen Productions (GSP), a feature film production company established by indie film veterans Alan Latham and Tom Mattinson was well as Monkman, all of whom had been involved in the *Toomey* project. The author brokered an 'umbrella agreement' between the company and HS that enabled priority access to TFTV facilities out-of-hours. It stipulated that there would be a minimum of five large-scale films per year, primarily produced with HS resources, brought to the department from GSP, for which a minimum fee would be paid to HS for each as well as small profit-share (University of York 2012b).

The first project was *The Knife That Killed Me* (2014), an experimental feature film backed by Universal Pictures UK that was seen as a 'flagship' project for GSP. Monkman and theatre director Marcus Romer co-directed the film with Latham and Mattinson producing (the author was one of the films executive producers and also was the VFX producer). The £3M film was based on the best-selling teen book and featured a highly stylised look, being shot on green screen with all setting created through CGI. What was particularly novel was that, apart from the author, all of the visual effects team were recent TFTV graduates, all of whom were on staff with GSP and paid full industry salaries. The VFX team was housed in the TFTV building itself and made use of all of its facilities. While the film achieved some strong reviews, including being named '10th Best Film of 2014' by the *Huffington Post* (Crow 2014) and receiving a four-star rating in *The Times* (Ide 2014), Universal did not see value in marketing it heavily and the film obtained only limited release. As a result, the film generated minimal revenue.

During the production of *The Knife That Killed Me*, senior department staff became worried that GSP was not bringing in the number of large-scale projects promised in the agreement. There were several projects that involved low-level support such as basic sound mixing or picture finishing, including *Entity* (2012) starring Dervla Kerwin and *Sparks and Embers* (2015) with Chris Marshall, but these did not yield the income the department expected. At times payment from GSP was late and there was tension between the uncertain culture of independent filmmaking and the regularity required by academia.

In 2016, department senior management reconsidered whether Heslington Studios was really cost-effective, given its two dedicated full-time members of staff, particularly since ERDF requirements had been met. It decided to disband the company and conduct industry engagement directly through the department. Somewhat surprisingly, central to this plan was creating an exclusive arrangement with Green Screen Productions, which had now created a new company, GSP Studios, that also included a distribution arm. The 'umbrella agreement' was reworked to both better reflect the actual level of production and enable exclusivity but also tighten payment requirements. A number of other films were supported from that point including Bliss! (2016), *Dusty & Me* (2016), *Mad to be Normal* (2017) with David Tenant and Elizabeth Moss, *In Extremis* (2017) and John Hurt's last film, *That Good Night* (2017). During this time GSP developed and produced Macbeth (2018), its second 'flagship' film. This project utilised the green screen production model as well as the same key personnel as *The Knife That Killed Me*, including a now-expanded VFX team involving more graduates and the addition of Prof Judith Buchanan as the screenwriter, with Monkman being the sole director. During its completion, Green

Screen Productions, the original production company established by Latham, got into tax trouble with the UK government and was forced to cease trading in late 2016. While this did not directly affect *Macbeth* or TFTV's agreement with GSP Studios (which was a separate entity), the formal agreement was ended in mid-2017 although some collaboration continues on an ad-hoc basis. GSP Studios merged with Goldfinch Entertainment in late 2017 but still has offices and a studio complex in Yorkshire.

Despite these ups and downs, the overall collaboration has been viewed as a success as it generated over 20 full-time jobs for TFTV graduates (14 of which have continued with Viridian VFX, the new company born out of the merger with Goldfinch), a substantial number of work placement opportunities for TFTV students, and appreciable revenue to the department although not at the levels originally hoped.

Conclusions

The range of experiences detailed in the examples above show the opportunities and challenges involved in academic–industry collaborations for feature film production irrespective of the model used. Each approach can be seen as workable but both partners, particularly those on the academic side, need to consider the nature of engagement in terms of how it directly relates to their overall institutional objectives. If these are closely aligned, the likelihood of success is demonstrably greater. However, if either side has unrealistic expectations, it is clear that few benefits will be realised and, indeed, such partnerships can prove to be expensive. Clearly these types of collaborations are evolving and the ability to conduct them is becoming increasingly fluid, particularly with increased support (and pressure) from government. However, looking at the revenue generated by even the most successful of these projects, it is evident that benefits need to be considered using other measures. While academic–industry collaborations for feature film production usually do not represent 'The Sting', it is clear they also do not yield 'A Fistful of Dollars'.

Notes

1. Petrie and Stoneman (2014) provide a comprehensive overview of the development of film schools worldwide.
2. Financial information should be seen as indicative unless otherwise stated. In most instances, it has not been possible to verify whether budgets listed are 'cost' (i.e., actual expenditure only) or 'cash-equivalent' (i.e., actual expenditure plus the value of all in-kind services)
3. The University of Salford (n.d.) and Birmingham City University (n.d.) in the UK, and Chapman University (n.d.) and Florida State University (n.d.) in the US, are but four recent examples of academic institutions committing significant investment in facilities to support their media production-related programmes.
4. The Filmmaking Research Network, led by Joanna Callaghan and Susan Kerrigan, was designed in part to document the range of filmmaking projects involved in 'research by practice' through a register of films (FRN, n.d.).
5. It should be noted that, as a private university, Chapman is not subject to the same regulatory issues involved in public-private partnerships as the University of Texas, which is a public institution.
6. It is important to note that the author was directly involved in many of the projects at York so much of the information provided in this section is first hand although additional sources have been included wherever possible.

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John Mateer has been working in film and TV for over 30 years and as an academic for over 15. He recently worked on feature films *The Knife That Killed Me* (Universal Pictures UK) as Executive Producer and *Macbeth* (GSP Studios) as Visual Effects Producer. He was a founding member of the department of Theatre, Film and Television and helped to establish its industry engagement strategy.

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Academic-Industry Collaboration for Commercial Film and Television Production: an exploration of case studies

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Abstract

Over the past decade, new types of academic-industry collaborations for commercial film and television production have emerged that aim to help the university partner enhance vocational relevance of their programmes and the industry partner to both find and nurture new talent as well as enable more cost-effective means of production. Building on previous work, this paper considers two collaborative models: *University as 'Production Partner'* and *University as 'Service Provider'*. It presents an overview of case studies from a range of collaborations worldwide considering how these partnerships were structured, how stakeholder needs were considered, the benefit to students and graduates, and overall project effectiveness. It then looks in detail at the collaboration between the University of York, UK, and Green Screen Productions Ltd. for the creation of the feature film, *The Knife That Killed Me* (2014), backed by Universal Pictures UK. Findings suggest that both models are viable but that partners, particularly academic, must understand the nature of engagement in terms of how it relates to their institutional objectives to maximise benefit. It is suggested that these types of collaborations can be utilised in any industrial media setting globally so long as there is careful consideration of the needs and expectations of all participants.

Keywords: academic–industry collaboration, public–private partnerships, feature film production, television production, media business models

Academic-Industry Collaboration for Commercial Film and Television Production

University film and television production courses have long been seen as a primary source of the industry's next generation of creative and technical talent[1]. But with growing numbers of students and greater competition in the sector, institutions have had to find novel ways to make their programmes stand out as well as to ensure their vocational relevance to a changing industry. Many universities have looked to include working practitioners in the support and delivery of courses to address these issues[2]. Indeed, the involvement of industry in informing higher education is increasingly being seen as important, as reflected in government-industry accreditation schemes such as ScreenSkills in the United Kingdom (ScreenSkills, n.d.). The availability of work experience opportunities or industry placements for students is now regarded as a required component of most taught programmes. However, with an increasing number of film and television courses being offered, providing these opportunities has become challenging as more institutions compete for a finite number of places.

Relatedly, the film and television industry is experiencing an arguably unprecedented period of change. Production companies are facing economic pressure from an over-saturated marketplace as well as changes to long established revenue streams as a result of 'digital disruption' – DeFillippi & Wikström (2014) and Holt & Sanson (2013) provide good overviews and analysis. Traditional television commissions and associated budgets have been decreasing at an appreciable rate over the last five years – Williams, C. (2019), Deen (2018) and Glennie (2015) document this clearly for the UK – and feature film budget levels are becoming polarised with the studios increasing reliance on 'tent pole' films and independent film shifting to 'no to low budget' models to be profitable – Fellows (2017)

[1] Petrie & Stoneman (2014) provide useful overview of the development of film schools.
[2] This has generally been effective although there have been tensions as noted in Mateer (2019).

explores this shift in detail. As a result, many production companies have been forced to find more cost-effective means of developing, creating and distributing their product.

Over the past decade, new types of academic-industry collaborations for commercial film and television production have emerged that aim to help both university and industry partners address these issues and others they face. Building on previous work, this paper considers two models in particular: *University as 'Production Partner'*, where the university and company work together in a 'co-production' capacity; and *University as 'Service Provider'*, where equipment and/or facilities are used in direct support of production or postproduction (Mateer, 2018). It provides an overview of case studies from a range of academic institutions and industry partners worldwide, including major projects in North America, South America and Europe. How these partnerships were structured, the manner in which stakeholder needs were considered, the involvement and benefit to students, and the overall effectiveness of the projects based on stated partner aims are all explored.

This paper then looks in detail at the collaboration between the University of York, UK, and Green Screen Productions Ltd. for the creation of the feature film, *The Knife That Killed Me* (2014), which was backed by Universal Pictures UK and involved the author as an Executive Producer. This particular initiative was designed specifically as a research 'test bed', utilising a series of interviews and surveys, across preproduction, production and postproduction phases, with key participants and stakeholders to systematically assess the efficacy of this type of partnership. The paper concludes with an analysis of findings from this case study, as well as others presented, to provide insight into the advantages and challenges academic-industry collaborations can present in the media sector.

Methodology

This paper draws, in part, on the author's prior work exploring academic-industry collaboration for feature film (Mateer, 2018) and expands on those findings where possible. For both the original and this article, a range of sources of information, compiled from 2008 onward, has been used. Primary sources include in-person and email-based interviews with academic and industry personnel involved in relevant collaborations. In some cases, contacts were known to the author. In others they were obtained through contact lists from film-focused university organisations including CILECT and NAHEMI; referrals were considered as well. Secondary sources include information obtained through institutional web sites as well as news and trade press. Only projects released on a commercial basis – theatrically, direct to DVD, via a commercial online service such as Netflix, Amazon, etc. – as verified by Internet Movie Database Professional (https://pro.imdb.com/) or The Numbers (http://www.the-numbers.com) have been included. Financial figures cited are based either on primary source information, data published on institutional sources or from IMDB Pro[3].

Details concerning the specific methods used for data gathering and evaluation of the academic-industry collaboration that produced *The Knife That Killed Me* are described in the section dedicated to that case study later in the article.

Models of Academic-Industry Collaboration in the Media Industries

Background

As noted in the author's initial study (Mateer, 2018), formal exploration of academic-industry collaboration in the media industries is predominantly recent. The benefits to students in undertaking production work in a realistic setting have been explored in different contexts including curriculum design (Pfaff and Wilks, 1977; Sabal, 2009), media-specific work placements (Allen et al., 2012; Berger et al., 2013), and integration of the two, cf., Collis (2010). Holt (2013) considers industry engagement in support of 'screen studies' in different contexts although physical production itself is not considered.

[3] Financial information should be seen as indicative unless otherwise stated. In most instances, it has not been possible to verify whether budgets listed are 'cost' (i.e., actual expenditure only) or 'cash-equivalent' (i.e., actual expenditure plus the value of all in-kind services).

Ashton (2016) describes related research in his examination of the relationship between higher education and the creative industries labour market.

Mateer (2018) outlined the potential benefits of academic-industry collaborations for commercial feature film production and explored a range of case studies. It also proposed that these collaborations could be categorised according to three distinct models: *University as Film Production Company with 'Soft' Investment*; *University as Film Production Company with 'Hard' Investment*; and *University as Film Production 'Service Provider'*. For the purposes of this paper, this has been simplified into two categories – *University as 'Production Partner'* and *University as 'Service Provider'*.

University as 'Production Partner'

This model represents the most common form of academic-industry collaboration for the creation of feature films or television programmes. The term 'Production Partner' is used to suggest that the projects could not have been undertaken in the manner required without the support of the academic institution. Here, the academic institution provides some form of significant resource to enable production. This support can be described as 'hard', where the university is making a direct financial investment, or 'soft', where the investment is in-kind.

There are many examples of projects involving 'soft' support though the form this takes can vary significantly. The simplest involve allowing university staff time to undertake formal production roles. *Denial* (2016), a $10M US-UK co-production starring Rachel Weisz, is a good example. Deborah Lipstadt, a Professor at Emory University in the United States, is the subject of the film and author of the book on which it is based. Emory agreed to give her time off to participate in the project if the production company would use campus as a shooting location and involve students where possible (Williams, K., 2016). As these requirements added authenticity to the production, the collaboration was straightforward to arrange and, although assistance provided by the university was comparatively minimal, the project could not have proceeded in the manner it did without its consent, given Lipstadt is central to the story.

Many instances of universities acting as 'Production Partner' with 'soft' support are focused on furthering institutional objectives rather than generating revenue. Academic staff members who have industry experience often seek to undertake 'practice as research', which is seen in several countries, including the UK and Australia, as an accepted way in which to fulfil requirements for research output[4]. Typically, these projects are produced using a mix of in-kind support from their institutions as well as funding from external sources and involve students in production roles working alongside industry professionals from both inside and outside the academic institution. Three examples are *High Tide* (2015), directed by Jimmy Hay at Swansea University, *Laurence* (2016), produced by Sharon Teo-Gooding and co-written and co-directed by Richard Endacott at the University of Nebraska at Lincoln, and *Wilderness* (2017), written by Senior Lecturer Neil Fox at Falmouth University.

Despite the academic emphasis of projects undertaken as 'practice as research', obtaining commercial release is frequently regarded as key in order to demonstrate 'impact' and audience reach, common measures of the value of research – strategies for this are explored by Mateer & Haillay (2019). Indeed, in some instances, particularly television projects, the collaboration can originate with industry commissioning, with support from the academic institution brought in after that is secured. One example of this is the highly acclaimed 2011 Al Jazeera television series *Slavery: a 21st Century Evil*, which was supported by the University of York, UK. David Hickman, then a Senior Lecturer, produced and directed three episodes with postproduction support provided through his university department. Over 35 million people viewed the series and, as a result of its airing, $3M was secured for the creation of a shelter for bonded labourers in Lahore and at least four people were known to have been freed

[4] Although institutional acceptance of film practice as research varies markedly (Mateer, 2019).

from bonded slavery. The impact was viewed as so significant that the project was chosen to be one of the university's case studies for the 2014 Research Excellence Framework (ibid).

Over the past decade a number of specialist university programmes have emerged that are specifically designed to involve students in the creation of commercial product. They include the *MA in Feature Filmmaking* at Bath Spa University and Fairleigh Dickinson University's *Summer Feature Film* programme, which has produced several projects – such as *Dark Tarot* (2014), *Stray* (2015) and *Title VII* (2017) – that have had commercial release. The *Masters Digital Feature Film Production*, run by Filmbase in Ireland, was arguably the most prolific of these programmes having supported several films with commercial release including: *Keys to the City* (2012), *How to be Happy* (2013), *Poison Pen* (2014), *Light of Day* (2014), *Fading Away* (2015), *Monged* (2015), *The Randomer* (2016) and *Writing Home* (2017). Filmbase worked closely with local industry in supporting and producing these projects but ultimately the organisation became financially unviable and folded in 2018 (Clarke, 2018)[5]. In all of these programmes, projects involved tutors with industry experience who served as liaisons to facilitate industry access and support. The academic institutions provided infrastructural support in terms of basic equipment, facilities and supervision, with additional production funding coming from external sources, including 'crowdsourced' funding (Mateer, 2018)

Although its degree programmes are not dedicated to feature film production per se, INCINE in Ecuador has supported their students in securing production support after graduation. Camilo Luzuriaga, Productor of OUTCINE, explains:

> "Graduates start developing their feature projects during their fourth and last year of studies. Once they are graduates, a commission of three teachers […] keep track on the developing of

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[5] Filmbase's final feature film, ironically titled *The Comeback* (2018), had production completed through support from the Dublin Business School (Griffin, 2018).

> the projects, through monthly meetings with the writers and producers of the projects, who have to be necessarily INCINE graduates. We help and support them to send the projects for funding. The project that gets the cash funding receives the OUTCINE support with equipment, transportation, wardrobe, props and other production and postproduction facilities." (Luzuriaga in Mateer, 2018)

The Law of the Swindler (aka. *Distante cercanía, la ley del más vivo*, 2013) remains the most high-profile of the INCINE-supported projects as it secured international release through the Australian distributor, Galloping Films. A similar approach for development of feature films has been used by the Milano Scuola di Cinema e Televisione in Italy as well, involving professional production companies working with recent graduates to develop commercially viable projects (Mateer, 2018), although it has not been possible to confirm whether these initiatives are still active.

In a related model, the University of Pittsburgh (Pitt) partnered with the commercial production company Two Kids and a Camera through a joint venture known as the Steeltown Film Lab (n.d.). This collaboration was driven by industry veteran Carl Kurlander, who became a Senior Lecturer at Pitt, and professional filmmaker Demetrius Wren. The primary objective of the collaboration was to merge academic film studies with actual film production to enhance both the educational experience and vocational relevance of their courses by having students work with industry professionals on a commercial project (Fike & Dyer, 2017). The initiative's first feature film, *The Rehabilitation of the Hill* was completed in 2018 and distributed by sister company Steeltown Entertainment. While it has gained exposure in festivals, the project's commercial success appears to be limited. Steeltown Film Lab remains active although plans for undertaking future feature film projects are unclear

Like Pitt, Point Park University, also located in Pittsburgh, looked to use academic-industry collaborations to "expand its cinema and digital arts offerings to a wider array of students who have the desire to forge a career in the entertainment industry" (Point Park University, 2014, May 21) but looked at television production as well. In 2014 it developed and produced *The Chair*, a weekly hour-long reality series, working with premium US cable and satellite network STARZ. The project was produced by Hollywood veteran Chris Moore and actor Zachary Quinto (a Pittsburgh native) and also involved Steeltown Entertainment. Over 100 Point Park students and recent graduates worked on the series in a variety of production roles with supervision from industry professionals (Point Park University, 2014, April 10). Despite solid critical reviews (Rotten Tomatoes, The Chair, n.d.), viewing figures were weak and the series only lasted on the network one season (10 episodes)[6].

Point Park also produced three feature films in conjunction with STARZ, all of which also involved Point Park staff, students and alumni working alongside established professionals. *Not Cool* (2014) and *Hollidaysburg* (2014) both utilised little known but up-and-coming talent and had budgets of approximately $800K. Neither performed very well financially with revenue reports of $140K ($35K theatrical and $105K from DVD) for *Not Cool* and less than $4K overall for *Hollidaysburg*. *The Umbrella Man* (2016), Point Park's last feature film project, was directed by veteran Michael Grasso and produced by experienced television producer Philipp Barnett. Financial information about the project is scarce but the film has been reported as 'low budget' so it is reasonable to speculate that it is roughly consistent with Point Park's previous projects. It played several festivals but did not get significant theatrical release, ultimately being placed on video-on-demand services including iTunes and Amazon after airing on STARZ. In 2017, it was picked up by Super Channel in Canada (The Umbrella Man Movie, 2017). Given this release pattern it is highly unlikely that the project recouped its costs but it has not been possible to verify this. It is speculated that the poor performance of all four projects ultimately led to the disbanding of the partnership between Point Park and STARZ.

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[6] The series was subsequently picked up by Amazon Prime and is still available.

There are several instances of more complex implementations of the *University as 'Production Partner'* model that often involve the use of an intermediary company to serve as a bridge between the academic and industry partners (Mateer, 2018). Unlike the Steeltown Film Lab collaboration, these usually involve a direct cash – or 'hard' – investment by the academic institution. Given this financial commitment, universities expect the projects to generate significant benefit, either through profit or other tangible forms (e.g., increased institutional awareness, increased recruitment, increased donations, etc.). Likewise, risks to the academic institution are significantly higher in this type of model than those where the contribution is 'soft'. The scale of these risks can be significant, as exemplified by the case of the University of Texas Film Institute (ibid.)

In 2003, the University of Texas at Austin established the University of Texas Film Institute (UTFI), which was overseen by Prof. Tom Schatz, and a for-profit spin-out company, Burnt Orange Productions, run by industry veteran Carolyn Pfeiffer. The goal was to regularly produce commercial feature films that would involve students and recent graduates in production roles working alongside establish industry professionals. The project was highly ambitious with the university planning to produce "eight to 10 high-quality, low budget independent feature films during its first three years of operation" (UT News, 2003). $3M of private equity financing was raised to cover production and other related costs (Schatz, 2008) and a total of five films were produced. The first of these, *The Quiet* (2005), starred Hollywood actors Elisha Cuthbert and Edie Falco, and involved over fifty students and recent graduates in production. The film was picked up by Sony Pictures Classics and screened in over 300 theatres, but only grossed $380K across all platforms. Given the production budget was $900K this represented a significant loss.

UTFI's second project, *The Cassidy Kids* (2006), was scaled down as a result. It involved relatively unknown actors but still had over sixty students and graduates involved in the production, this time with many in key roles. Although official budget figures are not available, it is speculated that it was at least $300K. The film struggled to find distribution and, although it was picked up for broadcast by Independent Film Channel, it did not generate any significant revenue (Schatz, 2008).

The initiative's third project, *Homo Erectus* (2007) was "more of a project for hire" with much lower student involvement (ibid). Here, the collaboration model was more along the lines of *University as 'Service Provider'* in that name industry personnel – including established director Adam Rifkin – drove production although the university still had a financial stake. Schatz indicated that the project was intended specifically to generate revenue for Burnt Orange Productions (ibid). The film was picked up as a direct-to-DVD project and rebranded as *National Lampoon's Homo Erectus* (to utilise the name recognition of the well-known humour magazine). Although there was a pre-release order of 220,000 copies, and some theatrical revenue (the film generated just under $100K worldwide), it did not recoup its $1.1M budget. Schatz expressed disappointment with the project saying that it was not worthwhile pedagogically and poorly placed in terms of budget to be cost-effective (ibid).

UTFI produced two more feature films, both of which were much smaller in scale but, unlike previous projects, Burnt Orange did not provide funding. *Elvis and Annabelle* (2007) had a budget of $240,000 and featured known actors including Joe Mantegna, Mary Steenburgen, Keith Carradine and Blake Lively. *Dance with the One* (2010) had a comparable budget but no 'name' cast. As with the first two UTFI projects, a significant number of students and recent graduates were involved in production. However, neither film was able to secure industry distribution and thus did not generate any notable revenue. The losses of these and the other UTFI films – it is estimated that Burnt Orange Productions accrued a deficit at one point of over $760K (Daily Texan, 2013) – combined with the economic downturn of the late 1990s and budget cuts at the University of Texas meant that the UTFI initiative had become unsustainable (Schatz, 2010). Despite the many issues faced, Schatz was still bullish about academic-industry collaborations even after UTFI was suspended saying, "I remain convinced that [academic-industry production collaborations are] something films schools should be pursuing. Although original cable programming may make more sense these days than theatrical features" (ibid)[7].

Chapman University, located in Orange, California, adopted a similar approach to UTFI and established Chapman Filmed Entertainment (CFE) in 2013 as a "launching pad" for students to enter the industry by working alongside professionals on projects with budgets ranging from $250K to $1M (Chapman University, n.d.). Although specific details are scarce, projects to date appeared to have been structured in a similar way to UTFI's with several Chapman students involved in key production roles working alongside industry personnel and overseen by Chapman staff – Hollywood veteran Travis Knox, who has served as Producer on all of CFE's films, is also an Associate Professor at the university. Principal financing seems to have been secured through private investment though details about how this was structured and the terms of investment are not available. Originally the initiative was similarly ambitious to UTFI's, aiming to produce four to six films per year (Dodge College, n.d.)[8], but to date, only one has been completed and released – *The Barber* (2014), starring Scott Glenn and Chris Coy. Revenue figures for the film show income of about $775K and it is unclear whether the project recouped costs. After a four-year hiatus, CFE's second project *Static* was shot in 2018 and appears to be close to completion (it is still listed as 'in postproduction' as of this writing) and two further projects are listed as 'in development' suggesting CFE's model may be beginning to work. Indeed, the initiative seems to have value to the university as it continues to feature prominently in their advertising.

Of the large-scale *University as 'Production Partner'* collaborations, those where the academic institution prioritises non-financial benefits, are arguably the most successful. Mateer (2018) described

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[7] The UTFI case is quite complex and included controversy surrounding the University of Texas Communication Foundation, the non-profit bridging entity that enabled the university to have financial dealings with Burnt Orange Productions. This has not been included here as it is not strictly relevant to this article, however, full details can be found in Mateer (2018).

[8] Subsequent press releases indicate the target is now two to three films per year (Dodge College of Film and Media Arts, 2018).

the first production initiatives at the US faith-based institutions Regent University, whose CEO is televangelist Pat Robertson, and Liberty University, whose President is Jerry Falwell, Jr., son of another famous televangelist. This section briefly reviews these and details their most recent activities. Both universities view promotion of their beliefs as a key aspect of their activities and have invested significant amounts in the creation of commercial feature films involving name Hollywood talent working alongside students and staff. Rather than create spin-out entities like UTFI or CFE, these institutions commission and fund projects internally only bringing in industry as needed to ensure production quality and raise public visibility.

Regent's first feature film project was the comedy *In-Lawfully Yours* (2016), featuring US television stars Marilu Henner and Corbin Bernsen, and was budgeted at $625K. Dean of the School of Communication & The Arts, Mitch Land, served as the film's Executive Producer and more than 80 students worked on the project in a range of production roles (Regent University, 2016). The film was promoted through Robertson's *The 700 Club* – which claims a viewership of over 300M people (CBN, n.d.) – but grossed just $120K worldwide. Despite failing to recoup costs, the university trumpeted that the project "enjoyed great success on multiple levels" and a second project, *Mary for Mayor* (2020) was commissioned for production in 2018 (Regent University, 2018). It was released in April 2020.

Liberty University states that it has produced five films through an academic-industry collaboration model but it appears only one has had commercial release. *Extraordinary* (2017), a drama starring established actors Karen Abercrombie and Kirk Cameron with a $2M budget, was touted as the first "feature film created by a university film program [released] in movie theaters nationwide" (Liberty News, 2017) having screened in 400 US cinemas. However, the film grossed only $55K. Despite this low financial performance, Liberty subsequently produced *The Trump Prophecy* (2018), a drama based on the 2017 book by Mark Taylor. Like *Extraordinary* the film also had a $2M budget and a wide North American release (in over 550 theaters) but no 'name' cast. Financial performance was notably better with theatrical revenue of over $670K and DVD income of just over $60K but this still falls well short of covering costs. In both instances, over 50 students were involved in the project working alongside both university staff and industry professionals (Smith, 2018).

Considering the income generated and the faith-based nature of Liberty and Regent, it would seem quite likely that the return on investment from these projects and value to the institutions is not being considered in terms of revenue but rather for their educational and, principally, evangelical benefits.

Academic institutions can also consider benefits in non-financial terms if all project funding is fully secured and constrained. In some instances, this can mean project support comes from an existing resource within the institution, which can inherently contain its scope. In others, financial support comes in the form of a grant without which the project (and collaboration) could not take place.

The University of Missouri-Columbia (MU) has produced feature film projects involving the Computer Science and Film Studies departments working jointly. This interdisciplinary initiative enabled engineering and film students the opportunity to work together alongside industry professionals on films financed (in part) by MU's Interdisciplinary Innovation Fund and produced through MU's Project IT production company (Wiese-Fales, 2011). These projects included *Mil Mascaras vs. the Aztec Mummy* (2007), *Academy of Doom* (2008) and *Aztec Revenge* (2015) – three 'Lucha Libre' themed films directed by Chip Gubera, Professor of Practice in the Computer Science department, written by Jeff Uhlmann, an Associate Professor of Computer Science, and co-produced with local professional companies including Osmium Entertainment and Boster Castle. Each of the films involved students working in various crew roles. The first two were budgeted at approximately $800K each and were distributed by Monogram Releasing with limited theatrical and DVD release. *Aztec Revenge* was a much smaller project with a budget of $20K and only had festival exhibition. Financial performance data for these films is scarce but it appears the initiative has been seen as a success as *Lost Treasure of Jesse James*, a new feature film collaboration involving Gubera, MU students and Boster Castle, recently completed production (Gubera, 2018) and is in postproduction at the time of writing.

Two feature film projects produced at the University of Hawaii at Manoa, *State of Aloha* (2009) and *Go For Broke* (2018) are good examples of academic-industry collaborations facilitated by external grant funding. Here both projects involved themes of heritage and cultural identity that made them eligible for state and national funding. *State of Aloha* was a documentary commissioned to commemorate Hawaii gaining US statehood. It was funded in 2004 by a $400K grant from the General Services Administration (GSA), part of the US government. Anne Misawa, an established cinematographer and producer, was hired by the university as an Associate Professor in the Academy for Creative Media (ACM) specifically to oversee the project. Production took place over a four-year period with students playing a significant role, shooting segments and conducting interviews. What is of particular note is that the project was embedded in the curriculum so students obtained credit as well as experience through working with professionals (Misawa, 2019). The film was completed in 2009 and released by the US public broadcaster PBS. The university viewed the project as highly successful, which led to ACM looking for other forms of industry collaboration (ibid)[9].

ACM's second feature film project, *Go For Broke* (2018), is a dramatized account of the formation of the United States Army's 442nd Infantry Regiment that was comprised almost exclusively of second-generation Americans of Japanese descent. The story is culturally significant in that the 442nd was the most highly decorated combat unit in World War II and changed public perception of Japanese Americans such that statehood for Hawaii became possible. Here, $200K in state grant aid was secured given the historical significance of the story. Terms of the grant required co-production so the

[9] Misawa noted challenges in cash-flow management as university systems are not designed for the rapid response required by industry so some logistical aspects were less successful.

project was explicitly set up to involve industry although Misawa again acted as Producer. Over 30 students and alumni worked as crew on the project (comprising more than half overall) with industry professionals acting as department heads. Staff from ACM, led by Misawa, oversaw the creative aspects of the project. Although the project was not intended to make money (ibid) it was successfully received at several film festivals and garnered good press reviews (Rotten Tomatoes, Go For Broke, n.d.). As with *State of Aloha*, the project was seen as a strong success by all stakeholders.

Outside of the United States there are examples of academic institutions engaged in industry collaborations acting as a 'Production Partner' with direct financial investment but these are less common. As with the models above, all involve students working alongside professionals during production. In Israel, the Sam Speigel Film and Television School collaborated with Channel 2 TV for *Miss Entebbe* (2003), which also had financial support from the Jerusalem Fund and the Israeli Lottery Fund. Despite significant festival recognition, including winning a 'Crystal Bear' award at the Berlin International Film Festival, the film only generated limited revenue and the school did not recoup the $250K investment (Shahar, 2012). In Singapore, the Puttnam School of Film at the Lasalle College of the Arts produced *Sandcastle* (2010), a feature film with a budget of $330K that was directed by Junfeng Boo. The film received several significant festival nominations, including the 'Critic's Week Grand Prize' at Cannes, and secured international distribution. Although there is no financial data available, Lasalle College was said to have been very happy with the performance of the project and was looking to expand support through an 'incubation' model (Mateer, 2018). However, it does not appear that the school has been involved with any further feature films.

Live Lab initially appeared to be one of the largest academic-industry collaboration initiatives outside of North America but its scope has changed. It was established in 2010 by the Griffith Film School in Australia as an "in-house production studio […] offering students a unique opportunity to work in industry whilst studying" (Live Lab, n.d.). Originally, feature film production was seen as a priority:

“We are now Australia’s largest film school and […] we want to give our students the opportunity to work on long-form films and open up opportunities for industry collaboration” (Herman van Eyken, Head of Griffith Film School, in Crossen, 2016).

In 2015 they produced an adventure comedy entitled *Bullets for the Dead* (2015) collaborating with VisionQuest, veteran producer Norm Wilkinson’s production company. The project had a budget of $2M and secured distribution through GSP Studios International, who had previous involvement in feature film collaborations with universities (detailed below). Although financial data is not readily available, it appears that this project did not generate enough revenue to break even and the film was Visionquest’s last. As of this writing, Live Lab is still active but the emphasis has changed such that the projects supported are now smaller in scale. The ability to partner in broadcast co-productions is still mentioned on the Live Lab web site but the majority of projects listed are short form (Live Lab, n.d.).

In the United Kingdom, both the Met Film School (MFS) and National Film and Television School (NFTS) collaborate heavily with industry. MFS launched Met Film Production (MFP), an independent production company, in 2007 two years after it relocated to Ealing Studios, the oldest commercial film studio in the world (Ealing Studios, n.d.). Jonny Persey, MFS’s Chief Executive noted that this move was by design, “We pride ourselves on blurring the boundaries between education and industry” (in Mateer, 2018). The goal was to provided production opportunities for students to “cut their teeth on real industry projects” (ibid) working on films developed and overseen by MFS staff – many of whom come from industry – and working with other professionals. Although not all of the projects MFP is involved in are academic-industry collaborations, many are. *Town of Runners* (2012), *How to Change the World* (2015) and *Sour Grapes* (2016) were all produced through MFP and overseen by Head of Documentary for MFS, Al Morrow. While the financial performance of these projects has not been strong – with reported gross revenue of $35K, $179K and $25K respectively – MFP has nonetheless been actively producing projects using this model. Most recently, they produced *Swimming with Men* (2018), which grossed over $1.4M and involved 12 recent graduates in production. Their most recent release was *Last Breath* (2019), a Netflix documentary project involving Morrow that grossed just under $30K.

Although they are not involved in feature film production, the National Film and Television School's academic-industry collaboration model is worthy of discussion as it features strong industry backing. *The Bridges to Industry* programme is specifically designed to enable short film projects pitched by recent NFTS graduates to obtain direct financial support from industry that would otherwise be exceedingly difficult to secure – both BBC Films and Channel 4 Films are involved. They provide a cash contribution to each production with all equipment and facilities being provided by NFTS. Production crew are comprised of other recent graduates and some professionals on a paid basis but at low rates to maximise budget (Wardle, 2019). The benefit to the industry partners is that they can find new talent – not only 'high-flyers' but also those who can work effectively in support roles. For NTFS, it is a means to "jump-start" the careers of their graduates, effectively serving as a "mid-point between the school and (paid industry work)" (ibid). The model has been in use since 2016 and supports approximately six projects annually.

The examples above demonstrate that the implementations of the *University as 'Production Partner'* model have varied from institution to institution with the level of success and risk seemingly linked. Initiatives that have not relied on revenue generation or wide-scale distribution have been the most successful for the universities. Conversely, those with more ambitious 'studio-like' models have struggled in large part due to difficulties in establishing a sufficient and consistent revenue stream. The risks associated with direct financial involvement are arguably disproportionately high if return on investment is considered to be a priority.

University as 'Service Provider'

The proliferation of film and television courses world-wide has arguably been driven by both an increased demand for media product (and thus industry personnel) and a lower cost of entry for academic institutions with the advent of more cost-effective technologies. This has resulted in several universities and other academic organisations investing in facilities that are effectively on par with commercial studios[10]. Apart from many CILECT member organisations[11], which often are well-equipped given the nature of their focus, other institutions such as Birmingham City University (n.d.), The University of Salford (n.d.) and the University of York (discussed below) in the UK have recently made significant investments in facilities to support their media production-related programmes. Some of these institutions are now looking to both maximise their return on investment and enhance the student experience by making their resources available to industry. This has given rise to the *University as 'Service Provider'* model for academic-industry collaboration. Here, the academic institution only provides logistical or infrastructural support to the projects with the industry partner, engaging with them in essentially the same manner it would engage a commercial service provider such as an equipment hire company, a film or television studio complex or a postproduction house. All creative control, funding and overall logistical responsibility therefore rests with the industry partner. This model represents the lowest risk to academic organisations as access can be controlled so that commercial activities only take place in quiet periods. That said, limitations on access can make this form of collaboration difficult. Likewise, culture clashes and differing expectations between partners can mean that supporting projects effectively is not always straightforward. Because of the sporadic nature of service provision – it occurs on a per-project basis – and commercial sensitivities surrounding many film and television projects, it is difficult to provide an accurate account of how many academic institutions are currently involved in this type of collaboration due to confidentiality concerns. However, three UK institutions actively acting *University as 'Service Provider'* are described below.

[10] The ambitiousness of some universities is exemplified by Leeds Beckett University's £80M Creative Arts building project (Leeds Beckett University, n.d.).

[11] CILECT is the International Association of Film and Television schools whose members are often regarded as offering the top programmes in their respective countries.

Birmingham City University opened Curzon Street Studios in 2013, which is presently comprised of five television studios, six radio studios, three Avid editing suites, two dedicated Pro Tools-based audio postproduction suites and a range of HD production equipment (Curzon Street Studios, n.d.). These are available for ‘wet’ or ‘dry’ hire[12] although it is not apparent what background operators have (i.e., whether they are BCU staff, students or bought-in industry experts). These are shared teaching spaces and how commercial activity is accommodated around this is unclear.

The University of Salford is situated within MediaCity UK, a media production complex located at the Salford Quays near Manchester, that includes a range of professional media organisations including ITV and serves as the regional headquarters for the BBC. The university features its own commercial grade facilities, including two HD television studios, three professional radio studios and a large format dubbing theatre for audio postproduction, all of which are available for commercial hire. As is the case with BCU, these are shared teaching spaces but the way in which industry projects are accommodated and the level of student involvement is unclear.

The University of York’s involvement as a ‘Service Provider’ for commercial feature film and broadcast television projects dates back to 2006[13]. This started with *The Christmas Miracle of Jonathan Toomey* (2007), a feature film produced by Bauer-Martinez for MGM Studios that stars Joely Richardson and Tom Berenger. The author, then part of the Department of Electronics, was approached by the film’s Visual Effects Supervisor, Kit Monkman, whose team was responsible for creating composites for a handful of ‘blue screen’ shots for the film. Given the scope of work was small, Monkman thought he could train students to complete the sequences using the compositing software Shake. The department was receptive to this, five students were selected to participate and an office space was secured for the

[12] ‘Wet’ hire refers to rental of facilities with operators included; ‘Dry’ hire is rental of facilities only.

[13] The author was directly involved in several of the projects at the University of York. The majority of information provided in this section is first-hand although additional sources have been included where possible.

team on the University's Science Park (University of York, 2006). As the work progressed, the producers became increasingly impressed with the quality of the students' work and allocated more shots to the team for compositing – this grew substantially to nearly 30 finished minutes of the 91 minute film. The project was seen as a great success with students gaining paid work experience, the University obtaining positive press and Bauer-Martinez receiving solid visual effects work at a reduced cost.

Around the same time, the University decided to establish a new Department of Theatre, Film and Television (TFTV)[14] as part of the first phase of its £750M Heslington East campus expansion. Part of the funding for the department was provided by a grant from the European Regional Development Fund. Conditions of the grant required that the department facilitate a number a business 'assists', supporting local companies to add value to the regional economy (Mateer, 2018). The University took the view that these requirements could be met by providing professional production and postproduction facilities to support film and television projects. Although this required a higher level of investment than was originally envisioned, it was felt that students would benefit from learning using industry-standard equipment and through the ability to work with professionals on commercial projects (ibid). TFTV's bespoke £25M building opened in September 2010.

To manage commercial use of the facilities, the University set up Heslington Studios eighteen months later (University of York, 2012, n.d.). Through this business vehicle a range of broadcast television programmes were supported including sound mixing for the BBC 1 series *In the Club* and *The Syndicate* as well as postproduction support for Channel 4's popular *Location, Location, Location* and BBC 1's *Emergency Rescue Down Under* (produced by AirTV, which had offices in the University's Ron

[14] TFTV changed its name to the Department of Theatre, Film, Television and Interactive Media (TFTI) in 2019.

Cooke Hub). In addition, numerous feature films were supported including *First Night* (2010)[15] starring Richard E. Grant and Sarah Brightman, *Mad to Be Normal* (2017) starring David Tennant, and John Hurt's final film, *That Good Night* (2017). Since 2010, over 20 commercial feature films and 10 commissioned broadcast television programmes, as well as a range of interactive media projects and industry-related Continuing Professional Development (CPD) courses, have been supported by TFTV. This has yielded dozens of paid placement for students and jobs for several graduates as well as generated income to the university approaching £500K (Mateer, 2018). However, despite these benefits, the use of Heslington Studios to enable this work began to be seen as disproportionately expensive to run due to staff overheads. In 2016, the decision was taken to dissolve it, with TFTV management itself taking over commercial engagement activities (ibid).

Several of the film projects supported by TFTV were in collaboration with Green Screen Productions (GSP), an independent feature film production company established by veteran Producer Alan Latham, with Oscar-winning Producer Stephan Evans serving as its Chairman. These films were part of an 'umbrella agreement' between GSP and Heslington Studios (brokered by the author in 2011) that gave GSP priority access to TFTV facilities out-of-hours. GSP guaranteed a minimum of five commercial feature films per year brought to the department that would be funded externally but produced with TFTV resources in large part. A fee would be paid to the university for each project and it was to receive a small profit-share as well (University of York, 2012, March 8). Despite multiple projects having been brought in, the volume was not as high as promised. GSP was late with payments on various occasions and tension arose between the uncertain culture of independent filmmaking and the regularity required by academia. Despite this friction, TFTV's management decided to expand the umbrella agreement in

[15] The film's UK release was in 2010 but the Producers wanted to recut it to better target the US market. It was this work that was supported by Heslington Studios, enabling US release in 2013.

2016 in order to simplify its commercial dealings in light of the dissolution of Heslington Studios. However, unbeknownst to the university, GSP got into tax trouble with the UK government and was forced to cease trading at the end of that year. This effectively killed the collaboration as it created significant distrust (Mateer, 2018). Although the partnership with Green Screen Productions ended on a sour note, some of the projects undertaken are still seen as highly innovative and successful examples of academic-industry collaboration, in particular *The Knife That Killed Me* (2014).

The Knife That Killed Me – A Case Study

The Knife That Killed Me is a highly stylised dramatic feature film backed by major film studio Universal Pictures UK that was seen as a 'flagship' project for the umbrella agreement between Heslington Studios and Green Screen Productions. Unlike the majority of projects supported under the agreement, this was an instance where the University of York acted as a 'Production Partner' rather than 'Service Provider'. The film is based on the best-selling teen book of the same name by Anthony McGowan and featured a unique sketch-like look that blended abstract and photo-realistic computer graphics with live-action that was shot on green screen – see Figure 1 for examples of the visual style. The team behind it included Kit Monkman, here in a Directing capacity, working alongside theatre veteran Marcus Romer as Co-director; Alan Latham and Tom Mattinson, the producing team behind *The Christmas Miracle of Jonathan Toomey*, were the film's Producers. The author had a dual role as an Executive Producer as well as the film's Visual Effects Producer. What was unique was that the entire visual effects team consisted of recent TFTV graduates – without any prior professional experience – who were hired as staff by GSP with full industry salaries. The seven-member team, overseen by the author and Visual Effects Supervisor Tom Wexler, was located in a dedicated room within the TFTV building and the facilities used were a mix of GSP equipment and department resources. Initially, having such an inexperienced team with the responsibility of delivering an entire visual effects-heavy film was problematic as several completion bond companies felt the project was too risky thus funding could not be secured easily. However, after various test sequences were created to prove that the team could deliver, bonding was obtained and financing was completed. In total, the production took two years to finish, which is remarkable given the very small size of the VFX team and complexity of the work[16].

The film itself was generally well received and garnered some strong reviews, including being named the "10th Best Film of 2014" by the Huffington Post (Crow, 2014), earning a four-star rating in The Times (Ide, 2014) and being an official selection of Alice nella Città, a side bar competition of the Rome Film Festival. However, the film, which has an extreme look, also polarised reaction. It was given some less favourable reviews from The Guardian (Felperin, 2014) and Empire Magazine (Parkinson, 2014). As a result of this mixed response, Universal did not see value in marketing it heavily and the film obtained only limited theatrical release generating a disappointing level of revenue. However, the visual effects were universally lauded as 'innovative' and 'high quality'. The response was such that Green Screen Productions spun-out the visual effects team to form a new company called Viridian FX. As a result, both GSP and TFTV viewed the collaboration as a success, entering into a second production partnership in 2015 to produce a green screen version of *Macbeth* (2018)[17].

Uniquely, *The Knife That Killed Me* also served as a formal means to assess the viability and efficacy of academic-industry collaborations for feature film production. Given the author's dual role as academic and practitioner, he was able to get consent from a wide range of stakeholders including University of York and GSP staff, students and recent graduates, and others involved in the project such as hired crew (who were not GSP staff) and investors. Three surveys were conducted using Survey Monkey (https://www.surveymonkey.co.uk/) to gauge expectations and perceptions of the project – one prior to the start of production; one after the completion of principal photography; and one when

[16] To put this in perspective, *Sin City* (2005) had over 80 visual effects artists working on just one of its three segments and the overall scope of its postproduction work was roughly comparable (DiLullo, 2005)

[17] The project was started in 2015 and completed before GSP ceased trading although the film was not released until 2018. Further details can be found in Mateer (2018).

the film was completed before release. For each survey, participants were asked basic questions to understand their specific relationship to the project and then presented with a series of statements with which they had to indicate their level of agreement: *Strongly Agree*, *Somewhat Agree*, *Somewhat Disagree*, *Strongly Disagree*, or *Don't Know*. The discussion below identifies key reactions and sentiments of the participants but a more in-depth analysis is needed to break this down by stakeholder group – this is an area for future work.

The first survey was designed to assess expectations of the project. In total 19 participants completed the survey: 8 from GSP, 3 from the University, 5 hired crew and 3 others – see Table 1 for a breakdown of responses. It is interesting to note that the respondents were generally quite optimistic about the prospects of this type of collaboration (particularly that it might work on a range of productions) but thought that industry would be sceptical of this model. The respondents also seemed to feel that there are potentially significant benefits to the University and students.

The second survey was intended to gauge perceptions of the project directly after principal photography was completed but prior to postproduction. Overall 17 people responded: 7 from GSP, 1 from the University, 7 from hired crew and 2 others – see Table 2 for a breakdown of responses. Here views are somewhat more varied although there is general agreement that the use of recent graduates was received favourably and did not detract from the overall production process despite the majority feeling that they clearly were not professionals. Likewise, less than 20% felt that the efficiency of production was adversely affected by having a comparatively inexperienced crew[18] and all felt that the experience would enhance the students' and graduates' employability. It is also interesting to note that

[18] It is important to note that the visual effects team was heavily involved in production given the unique way in which shooting had to be conducted given there were up to 20 camera passes required for each shot.

after production had finished, all of the respondents felt that this type of collaboration would be beneficial to industry.

The final survey was intended to gauge stakeholder reaction to the finished film so the participant base had a slightly different profile with 19 respondents in total: 9 from GSP, 6 from the University, 3 from hired crew and 1 other – see Table 3 for a breakdown of responses. This survey focused in large part on the perceived quality of the finished film. It is interesting that over 80% of respondents felt that the film was of a comparable standard to other commercial feature films yet only about half felt that it would be apparent that it was a studio-backed project. All respondents felt that there were benefits to the University in terms of enhancing teaching and generating publicity. It is notable too that all respondents felt that this specific implementation of the academic-industry model enabled the film to be made in a way that would not be otherwise possible. This feeling is likely related to the unique production methods used given the experimental nature of the computer graphics and would suggest that the use of a similar collaborative model could fill a niche in the support of projects that are more creatively 'risky'. That said, nearly all respondents indicated that industry would likely be sceptical of these collaborations, which suggests adoption of the approach could be difficult.

As noted above, a deeper level of analysis is required to identify particular views of the individual stakeholder groups. However, the data does suggest that the project was seen positively overall with the potential for significant benefit to all involved.

Conclusions

The case studies above show a wide range of experiences for those organisations undertaking academic-industry collaborations for commercial feature film or television production. While there is clear evidence that both models – *University as 'Production Partner'* and *University as 'Service Provider'* – can be effective and seen as worthwhile, stakeholder definition of what constitutes 'success' is critical.

Collaborations where the objectives are closely aligned with traditional goals of the academic partner are most likely to succeed. However, this is dependent on the level of 'hard' investment and thus overall risk. Projects where the academic resource commitment is limited to staff time (e.g., *Denial* produced at Emory University) or existing facilities that have available capacity (e.g., Birmingham City University, University of Salford and University of York) have been shown to be highly effective. Likewise, even where there is a financial commitment by the academic institution, these collaborations can be worthwhile if the intended outcomes support traditional activities, such as research or teaching, but full return-on-investment or profit is not seen as a main requirement – as exemplified by the projects at the University of Hawaii at Manoa and the various examples of practice-as-research at Falmouth University and elsewhere. Indeed, the clearest evidence of this is from the films produced by Regent University and Liberty University where there was significant financial investment which was not recovered yet the projects have been seen as highly successful as generating income was not a priority.

Partnerships that rely more on commercial success (and subsequent income) are potentially problematic even if core project objectives are traditional. Some collaborations, such as those at Point Park University and Filmbase, had some success but were ultimately unsustainable financially. Others where the academic institution investment was higher, such as the initiatives at Griffith University and the University of Texas' UTFI, demonstrate that relying on income generated by the product developed through collaborations can be risky and financially dangerous. Volatility and over-saturation in the marketplace mean that securing distribution alone – even from 'name' distributors – is often insufficient to ensure adequate financial return. The monetisation of film and television content is proving to be increasingly challenging due to ‘digital disruption’[19] so focusing on income generation is arguably ill-advised.

Finally, it is apparent from the review of these case studies that for either the ‘Production Partner’ or ‘Service Provider’ model to be effective, the academic institution needs to recognise (if not embrace) the cultural and operational differences between academia and industry. Projects where there was understanding by the academic partner of the need for timely decision making, rapid reaction and response to changing circumstances, and the unpredictability of cash-flow and revenue that is common in the film and television industry, were the ones with the highest level of benefit (even if long-term success was not sustained). Although academic-industry collaborations for commercial film or television production can involve significant risk, they have the potential to be successful if they are carefully designed with clear objectives and an understanding of the business environment in order to minimise that risk.

[19] Tryon (2013) provides a detailed account of this including emerging changes to delivery mechanisms and subsequent impact on consumption patterns and revenue streams.

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Table 1

First survey, to assess stakeholder expectations of the project prior to production commencing

The Knife That Killed Me – Expectations	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Don't Know
The quality of the finished film can be as good as standard commercial projects	**31.58%** 6	**42.11%** 8	**10.53%** 2	**0.00%** 0	**15.79%** 3
Industry is sceptical of this type of production model	**11.11%** 2	**44.44%** 8	**0.00%** 0	**0.00%** 0	**44.44%** 8
Using students and recent graduates for crew takes jobs away from freelancers	**0.00%** 0	**33.33%** 6	**27.78%** 5	**22.22%** 4	**16.67%** 3
This type of production model is riskier than that for traditional commercial film projects	**5.26%** 1	**47.37%** 9	**31.58%** 6	**10.53%** 2	**5.26%** 1
This type of production model is potentially more profitable than that for traditional commercial film projects	**5.26%** 1	**52.63%** 10	**31.58%** 6	**0.00%** 0	**10.53%** 2
Using students and recent graduates will mean that production schedules are longer than for traditional commercial film projects	**10.53%** 2	**47.37%** 9	**21.05%** 4	**0.00%** 0	**21.05%** 4
This type of production model can work for all types of feature film productions (e.g., live action, animated, mixed, etc.)	**10.53%** 2	**63.16%** 12	**10.53%** 2	**5.26%** 1	**10.53%** 2
Academic-commercial partnerships allow more creative freedom than traditional commercial film projects	**21.05%** 4	**47.37%** 9	**21.05%** 4	**0.00%** 0	**10.53%** 2
Using students and recent graduates will mean that production budgets can be lower than those for traditional commercial film projects	**42.11%** 8	**47.37%** 9	**5.26%** 1	**0.00%** 0	**5.26%** 1
This type of production model enables certain types of films to be made that would not be made otherwise	**31.58%** 6	**42.11%** 8	**10.53%** 2	**0.00%** 0	**15.79%** 3
Academic-commercial partnerships are a sustainable business model	**26.32%** 5	**42.11%** 8	**5.26%** 1	**0.00%** 0	**26.32%** 5
Academic-commercial partnerships are simply a way to exploit public resources for commercial gain	**0.00%** 0	**10.53%** 2	**36.84%** 7	**42.11%** 8	**10.53%** 2
This type of production model can enable the University to gain publicity that it could not otherwise	**42.11%** 8	**57.89%** 11	**0.00%** 0	**0.00%** 0	**0.00%** 0
This type of production model can enable the University to generate significant revenue that it could not otherwise	**36.84%** 7	**47.37%** 9	**0.00%** 0	**5.26%** 1	**10.53%** 2
This type of production model can enhance the University's teaching	**78.95%** 15	**15.79%** 3	**5.26%** 1	**0.00%** 0	**0.00%** 0
Studios will embrace this type of production model	**15.79%** 3	**26.32%** 5	**31.58%** 6	**0.00%** 0	**26.32%** 5
Academic-commercial collaboration is beneficial to the industry	**36.84%** 7	**52.63%** 10	**5.26%** 1	**0.00%** 0	**5.26%** 1

Table 2

Second survey, to gauge perceptions of the project directly after completion of principal photography

The Knife That Killed Me – After Production	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Don't Know
The professionalism of recent graduates during production was high	**52.38%** 11	**38.10%** 8	**4.76%** 1	**0.00%** 0	**4.76%** 1
It was easy to tell recent graduates from established professionals during production in the way they work	**4.55%** 1	**36.36%** 8	**40.91%** 9	**18.18%** 4	**0.00%** 0
The production value (i.e., quality) of this film has likely suffered due to the involvement of recent graduates	**0.00%** 0	**27.27%** 6	**18.18%** 4	**50.00%** 11	**4.55%** 1
Inexperience of recent graduates slowed production down	**9.09%** 2	**13.64%** 3	**22.73%** 5	**40.91%** 9	**13.64%** 3
Roles filled by recent graduates would have been better filled by established freelancers	**4.55%** 1	**27.27%** 6	**22.73%** 5	**45.45%** 10	**0.00%** 0
Only specialist films like this (i.e., green screen projects) can accommodate this number of recent graduates as crew	**0.00%** 0	**36.36%** 8	**31.82%** 7	**18.18%** 4	**13.64%** 3
This type of production model enables certain types of films to be made that would not be made otherwise	**40.91%** 9	**40.91%** 9	**4.55%** 1	**4.55%** 1	**9.09%** 2
Academic-commercial partnerships are a sustainable business model	**36.36%** 8	**40.91%** 9	**0.00%** 0	**0.00%** 0	**22.73%** 5
Academic-commercial partnerships are simply a way to exploit public resources for commercial gain	**4.55%** 1	**9.09%** 2	**22.73%** 5	**36.36%** 8	**27.27%** 6
The equipment acquired from the University was of a professional industry standard	**54.55%** 12	**22.73%** 5	**4.55%** 1	**0.00%** 0	**18.18%** 4
The equipment acquired from the University required more set-up and maintenance than that from a professional hire company (e.g., Provision)	**13.64%** 3	**9.09%** 2	**13.64%** 3	**36.36%** 8	**27.27%** 6
Involving recent graduates in this project has enhanced their ability to gain further employment in the industry	**86.36%** 19	**13.64%** 3	**0.00%** 0	**0.00%** 0	**0.00%** 0
Studios will embrace this type of production model	**22.73%** 5	**45.45%** 10	**9.09%** 2	**0.00%** 0	**22.73%** 5
Academic-commercial collaboration is beneficial to the industry	**59.09%** 13	**31.82%** 7	**0.00%** 0	**0.00%** 0	**9.09%** 2
The use of recent graduates is purely a cost-saving measure	**13.64%** 3	**22.73%** 5	**18.18%** 4	**45.45%** 10	**0.00%** 0

Table 3

Final survey, to gauge stakeholder reaction to the finished film after completion of postproduction

The Knife That Killed Me – Finished Film Perception	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Don't Know
The quality of the finished film is as good as standard commercial projects	**31.58%** 6	**52.63%** 10	**15.79%** 3	**0.00%** 0	**0.00%** 0
Industry is sceptical of this type of production model	**26.32%** 5	**36.84%** 7	**5.26%** 1	**5.26%** 1	**26.32%** 5
Using students and recent graduates for crew took jobs away from freelancers	**0.00%** 0	**42.11%** 8	**10.53%** 2	**31.58%** 6	**15.79%** 3
This type of production model was riskier than that for traditional commercial film projects	**15.79%** 3	**36.84%** 7	**21.05%** 4	**10.53%** 2	**15.79%** 3
This type of production model is potentially more profitable than that for traditional commercial film projects	**11.11%** 2	**38.89%** 7	**11.11%** 2	**5.56%** 1	**33.33%** 6
Using students and recent graduates means that the film took longer to complete than for traditional commercial film projects	**21.05%** 4	**31.58%** 6	**15.79%** 3	**10.53%** 2	**21.05%** 4
This type of production model can work for all types of feature film productions (e.g., live action, animated, mixed, etc.)	**21.05%** 4	**31.58%** 6	**31.58%** 6	**5.26%** 1	**10.53%** 2
Academic-commercial partnerships allow more creative freedom than traditional commercial film projects	**36.84%** 7	**31.58%** 6	**21.05%** 4	**0.00%** 0	**10.53%** 2
Using students and recent graduates meant the production budget was lower for this film than it would have been if a traditional production model had been used	**57.89%** 11	**36.84%** 7	**0.00%** 0	**0.00%** 0	**5.26%** 1
This type of production model enabled this film to be made in a way that would not be possible otherwise	**68.42%** 13	**31.58%** 6	**0.00%** 0	**0.00%** 0	**0.00%** 0
Academic-commercial partnerships are a sustainable business model	**26.32%** 5	**42.11%** 8	**5.26%** 1	**0.00%** 0	**26.32%** 5
Academic-commercial partnerships are simply a way to exploit public resources for commercial gain	**5.26%** 1	**5.26%** 1	**47.37%** 9	**31.58%** 6	**10.53%** 2
This type of production model can enable the University to gain publicity that it could not otherwise	**63.16%** 12	**31.58%** 6	**5.26%** 1	**0.00%** 0	**0.00%** 0
This type of production model can enable the University to generate significant revenue that it could not otherwise	**21.05%** 4	**47.37%** 9	**10.53%** 2	**0.00%** 0	**21.05%** 4
This type of production model can enhance the University's teaching	**73.68%** 14	**26.32%** 5	**0.00%** 0	**0.00%** 0	**0.00%** 0
Based on this project, studios will be more likely to embrace this type of production model	**15.79%** 3	**57.89%** 11	**5.26%** 1	**0.00%** 0	**21.05%** 4
Academic-commercial collaboration is beneficial to the industry	**63.16%** 12	**26.32%** 5	**0.00%** 0	**0.00%** 0	**10.53%** 2
It is apparent this film was backed by a studio	**5.26%** 1	**47.37%** 9	**21.05%** 4	**5.26%** 1	**21.05%** 4

Figure 1

Four sample frames from the completed version of The Knife That Killed Me *(Viridian FX, n.d.)*

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Enhancing the Competitiveness of an Independent Feature Film Production Company through the Application Of New Digital Technologies using Knowledge Transfer
A Case Study of Green Screen Productions

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Abstract

This paper describes the Knowledge Transfer Partnership (KTP) between Green Screen Productions (GSP), a commercial feature film production company, and the University of York's Department of Theatre, Film and Television (TFTV). Supported by the Technology Strategy Board (TSB) and the Arts & Humanities Research Council (AHRC), the two-year project began in January 2013.

A contextual discussion details how the feature film industry is undergoing a significant technological transition as it moves away from traditional analogue tools towards digital systems. The paper describes how this changing industry context prompted the KTP project as GSP seeks to become more competitive by embracing new technologies and processes in order to maximise efficiency and profitability.

After describing the origin of the relationship between GSP and TFTV, and the development of the KTP, the paper discusses how the main objective of the project was to develop a set of resources to enable the company to choose and apply different types of digital technologies in support of production and distribution of its film projects. It then discusses the strategy to achieve this objective and how the knowledge transfer process between the Company Partner, Knowledge Base and Associate occurred. Lastly, the paper presents the benefits that each partner has obtained since the project was initiated.

Keywords: *feature film production, film distribution, film value chain, Technology Strategy Board, Arts and Humanities Research Council*

1. Introduction

Knowledge Transfer Partnerships (KTP) offer companies a unique opportunity to grow by exploring specific strategic business needs and capitalising on cost-effective collaborative relationships with key academic research groups. Often these partnerships involve the commercial development of advances in research and yield a tangible product or manufacturing process as the main outcome. KTPs within the creative sector are comparatively new and are more difficult to characterise than those in the engineering, manufacturing or scientific industries. This is due to an inherent paradox that lies at the centre of creative industry, particularly the film industry, where management must contend with both creative and commercial demands. Managing the creative process while at the same time balancing the financial requirements makes for a highly dynamic environment that requires flexibility [1]. The KTP between Green Screen Productions (GSP) – an independent feature film production company – and the University of York's Department of Theatre, Film and Television (TFTV) is one such collaboration. The partnership involves a detailed exploration of cutting-edge production methods, distribution methodologies and enhanced digital marketing practices with the goal of imparting core knowledge to enable Green Screen Productions to maximise its ability to be competitive and enhance productivity. This paper will describe both the nature of the project as well as the broader commercial context that prompted it.

2. Feature Film Industry: Changing Landscapes

The feature film market is complex, constituting an array of specialised players, each with their own business dynamics and market requirements. These players involve producers, financiers, sales agents, distributors, exhibitors and retailers. Correspondingly the activities that draw these professionals together to produce a film product involve the lifecycle of development, financing, production, distribution and exploitation. The relationship between these diverse and often disconnected players and activities forms what is known as the film value chain [1,2]. Within the UK this value chain is mainly operated by small-to-medium-sized businesses (SMEs), often running on tight margins [3].

The strategic effect of what could be termed a 'disintegrated model' is that each element in the film value chain is heavily dependent on the next player/operator's partnership and cooperation in order to drive a project forward [4]. A significant technological shift is occurring as the industry moves away from traditional analogue tools towards digital systems, which has begun to change the nature of the chain. This shift has allowed companies to have greater integration across the value chain by converging resources, reducing the reliance on specialty skills from third parties and consultant experts.

An example of this can be found in the domain of principal photography where relatively inexpensive digital cameras, such as the Red Epic, can deliver picture resolution similar to that of a conventional 35mm negative. In post-production, digital images can now be acquired and immediately edited as well as enhanced with visual effects, using personal computers at a fraction of the cost of those processes for physical film [2]. These cost efficient advances in technology are lowering the entry level for filmmakers and facilitating a greater number of low-budget breakout hits. This was recently witnessed in the release of British director Gareth Edwards 'Monsters' in 2010. The film was shot on a Red Epic and went through an extensive post-production process involving 250 highly technical visual effects shots [5]. This was completed single handily by Edwards and his editor and was only possible due to the low cost of new industry standard software tools and computer hardware. 'Monsters' had a production budget of only $500,000, yet the film went on to gain an international theatrical release, earning approximately $4.2million at the box office [6].

While these technological advances have provided filmmakers with more efficient and cost effective methods of producing films, they have paradoxically created a more competitive marketplace by opening the filmmaking process up to more people. This was highlighted in the British Film Institute's 2013 annual statistical yearbook that notes an ever-increasing congestion within the marketplace. In the ten-year period between 2003 and 2013, there was a 40% increase in the number of films released in the UK, with 423 films released in 2003 compared with 698 in 2012 [7]. This increase in releases has been exacerbated by a transition away from traditional 35mm print towards digital cinema projection (D-cinema), which allows exhibitors to be more flexible in programming.

To compound the issue even further, annual theatrical ticket sales have plateaued during this period. In 2003 admissions stood at 167.3 million and in 2013, 165.5 million [7]. It should also be noted that the revenues generated from these admissions favour the bigger budget films; the top 100 films released in the UK have taken an average of 91% of the gross revenues over the past five years [7]. Within the current industry, there are too many films now competing for too few viewers, resulting on a squeeze on revenues, particularly among independent film producers. Recent statistics highlight the difficulty that companies face operating in the market, indicating that films with budgets between £2m - £5m have only a 4.6% chance of returning a profit. This rises to 17.4% for films with budgets over £10m [8].

As a result, the film industry is looking more progressively at new ways of commercialising product utilising new technologies. Broadband Internet, mobile and connected devices, and video on demand (VOD) platforms such as Netflix are seen as increasingly important in monetizing product. Indeed, producers are now using VOD technology to reconsider established production-distribution models and explore new business opportunities. This was evidenced in a watershed moment in 2011, when Netflix commissioned the $100M development of the political drama serial *House of Cards* (2013) starring Kevin Spacey. It marked the first major production solely financed and distributed by an online VOD platform, completely bypassing the traditional television ecosystem of networks and cable operators, and entering the value chain system at the beginning stages. By utilising sophisticated algorithms, the Netflix platform could determine specific audience preferences from their downloads, which provided a profile for a potentially successful product that was used to develop the project. This detailed knowledge about the market helped to reduce the investment risk inherent in film or TV production. Unlike traditional TV or film exhibition, which often staggers release dates to specific markets, the entire first season of the series was released on the same day in all Netflix's territories. This marked a new way of distributing TV content online and demonstrated to the industry the advantages of embracing online delivery not only for TV but for film as well, as Netflix core business is film rental. This type of fundamental change highlights the evolving economic and strategic nature of the industry and the opportunities for innovation that have emerged.

Building a solid understanding of these technological developments across the film value chain within Green Screen Productions is a core objective of the Knowledge Transfer Partnership with TFTV. The goal is to enable GSP to become more agile in a challenging marketplace and take advantage of suitable opportunities that competitors may not be able to exploit.

3. Company Partner, Knowledge Base and Background

Green Screen Productions (GSP), incorporated in 2008, is an independent feature film production company founded by a team of experienced industry personnel including producers Alan Latham (*Circus*, *Modigliani*) and Thomas Mattinson (*Victoria & Albert*, *Nancherrow*), and award-winning visual artist and director Kit Monkman (Prince, Kylie Minogue) with Oscar-winning producer Stephen Evans (*Madness of King George*, *Henry V*) serving as the company's Chairman. They established the company in North Yorkshire with the aim of producing cost-effective and innovative commercial films and television programmes for international distribution. A key component of their strategy was to take advantage of the lower overhead costs of establishing facilities in the North of England and to partner with an academic institution to source emerging talent. Serendipitously, the emergence of a new entity at the University of York directly fitted this objective.

Established in 2007, the Department of Theatre, Film and Television (TFTV) at the University of York was developed as part of the first phase of the University's Heslington East initiative, a £750M expansion project that is to ultimately double the size of the institution. TFTV differs from similar departments in other universities as a substantial portion of its funding has come from the European Regional Development Fund (ERDF). Conditions attached to this funding require that the department engage in commercial activity and help to build the local economy within the creative sector. To facilitate this, commercial-level facilities were required. In Autumn 2010, the department opened a state-of-the-art £30M facility purpose-built to support and foster interactions between the University, researchers and business. These facilities include high-end postproduction resources for editing, picture grading, visual effects and sound, two broadcast-compliant HD television studios, a black box sound stage, a 220 seat scenic stage theatre and a 150 seat digital cinema that can also function as a dubbing theatre. This production complex was designed to be one of the best-equipped commercial resources in the UK and this has played a major role in attracting industry collaborators.

Rather than build the department completely from scratch, the University sought to recruit from within using existing staff from other departments. Among the four founding members was John Mateer, a film and television industry veteran who had been hired to establish production elements of a course in Media Technology in the Electronics department. Mateer's professional experience has included working on innovative projects involving cutting-edge technologies for production and post-production as well as visual effects. This expertise helped to make a formal relationship between Green Screen Productions and the University viable.

In 2005, Alan Latham and Thomas Mattinson were producing a feature film for Bauer-Martinez and MGM Studios entitled *The Christmas Miracle of Jonathan Toomey*. Kit Monkman and his business partner Tom Wexler had been hired to oversee visual effects for the project. Originally this was only to have been a few shots for the film so Monkman got in touch with Mateer (whom he knew previously) to see about establishing a visual effects facility on the University Science Park and also to find out if any students might be interested in working on the project. A team was assembled from Media Technology and Music Technology undergraduates who were trained on the requisite software and hired as visual effects assistants. The production company was so pleased with the work that they took the decision to use Monkman and his team for the vast majority of the visual effects (about a third of the film). The alliance was highly successful with all parties benefitting – the production company obtained high-quality visual effects work at a reduced cost; Monkman and Wexler established themselves as capable feature film visual effects supervisors; the students involved were not only paid for their work but gained valuable industry experience and credit (two students, Lewis Saunders and Andrew Fensom, were immediately hired by established Soho postproduction companies) and the University gained strong publicity that later helped to drive the development of TFTV.

Based on the success of the …*Toomey* collaboration, Latham and Monkman looked to develop closer ties with the University working with Mateer. After Green Screen Productions was formed and TFTV was fully in operation, an Umbrella Agreement was made between the parties to establish a formal relationship. As part of this agreement, GSP would have access to the facilities and equipment in TFTV for feature film work, as well as access to top graduate talent. For the department, the partnership would enable teaching to be informed directly by current practice, the department's profile to be raised within the film industry, students and graduates the opportunity to gain experience working on professional projects and, most importantly, the University to fulfil the obligations associated with the ERDF funding.

The first feature film project to be developed from the Umbrella Agreement was *The Knife That Killed Me* for Universal Pictures UK, with production starting in 2011. This film used computer-generated backgrounds with live actors being incorporated into them, presenting a highly complex technical challenge. As the film developed, it became clear that there were company needs for expertise that transcended the scope of the project and current relationship. The University's

Research and Enterprise Office had been monitoring the collaboration between GSP and TFTV, and suggested that a Knowledge Transfer Partnership could be appropriate to meet GSP's emerging needs. A KTP would allow for a detailed exploration of cutting-edge production and distribution methodologies in a way not possible through the existing relationship either in traditional academic research or a standard business setting. GSP and TFTV agreed, with Mateer, Monkman and Latham taking the process forward with the assistance of Rukmal Abeysekera, the University's Knowledge Transfer Manager. An application for a Knowledge Transfer Partnership, jointly through the Technology Strategy Board (TSB) and the Arts and Humanities Research Council (AHRC), was submitted in 2012. A two-year £135K partnership was approved to start in January 2013. A search for a suitable Associate was conducted and Keith Kehoe, a recent graduate of the MA in Producing for Film and Television programme at Bournemouth University, was appointed. This decision was based, in large part, on the strength of his dissertation, which looked at financial aspects of independent feature film production. Given his interest in the financial side of film as well as his experience as a producer of short films (including one that was accepted at the Short Film Corner at the Cannes Film Festival) Kehoe stood out as the best fit for the project.

4. Knowledge Transfer Partnership Project

The Directors of GSP have significant skill and experience in traditional methods of film production and distribution. As such, they are experts in conventional methods of all stages of pre-production, production, post-production and distribution of feature films, but have not relied on digital technologies up to this point.

From the outset, the principals in the company have been interested in exploring new technologies that have been adopted by the industry. However to do so, they have had to rely on consultant experts to adapt these new systems to their projects, and only when such systems have been proven to be used on a wide scale. This reactive approach is very common in the film industry given the perception of risk associated with new methods. To ensure maximum production efficiency and profitability within the current industry climate, GSP were keen to engage in a more proactive approach. Therefore, recognising the benefits of digital technologies, but lacking sufficient knowledge to be able to fully utilise them for productions without outside assistance, GSP could see the opportunity of engaging in a formal Knowledge Transfer Partnership.

As such, the objective of the KTP was to develop a set of resources for GSP that would enable the company to choose and apply different types of digital technologies in support of production and distribution of its film projects. Similar production companies typically do not have this type of expertise in house thus the knowledge gained would give GSP a competitive advantage. In essence, this represents the beginning of a paradigm shift within the industry and GSP is looking to get ahead of the curve.

The project objectives would be achieved by undertaking specific outputs. The first began with the creation of a needs-analysis report to specify GSP's requirements. This was developed through meetings with the Managing Director, Producers and other staff to gain a precise understanding of the current methodologies for producing and distributing films within the company as well as to identify GSP's objectives for using new technologies.

Once the needs-analysis documentation was agreed with the primary stakeholders, the Associate conducted a literature review to determine appropriate technologies and to identify examples of best practice. This review covered all phases of production and distribution, with the Associate undertaking secondary research of trade publications, vendor literature and other standard industry resources. Primary research was carried out through attending specialist industry training events in the UK and across Europe. Regular meetings with GSP staff and TFTV personnel took place to discuss the findings and to ensure suitability to the company's needs.

Based on the formal analysis and review, 'toolkits' were developed to package the information as a series of resources for GSP staff to use. It was decided early on to divide these toolkits into six specific areas of the feature film process: Pre-production, Production, Post-production, Distribution, Marketing and Financing. Each toolkit consists of a set of documents that details technological solutions that can be applied to each specific production or distribution context. For example, the distribution toolkit outlined a series of strategies that the company could apply in order to release their films. This included case studies that discussed how other companies have utilised alternative strategies to distribute film and glossary descriptions detailing how different video on demand platforms operated. The knowledge transfer has been achieved through a formal presentation of each toolkit to GSP staff, with a discussion of the findings and conclusions of the research. This has been supported with regular consultations with GSP to ensure that staff can understand and apply the specific information of each toolkit. GSP trials each toolkit in different production contexts as dictated by its active slate of projects. The Associate has monitored these trials, collecting feedback that is used to refine and improve the toolkit before being formally integrated into business methods.

Digital technology is a highly technical and specialised area, so a key challenge the Associate has faced has centred on gaining a sufficient understanding of relevant new systems and processes. He has had to consider finding the correct level of descriptive detail and tone to communicate this information effectively to GSP staff who are not particularly technologically focused. To achieve this, close collaboration and frequent communication have been required between the Associate, Knowledge Base and Company Partner. Accordingly, on a weekly basis, the Associate met with the Academic Lead to draw on his expertise and receive guidance towards appropriate resources. Likewise, the Associate met with the Company Supervisor regularly to understand GSP's current operating procedures and to ensure that the company's needs were being examined in a way that accurately reflected their requirements for specific technologies. Monthly meetings also took place between the Associate, Company Supervisor and Academic Lead to ensure that the correct areas of GSP operations were being examined and that development of each toolkit was being properly conducted.

As the KTP has progressed, there have been agreed adjustments to the initial aims of the project. Through the process of acquiring new knowledge, the company have come to realise that some toolkits require more attention than others. This is to be expected given the dynamic nature of an industry experiencing significant change in the face of rapidly evolving digital technologies. However, more importantly, as a new company GSP have matured over the duration of the formal relationship with TFTV and have realised that some relevant expertise actually already exists within certain areas of the company. This was evidenced when the Associate began working on the Post-production toolkit. The employees within the Visual Effects department in the company had gained appreciable additional knowledge through GSP's production of *The Knife That Killed Me*. Though the Associate assisted in integrating improved project management systems within the visual effects department, the complex technical knowledge for graphics production was already largely present but the level had not been fully recognised. Because of this, it was felt that the company could gain more benefit by the KTP focusing on the most pressing needs within the company. As a result, more emphasis was placed on the Distribution and Marketing toolkits as the company prepared for the release of *The Knife That Killed Me*.

The Knife That Killed Me is an unusual product within the film market as it was shot entirely in a studio with the actors performing against a green screen with the backgrounds being subsequently created digitally. The film therefore has a unique visual style unlike any other current film within the market, which places it outside conventional genre and audience parameters that sales agents, distributors and exhibitors use to market film product. This has created challenges for the company in terms of securing theatrical distribution, despite strong test audience feedback and pre-release critical acclaim. Distribution and marketing are rapidly evolving areas of the feature film chain as the industry has begun to focus more on digital delivery of product. Aware of this transition, principals within GSP were keen to capitalise on the new opportunities available. Accordingly, the KTP Associate has explored emerging digital distribution and marketing strategies to connect the film with a young adult audience, the film's core target market. Working closely with the company, an online marketing campaign was developed that utilises social media as its primary means of generating awareness. A 'crowdsourced' funding campaign on the Kickstarter platform was launched to raise additional finance to distribute the film and raise further awareness with the film being released theatrically, on DVD and through online video on demand platforms in the Summer of 2014. Traditionally, GSP would have needed to hire third party specialists to develop and rollout a campaign such as this. The KTP enabled the company to take advantage of the technological transition in film exploitation and have control over the financial, creative and administrative requirements of film exploitation that would not have otherwise been possible.

5. Benefits To KTP Partners

The enhancement of knowledge has presented a variety of benefits to each of the KTP partners allowing them to grow in a number of ways:

5.1 Company Partner

For Green Screen Productions, the ability to apply the newest digital tools and techniques to their existing business practices are crucial if they are to become a more competitive and sustainable feature film business. This has been achieved by enabling GSP to choose and apply particular toolkits, adapting them to the specific needs of each production. The benefits of this are numerous:

- Utilising the newest filmmaking technologies and practices has not only enabled GSP to improve operational procedures but also offered them a new means of creative expression through gaining a deep understanding of production technologies that allows them to be used in innovative ways

- Having a thorough understanding of digital delivery of product has allowed the company to explore new opportunities for commercialising film. This involves utilising video on demand to shorten traditional film release windows and employing digital marketing techniques to raise product awareness

- The company has gained improved efficiency in the VFX department through employing new project management systems

- Staff have benefited from being upskilled enabling them to apply cutting-edge technologies in pre-production, production and post-production

Green Screen Productions are similar to other production companies in that they seek to continually improve their business efficiency by producing the best possible films at the lowest possible cost. Where GSP differ lies in their ambition to innovate utilising emerging technologies in order to reorganise relationships across the value chain and become more integrated. The architecture of the independent film value chain rarely involves companies producing and delivering film product to audiences through a single company. GSP realise the opportunity that having this ability to control product provides. This has enabled them to break away from a traditional business perspective that separates these activities (and ultimately results in lower direct revenue). This represents one of the most exciting benefits facilitated through the KTP collaboration.

Before the project began, GSP were not engaged in the final two stages of the feature film life cycle – marketing and distribution. This KTP has allowed the company to begin to explore these processes through the release of *The Knife That Killed Me*, which has served as an effective ‘test bed’. In terms of marketing, the company have benefited from being able to build direct brand awareness with consumers through digital engagement on social media. The ability to retain full control of the creative and administrative elements of the marketing campaign allows the company to be more responsive to audience reaction to marketing content. The company can quickly identify what is, or is not, working and adapt accordingly, allowing GSP to remain more agile than if they were working with third party specialists or consultants. For distribution, the company have explored reducing traditional release windows in order to make the film available on a number of platforms simultaneously. Part of the strategy involves live streaming the film online for free (as a 'one-off') during the film's national premiere. The approach can also be seen as a means of aligning to emerging audience viewing habits and expectations, which increasingly involve online platforms. A simultaneous release also offers a more cost-efficient approach, allowing GSP to concentrate on marketing using a single unified campaign for multiple platforms.

A key part of creating a competitive business strategy involves aligning an organisation with its strategic environment [9]. Through the KTP and collaborative relationship with TFTV, Green Screen Productions have been able to gain greater understanding of emerging digital opportunities for the film industry and have positioned themselves to take full advantage.

5.2 Knowledge Base

The Department of Theatre, Film & TV has gained unique insight into a number of different aspects of commercial feature film production and exploitation in the context of an emerging new digital economy. The ability to work very closely with GSP through all stages of an active commercial film project has meant that TFTV has gained absolutely up-to-date information about the business of independent feature film production through all phases of the process. It has also given direct exposure to challenges posed by current market conditions. This has helped to not only develop additional research strands in the domain (discussed below) but also to inform teaching by giving students an understanding of current and emerging practice, and how new technologies are affecting them. Research has been enhanced in a number of different ways:

- All phases of the development, production, marketing and exhibition of *The Knife That Killed Me* have been formally incorporated into a research framework whereby project stakeholder and participant expectations have been actively monitored and surveyed at each stage of the process (pre-production through completion). This has not only enabled the creation of a highly detailed snapshot of a current independent feature film project but, through the KTP, enabled direct analysis of financial and commercial aspects of the film that would otherwise have not been possible given the commercial sensitivity of the data

- New strands of research have emerged looking at areas such as changes in industry distribution methods, new means of feature film marketing and means to enhance post-production processes

- Existing areas of research have been strengthened including explorations of new financial models for independent feature film and the efficacy of academic-industry collaborations in the creative sector

Work placement and internship opportunities have also been made available to students as part of the collaboration. For example, during the digital marketing campaign of *The Knife That Killed Me*, the company hired a student intern directly from the department for three weeks in order to assist with the management and implementation of the digital marketing campaign. The KTP with Green Screen Productions has enabled TFTV to develop and expand its understanding of commercial filmmaking and enhance its ability to engage with industry partners that would not have been possible otherwise.

5.3 The KTP Associate

Through his close work with principals at Green Screen Productions, trips to film markets and exhibitions, and participation in numerous targeted courses and workshops, the project has allowed Kehoe to develop an in-depth understanding of all aspects of feature film creation and exploitation. This includes a strong understanding and appreciation of new technologies available to film practitioners. Kehoe has developed a close working relationship with staff in the company. He has been able to draw on their wealth of experience to understand the roles and responsibilities of industry professionals in a commercial film environment. This experience should serve him well as he pursues his overall career objective of ultimately becoming a feature film producer.

Unique to this project has been the ability for Kehoe to be fully engaged in the implementation process as the distribution and marketing toolkit has been trialled with a live project. This has allowed him to gain valuable practical experience that complements the knowledge obtained and has also enabled him to tailor his work directly to support GSP objectives.

The Knowledge Transfer Partnership supports personal development to ensure that the Associate has the skills and knowledge to successfully complete the project. This has allowed Kehoe to attend leading film industry training workshops including:

- London Film School - Sales Marketing and Distribution: a two-day intensive workshop with leading industry experts. This gave Kehoe his first introduction to the current UK distribution landscape and the impact of digital technology on traditional processes

- European Audiovisual Entrepreneurs (EAVE) – Film Marketing Workshop: a four-day residential programme in Luxembourg that focused on marketing during development, production, sales, distribution and exhibition. The international perspective gave new insights into alternative regional approaches to film marketing

- Squared Online – Certificate in Digital Marketing: a six-month online training programme created by Google to develop expertise in digital marketing technology and practice. This proved to be valuable in the creating of the campaign for *The Knife That Killed Me*

GSP are a company with a culture that encourages innovation and the sharing of ideas from all members of staff, not just principals. They use a flatter and less hierarchical reporting structure that is not common in production companies. As a result, Kehoe had to adapt to this different way of thinking, which had the benefit of him gaining a new sense of confidence in making proposals and approaching his project management tasks.

6. Conclusion

In the ten-year period between 2002 and 2012 the number of production companies operating in the UK almost doubled from just over 4,500 to nearly 9,000 [7]. To compete in the face of this increasingly crowded landscape, companies must be prepared to innovate and adapt to the newest advances in technology and practice. This is particularly pertinent against the current film industry backdrop where the intricate relationship between content and technology has become more complex than ever. New ways of producing film and delivering to audiences exist through digital technology. The film sector is grappling with the challenges and opportunities that these present.

Green Screen Productions have understood this since their inception in 2008 and have realised the value of a commercial relationship with a research-led university department, such as Theatre, Film and Television, to adapt to industry change. The objective of the KTP between GSP and TFTV has been to provide a proactive strategic response in order for the company to operate at the cutting-edge of digital film production, distribution and marketing. All indications suggest that, by the conclusion of the KTP in January 2015, the project will have successfully achieved this objective, injecting digital specialist expertise within Green Screen Productions that will strengthen their long-term competitiveness in a challenging UK film industry.

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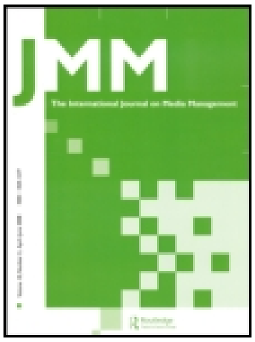

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The Impact of Digital Technology on the Distribution Value Chain Model of Independent Feature Films in the UK

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This article examines how emerging digital technologies have disrupted independent film distribution practice in the United Kingdom. The article uses the value chain concept as the framework to examine changes in audience consumption habits and to explore emerging business practice, as a result of new technology. The article argues that film distribution is shifting from a supply-led to a demand-led market. In this way, independent distributors can now break away from the rigid singular value chain that dominated the industry, and adopt bespoke release strategies that are tailored to the individual needs of each film. This arguably marks the beginning of a fundamental shift in the relationship between key segments in the film value chain by allowing independent distributors to create a more attractive product by conducting their business in response to consumer demands, as opposed to rigid market-driven conditions.

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INTRODUCTION

Until recently, the conventional rules for distributing feature films were largely set around analog technologies with business models based on rigid window systems and exclusivity. However, recent advances in digital technologies are changing the way audiences consume media, putting pressure on traditional models for releasing films. In this article, the value chain concept (Porter, 1985) is used as a structure to explore the impact of new technologies on film distribution and consumption activities. The key argument is that the singular value chain that has dominated traditional film distribution is being replaced by bespoke business strategies that can be tailored to the demand of each individual film release. This represents a potentially significant change for independent film as it shifts from a supply-led to a demand-led market. Previous studies investigating the impact of technology on the film value chain (e.g., Bloore, 2009; Crissey, 2010; Finney, 2010) take a macro-analysis approach, exploring the digitization of all horizontal activities across the value chain: development, financing, production, sales, distribution, and consumption. The focus of the analysis was specifically on the vertical-linkages within the distribution and consumption activities. To facilitate the narrative of this research, the U.K. film industry is used as a situational case study.

The article begins with a contextual discussion of the origins of the value chain concept and its subsequent application within academic film industry research. A situational analysis of U.K. film distribution is provided to give an understanding of market conditions. The authors deconstruct traditional distribution windows with a focus on the staple markets of feature film commerciality: theatrical and home video. Then, the authors proceed to explore the emergence of new technologies and evolving consumer relationships with content. In an exploratory way, the article examines two movements impacting the industry: changes in consumption habits and the emergence of new business models. A summary regarding these key developments and the future of independent film distribution and consumption is discussed. The current analysis involves literature from thought-leaders in value chain research and digitization of the film industry, while referencing leading trade publications (e.g., *Screen International*) and public-funded research (e.g., British Film Institute [BFI]) to factor in current market conditions.

VALUE CHAIN CONCEPT

Porter (1985) arguably coined the term "value chain" in his seminal book, *Competitive Advantage: Creating and Sustaining Superior Performance*. He describes the value chain as a framework for identifying the set

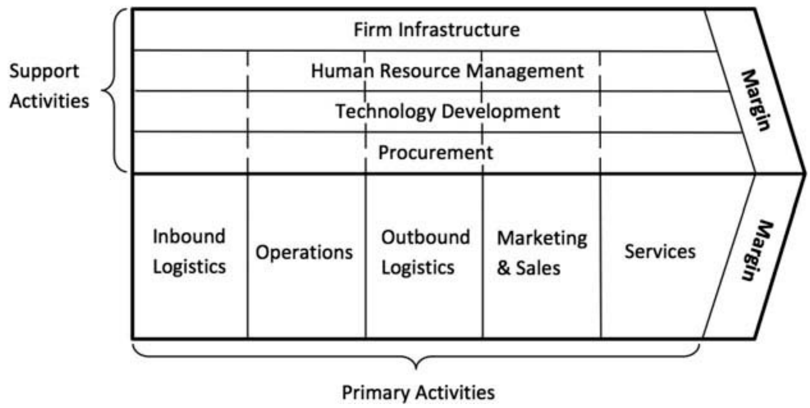

FIGURE 1 Porter value chain.

of interconnected value-creating activities that a company performs in developing, manufacturing, delivering, and supporting its product, and the points of connection with the activities of suppliers, channels, and customers.

Figure 1 illustrates this definition showing how each activity within a single company is linked to the next to create a value chain.

In gaining a broad understanding of its strategically important activities, a company can ensure that it remains competitive by adjusting its strategy to match existing opportunities or changes within the marketplace. However, few products in the current economy can be created and delivered to the end user by a single company. To accommodate this, Porter suggests that a company's value chain is typically embedded within a larger "value system" (Crissey, 2010, p. 5). This includes the individual value chains of all the separate companies or players who are co-operating within an industry to deliver a final product. Therefore, if Porter's terminology were to strictly be applied, a company's own internal activities constitute a value chain and the collection of all the individual value chains from separate companies or players makes up a value system (Crissey, 2010, p. 5).

Over time, there have been changes in the ways business strategists apply and express the value chain in analysis. Finney (2010, p. 2) notes that business consultants and academics have gradually dispensed with the distinction between the value chain and value system. It is now generally accepted that a value chain encompasses all stages of the process, whether within one company or not. Küng (2008, p. 20) supports this, stating that the value chain concept is usually not used in the "pure form," analyzing an individual firms activities, but rather as a short hand means of depicting graphically all the various stages by which products are created and delivered to the end consumer.

FILM VALUE CHAIN

Eliashberg, Elberse, and Leenders (2006), Bloore (2009), Finney (2010), and Crissey (2010) have all explored the expansion of Porter's model to characterize the structure and economic organization of the film industry. Crissey (2010, p. 1) describes this "film value chain" paradigm as arguably the most prominent commercial analytical concept to emerge in the global motion-picture industry over the last 10 years. The film value chain comprises a chain of connected companies and individuals, all working on different elements of the film production and distribution process. The interlinking horizontal elements of the process typically follow the discrete stages of development, financing, production, sales, distribution, and consumption. Each of these elements has a series of vertically linked activities to progress a film project. Finney (2010, p. 6) terms the system a "disintegrated model" because each element in the chain is heavily dependent on a network of varying interacting individuals and companies. Each must be formally engaged and managed to deliver specific commitments and activities in order for a film project to proceed. Furthermore, Bloore (2009, p. 1) notes tha once the film is distributed, the revenue generated through cinema ticket sales, DVD purchases, or online download is subject to various revenue shares or commissions as it passes back through the chain, which then complicates the revenue flow.

U.K. SITUATIONAL ANALYSIS: A DISTRIBUTION PERSPECTIVE

The U.K. film industry is a valuable part of the British economy contributing £4.6B toward the U.K. gross domestic product (GDP) in 2011 (Oxford Economics, 2012). Tax relief schemes have played a major role in driving economic growth by incentivising international investment. This has attracted the six major Hollywood studios (Paramount, Sony, Walt Disney, Twentieth Century Fox, Universal, and Warner Bros) to invest heavily in the United Kingdom.

In 2013, these companies invested over 70% of the total production spend, which amounted to only 12% (19 films) of the total number of films produced in the United Kingdom (BFI, 2014a). While this benefits certain sectors of U.K. film industry, such as production and post-production, they have also dominated the distribution sector where much of the revenues are to be made, receiving 90% of the box office earnings in 2013 (BFI, 2014a). The dominant Hollywood system has found its success by establishing its business approach around an integrated value chain model where it can develop, produce, and globally market and distribute, all in house.

In contrast, the independent film industry rarely produces and delivers a film through a single company. Operating within a disintegrated value chain model, numerous companies must contribute throughout the process to successfully produce and distribute a film. For independent distributors, competition exists not only from Hollywood dominance, but also from an overcrowded market including the recent proliferation of high-end TV drama and alternative content online. The U.K. government has recognized these challenges, constructing film policy in 2012 (DCMS: A Future for British Film: It Begins With The Audience, 2012) that aims to increase demand and market share for independent films.

The traditional business model of film distribution was established around a lifecycle of "exploitation windows"—exclusive periods of time within specific market regions (or "territories") to enable repeated commercial exploitation of a film's intellectual property rights in order to maximize revenue (Ulin, 2010, p. 36). The film value chain segment for distribution is connected by a series of vertically linked activities, typically beginning with an exclusive window for theatrical exhibition. "Holdback periods"—periods of time where no other type of distribution of a specific film property is allowed—are set to ensure there is no competition from other distribution activity (Ulin, 2010, p. 36). The length of each holdback period and exploitation window, as well as whether they are exclusive or have a period of overlap with other distribution activities, has become relatively standardized. These have typically been about 17 weeks for the "home video window" (i.e., DVD/Blu-ray), 6 months for Pay-Per-View and video-on-demand (VOD), 12 months for Pay-TV subscription, and 24 months for free-to-air television broadcast (Ulin, 2010, p. 36). This restrictive model represents the framework of the supply-led market that independent film distribution has been built upon.

The theatrical window is often not the most significant revenue stream for an independent film distributed in the United Kingdom. This is due to the high investment cost in prints and advertising (P&A) and challenging recoupment structures shared with exhibitors. While a film may not turn a profit from box office alone, a successful theatrical release can drive awareness and fuel downstream revenues later in the distribution lifecycle. The opening weekend has become of increasing importance in determining the theatrical success a film might have. Until the late 1990s, successful independent films typically enjoyed long theatrical lives that could last months, building an incremental long tail of revenue; hits such as *Trainspotting* released by Polygram (February 1996–July 1996) and *Rogue Trader* released by Pathé (June 1999–August 1999) illustrate this well. Presently such long theatrical runs are rare and pressure has increased on the opening weekend of release where ticket sales now determine how long a film will stay in the cinema. Because the amount of film product available is so high, with an average of 13 releases per week in 2013, against eight releases in 2003 (BFI, 2014a; U.K. Film Council, 2004), exhibitors will no longer exercise patience, even with big budget films, if box office performance is not strong immediately. Advancements in "D-cinema," an emerging data-driven digital projection standard, have accelerated this approach by exhibitors as they allow greater programming flexibility due to the elimination of logistical delays that are associated with the physical distribution of 35 mm film reels.

Cinema is a supply-led market where exhibitors are the gatekeepers for curating entry into the theatrical retail environment. Over the 10-year period between 2003 and 2013, U.K. exhibitors have increased supply by 40%, with 423 films theatrically released in 2003 (U.K. Film Council, 2004) compared with 698 in 2013 (BFI, 2014a, p. 14). Annual admissions have plateaued during this period with cinema attendance in 2003 standing at 167.3M but by 2013 had actually slipped back to 165.5M (Sandwell, 2014; U.K. Film Council, 2004). Revenue generated from admissions favored bigger-budget films with the top 100 released in the United Kingdom over each of the past 5 years having taken an average of 91% of gross revenues (BFI, 2013b). Therefore, a greater number of films are now competing for limited cinema audience, resulting in a squeeze of revenues for independent distributors and an increasingly untenable commercial environment for independent filmmakers to operate within.

The home video window has become increasingly challenging for distributors as well. This market's emergence in the 1980s led to it developing into the most profitable segment of the film value chain. However, the home video market peaked in the United Kingdom in 2004 with video retail worth over £1.4B (BFI, 2014a). Since 2008, revenues have fallen year-on-year and by 2013 the market had shrunk by 33%, valued at £940M, its lowest point since 2001 (BFI, 2014a). A primary force behind this decline is digital piracy, which has been driven by increased consumer demand for readily available product led by advances in new technologies, such as broadband Internet and Web-enabled devices. The trend of declining sales and the impact of piracy are being felt on the high street as exemplified by the closure of Blockbuster, and HMV entering administration. The continued downward trajectory of the home video market suggests that the financial importance of the market for distributors will likely become minimal within a few years.

DIGITAL TECHNOLOGY AND THE IMPACT ON FILM DISTRIBUTION

The history of film industry practice runs in tandem with the history of associated technological development. The introduction of synchronized sound, followed by that of full spectrum color, along with the need to adapt to new audio-visual platforms (first television and then home video), are technological milestones that marked turning points by which the industry was ultimately strengthened (Pardo, 2014, p. 327). Over the last decade, digital technologies have also begun to transform the film industry. Traditional distribution systems are being reconsidered with questions raised concerning the viability of release windows and more fundamentally, the appropriateness of exclusivity and timing upon which these windows are constructed (Ulin, 2010, p. 299). These questions have arisen in response to the rising popularity of new technologies such as broadband Internet and connected devices that play movies (including iPads, internet-connected TVs, and mobile phones). The release of Sony's PS4 and Microsoft's Xbox One is also significant as both consoles have repositioned themselves not just as gaming devices but also as home entertainment centers that can live-stream content. Online habits are evolving as individuals spend more time accessing the Internet and consuming content on-line. In 2013, 36M adults in Great Britain (73%) used the Internet every day, 20M more than in 2006 (Office of National Statistics, 2013).

VOD[1] is a key part of this evolving expansion of entertainment delivery. The U.K. online VOD market is considered the most mature in Europe with numerous platforms competing for consumers including Netflix, Amazon Instant Video, and iTunes. There is evidence of this translating into market growth when analyzing revenues. This market was estimated to be worth £193M in 2013, up from an estimated £55M in 2011 (BFI, 2014a). While £193M is a small return when considered against more profitable windows such as theatrical (£1.1B) and home video (£940M), the doubling of revenue in such a short period suggests there is significant market traction occurring (BFI, 2014a). The television-based VOD "catch-up" market—where scheduled content can be subsequently watched again for a limited period as offered by Sky, Virgin Media and British Telecom services—has risen steadily increasing by 16% from an estimated £112M in 2012 to £130M in 2013 (BFI, 2014a).

As a result of these emerging digital technologies the independent film distribution value chain is being affected by two inter-related movements: First, a changing relationship with a new type of consumer (known as "active audiences"); and second, the opportunity to explore new business models that these technologies facilitate.

ACTIVE AUDIENCE: CONSUMPTION

The term 'Active Audience' (Gubbins, 2012, p. 37) refers to the emergence of a new group of technology-savvy consumers who primarily consume media product via the Internet. This demographic demand personalized online entertainment content—music, movies, TV shows, videogames—that entails greater freedom of choice, flexibility, and portability in their media consumption (Pardo, 2014, p. 330).

Bloore's (2009) study challenges long-held perceptions of customer identity and sets them within the context of the present Internet environment where film bloggers, social networking, and other movie opinion sites can either make or break a film. He identifies active audience consumers as fulfilling two key value-related functions: The first is purchasing the product and allowing financial value to return down the chain (customer consumption); the second, is that the long-term "library" value and reputation of the film is highly influenced by the response of both the general audience in driving word-of-mouth through social networks and as critical voices (Bloore, 2009, p. 11).

However, what Bloore does not address is the evolving consumer expectations of active audiences. The concept of the "Experience Economy," laid out in 1998 by U.S. economists Pine and Gilmore (cited in Gubbins, 2014, p. 50), is useful in this respect. They suggest that modern economies have been progressing from the sale of goods, to the sale of services, and now to the sale of experiences. For film, the cinema experience has been, and largely remains, central to both the film "experience" and to film business models, but it is being challenged to evolve in response to active audience expectations. Gubbins (2014, p. 51) states that in an age of ubiquitous media and an interactive, "always-on" mobile culture, the value of unique experiences increases. Many in the media and entertainment fields have been embracing "experience economics," finding that consumers will pay a premium for authentic personal experiences, such as live concerts and sporting events. In cinema, there has been a rise in the popularity of live theater programming as shown by the Royal Shakespeare Company's 2013 production of *Richard II*, which earned \$1.6M during its launch night, bettering films such as Disney's British Academy of Film and Television Arts (BAFTA)-nominated *Saving Mr. Banks* and Sony's horror remake of *Carrie* (Mitchell, 2013). Vickery and Hawkins (2008, p. 25) have pointed out that film has unique economic features as an "experience good" though market performance depends on complex interactions between psychological, social, and cultural factors.

Hollywood studios have begun to adjust their strategy to put more emphasis on the experience of spectacle to reinforce their business model (Gubbins, 2014, p. 53). The rise of the blockbuster film "tent-pole," utilizing technologies such as 3D, high frame rates, IMAX systems, and Dolby Atmos sound, represents a clear goal of creating event experiences to increase audience numbers (Gubbins, 2014, p. 53). While this approach appears to be effective, the introduction of these technologies to the production process is expensive.

Independent distributors have looked to exploit the power of "film as event," but in different ways to the major studios. British distributor Curzon World has used special screenings with Q&A sessions as a way of providing additional value to the theatrical experience but at minimal additional cost.

A prime example of this is the "one night stand" event screening of Lars von Trier's *Nymphomaniac* (BFI, 2014b). This occurred a week before its national "day-and-date" release, where the film was released online and in theaters simultaneously. The "one-night stand" event screened volumes one and two of the film on the same night at 73 venues across the United Kingdom (BFI, 2014b). This was followed by an onstage interview with the films' actors broadcast via satellite to all the venues. In attempts to increase engagement and connect the offline and online experience, audiences around the United Kingdom were invited to take part in the interview by sending questions through Facebook and Twitter. Audience members' personal images from the event were also published online and widely shared on social media platforms, creating organic publicity awareness but at a comparatively low cost. The £143K box office for *Nymphomaniac*'s "one night stand" event set a record opening night gross for a von Trier film in the United Kingdom (BFI, 2014b, p. 11). It compares strongly against von Triers similarly controversial 18-certificate *Antichrist* in 2009 that had an opening weekend gross of £99K (IMDB, 2009). Though the stronger performance was partly as a result of higher ticket prices for the event that were justified by the novel approach. It demonstrated that in a demand-led market audiences are willing to pay premium prices for unique event experiences.

Similarly, hybrid events such as those held by "secret cinema," which combine audience participation and theme-based activities before the screening of films, have become highly popular and a new means for audiences to enjoy films, but again with a comparatively low premium cost to distribution and exhibition. In 2014, the organization held a month-long preview of Wes Anderson's *The Grand Budapest Hotel* before its national release. The event featured a night of story-focused interactive theater prior to the screening of the movie. Despite tickets costing upwards of eight times a standard ticket rate (£53.50 per person), the event sold out 29 initial screenings, prompting an additional 12-day run (Bathe, 2014). Gubbins (2014, p. 54) notes that its success shows that watching film in a social space still has considerable potential for attracting new audiences.

The strategies used for *Nymphomaniac* and *The Grand Budapest Hotel* demonstrate that new approaches to marketing and packaging film product can be successful when they are aligned with consumer demands, even if they extend significantly beyond traditional exhibition. In both cases, the campaigns recognized that cinema release not only is at the center of the film "experience" but also acts as a driver for attention and revenue to alternative platforms for their subsequent national release (Sampomedia, 2014). Both sought to expand the offline event by encouraging audience participation online to share their experiences and fuel organic publicity buzz. It is important, however, to note that the reputations of von Trier and Anderson as "auteurs" likely influenced the success of these strategies. In essence, these approaches successfully traded on the "brands" of the directors and pre-established audience knowledge of their work.

BUSINESS MODELS: DISTRIBUTION

The impact of new technologies has prompted some distribution companies to re-examine the traditional windowing system within the film value chain, determining whether more commercially appropriate business models exist by breaking holdback periods and introducing VOD earlier into the release strategy. Multiplatform approaches including "ultra VOD" and "day-and-date" releasing have emerged, which are becoming particularly attractive to independent film distributors. The former refers to releasing a picture online via transactional video on demand (TVOD) a number of weeks before its scheduled theatrical release. Distributors charge a premium price to allow the audience an opportunity to view the film before its availability in the cinema, creating a sense of exclusivity and helping to promote good "buzz" around the film. "Day-and-date"[2] involves a simultaneous release on multiple distribution platforms. Typically this involves a picture being released in cinemas, online VOD and on home video (DVD and Blu-Ray) on the same day. These multiplatform distribution models represent a new way of monetizing film that breaks away from the singular value chain of traditional film release. It places convenience and accessibility for consumers at the heart of the transaction.

In the United Kingdom, the BFI has emerged as a major proponent of multiplatform release models, establishing a £4M "new models" funding strand to support distributors in experimenting with new ways of connecting films with audience. Ben Wheatley's low budget production, *A Field in England*, was one of the first films to be supported by this scheme. On July 5 2013, it utilized a day-and-date release in cinema, on DVD, on VOD, and via free terrestrial broadcast (Rosser, 2013). The film gained substantial publicity from the novelty of this release approach, with the campaign being featured in a key national newspaper (*The Independent*) as well as generating a high-level of interest online. This generated a level of buzz typically associated with films with much higher budgets. The opening weekend of *A Field in England* achieved a box office of nearly £22K from 17 sites, ultimately culminating in a theatrical return of just over £51K (Rosser, 2013). From October 2013, VOD sales accumulated to 6,212 transactions for £15K and DVD and Blu-ray amounted to 7,172 unit sales (Wiseman, 2013). The film averaged 367,000 viewers during the Film4 free screening, which represented a 3.13% share of the total television audience—up 8% for that slot in the schedule in terms of audience (BFI, 2013a, p. 9). Given the film's production budget of £300K (Burrell, 2013), these figures are impressive.

It is important to note, however, that the media interest in new release experiments can distort revenue results. This was commented upon in the

BFI report for *A Field in England*, which suggested that the publicity surrounding the innovative release played a big role in generating sales (BFI, 2013a, p. 14), although the scale of this has been difficult to quantify. Despite this, the approach the film utilized does suggest that there is potential for alternative release strategies to be effective if they are carefully considered. It is interesting that 77% of the film's cinema audience knew that *A Field in England* was available to view on broadcast television (Film4) for free, yet paid to see it anyway (BFI, 2013a, p. 14). This suggests that the assumption that the theatrical market will be completely undermined by multiplatform release is flawed. It also suggests that two audiences can exist for consuming film product: Those who enjoy the cinematic experience and those who prefer to control when, where, and how they watch films.

Such multiplatform release approaches are considered more relevant for independent films because their box office visibility is generally lower and their theatrical runs shorter. In this regard they can ease the pressure on the opening weekend box office. Instead of aiming for immediate "breakout" success, distributors can maximize their investment in distribution and marketing costs, and benefit from economies of scale by spreading it across multiple platforms. Philip Knatchbull, CEO of Curzon World, suggests that release windows in the traditional film value chain have become an irrelevant barrier between content and audience, commenting that, "Certain films deserve a smaller window. The key is finding a way to maintain flexibility and to keep control. We have to give the customers what they want, when they want" (Heidsiek, 2014, para. 2).

THE VALUE CHAIN: A WIDER VIEW

A key element of using value chain analysis is to enable a company to remain competitive by gaining an understanding of its strategically important activities and adjusting them in accordance with market changes. In the case studies explored above, the approaches adopted by Curzon World and Film4 Productions illustrate a proactive response to a market that is being impacted by digitally driven changes. What is emerging is that no one model for multiplatform distribution will replace the rigid value chain of the old distribution models. Rather, a number of different options, formats, and platforms can be utilized together according to the individual needs of each specific film. In doing so, companies can align their business to consumer demand and subsequently increase revenue by creating a more attractive experience or product.

The influential Hollywood film-makers Steven Spielberg and George Lucas have predicted that film exhibition is on the verge of a fundamental change. They have suggested that the American motion picture industry is facing an "implosion" that will occur following a simultaneous failure of a number of mega-budget films (Child, 2013, para.1). They argue that there will be fewer theatrical venues and the chains that remain will focus on event experiences in the form of high-budget blockbusters. Films will become exclusive offerings where they stay in theaters for extended periods and command premium ticket prices (Cohen, 2013). However, they arguably underestimate the economics of the Studio system where the losses of a number of pictures are outweighed by the significant profit from others. For example, in 2013 Universal Pictures lost a reported \$130M on *47 Ronin* (Mendelson, 2014) and \$80M on *R.I.P.D.* (Pomerantz, 2013) yet earned profits of over \$800M from *Despicable Me 2* alone (Mendelson, 2014). The globalized slate approach employed means the U.S. studios are able to mitigate the impact of failures by replacing unsuccessful pictures with others quickly, benefitting from a cumulative international box office. This means that, on balance, risk and return in the current model continues to be highly attractive. The results of this approach are telling as the six major U.S. studios enjoyed 82% of the U.K. box office market share in 2013 (Sandwell, 2014).

Therefore, it is arguable that as a result of the technological impact on the industry, the market will develop in two directions: one for the Hollywood studio conglomerates that continue to use film value chain models based on traditional mechanisms and the other for independent distributors based around flexible multiplatform releases that are tailored for individual films. For independent distributors this marks a significant shift from a supply-led market approach (as operated by the Hollywood studios) to a demand-led approach (Finney, 2015) that puts the needs of the consumer to the fore. Finney (2015, p. 223) pinpoints the changes within the industry are being driven in large part, not by old-style broadcasters and filmmakers, but by a range of new companies meeting consumer demands in ways the old systems did not. Among the most aggressive of these has been Netflix, which is presently dominating the subscription VOD (SVOD) market with over 62 million subscribers globally (Richwine, 2015). Netflix are restructuring the film value chain under their own terms, not only by tightening windows with day-and-date releases, but also by engaging in production of its own original content and, therefore, eliminating a number of established players from the value chain process. Netflix CEO, Ted Sarandos, has been vocal in his opinions of the traditional systems, describing windows as “creating artificial distance between the product and the consumer” (Sychowski, 2014, para. 45). He argues that competing for consumers’ attention and dollars over the “preciousness” of access is a thing of the past (Sychowski, 2014).

However, there is significant resistance to these strategies in some sectors. Major exhibition chains in the United States such as Regal, AMC Theatres, and Cinemark have indicated that they will not program Netflix-produced features. Similarly in the United Kingdom, multiplex chains—which account for 75% of screens in the United Kingdom (BFI, 2013b)—are presently refusing to participate in multiplatform releases that shorten the theatrical window. However, with continued pressure from technology companies such as Netflix, along with the financial support from the BFI, and companies such as Curzon showing a willingness to explore multiplatform releasing, it is likely that new release models will become increasingly common and accepted.

CONCLUSION

This article has illustrated that the traditional business environment for independent film product has become increasingly challenging due to the changing economics of theatrical releasing and the decline of home video. The vertical linkages of the traditional distribution value chain, built upon rigid window system constructs, are being questioned. This is forcing the industry to begin to reconsider whether such rigid periods are still relevant and the most effective means of generating maximum income. The impact of digital technology on distribution and consumption value chain activities is transitioning the independent market from supply-led to demand-led. But it is not just the technology that is challenging the value chain since few technologies are intrinsically disruptive. Rather, it is the business models that these technologies enable that create the disruptive impact (Ferrer-Roca, 2014, p. 19). As new business strategies are adopted, the market may develop in two directions: one for independent distributors based around multiplatform releases, the other for Hollywood studios that continue to use models centered on traditional mechanisms.

It is too early to confirm whether this is a true paradigm shift and, if so, define it concretely. The industry is still in a comparatively early stage in terms of adapting to and adopting new technologies. Lessons will continue to be learned as distributors gain experience and relevant data on the efficacy of new approaches to successfully adopt new business models. A key question left unanswered remains the economic viability of new distribution models. Do they present a stronger financial return to distributors or are the traditional models, despite the declines, economically more successful? Can new business models work for larger independent films or are they best suited for niche markets? Further research is needed in these areas and requires empirical evidence to support findings although access to this information is challenging. To date, the ability to test new models on a large scale has been hindered by the refusal of exhibitors—particularly the multiplex chains—to participate in multiplatform releases. Testing has been limited to niche films that would have likely received a restricted conventional release. Likewise, access to performance data from VOD platforms has also been limited; the reluctance of VOD providers to share this information makes analysis—of what is working successfully or what is not—extremely difficult.

The search for optimal business models in this new digitally driven market will undoubtedly continue for some time as the market evolves. The film value chain provides an effective framework for firms to re-examine their tactical and strategic operations in a dynamic business environment. In this case, it has acted as a stimulus to identify the impact of emerging digital technologies on distribution and consumption processes, arguably revealing the beginning of a fundamental shift toward a demand-led independent market. Consequently, film distributors can now develop alternative release models best suited to satisfying consumer demand, breaking away from the constraints of traditional distribution systems and transforming the relationship between key segments in the film value chain in the process.

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NOTES

1. VOD Business models are categorized by a series of rights that determine the nature of their service: TVOD, where consumers make an individual purchase to buy or rent a title; SVOD, where consumers are charged a monthly fee in return for access to a digital library of content; and ad-supported VOD (AVOD), where viewers can access content for free; however, advertisements are integrated into the delivery at various points throughout the film.
2. Day-and-date can also refer to a simultaneous theatrical release in a domestic and international market of a blockbuster, but within the context of this article it should be understood in reference to multiplatform.

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Digital disruption and its implications in generating 'impact' through film and television Practice-as-Research

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ABSTRACT

Both research funding bodies and the Research Excellence Framework (REF) are increasingly looking at 'impact' as an important measure of project success. For those involved in film or television practice-as-research, demonstrating impact beyond the academy and measuring 'reach' has often been considered through the public visibility of their projects. Yet, even for industry professionals it is becoming more difficult to reach target audiences due to the disruption caused by the emergence of on-demand distribution. This has resulted in reduced access to theatrical and broadcast exhibition and led to new challenges in gaining visibility in an increasingly crowded market space that affects commercial and academic projects alike. This paper considers issues faced by professional independent producers in this disrupted environment and examines strategies that have been developed to succeed within it. We argue that lessons learned by independent producers can be adapted by academics involved in film or television practice-as-research to enhance visibility of their own projects and demonstrate 'impact'.

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Introduction

The landscape of academic research is changing. In many countries, reforms to research council structures have resulted in new expectations for researchers to show 'impact' in their work to justify the value of public expenditure. 'Commercial potential' and 'societal relevance' are increasingly being emphasised to more closely link universities, industry and government (the 'Triple Helix' first discussed by Etzkowitz and Leydesdorff 1995 and developed by Benner and Sandström 2000). Models of research methods more directly relevant to industry, including different types of consideration of practice such as Research-in-Practice, Research-by-Practice, Practice-based-Research and Practice-as-Research (PaR), have grown and developed in response to these new demands.

The creative industries, including film and television, are widely recognised as significant contributors to many national economies – UK Business Secretary Greg Clark noted that the sector 'currently contributes £92 billion a year' to the British economy alone (GOV.UK 2018). Moreover, the demand for screen-based content has never been

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greater with commercial film production increasing by nearly 50% since 2010 (Statista n.d.) and the rapid growth of on-line services expanding the availability of both new and back catalogue television product (Wilson 2018).

New digital technologies, most notably Video-on-Demand (VoD), are changing the ways in which content is accessed by viewers and monetized by producers. Tryon (2013) provides a detailed account of this 'digital disruption' including emerging changes to delivery mechanisms and the resulting impact on consumption patterns. The transformation of the business of film and television has affected the independent production sector significantly. Reaching audiences and generating revenue has become increasingly difficult due to the growing amount of product available and the impact of new distribution practices by both Hollywood Studios and international digital content distributors (e.g. Netflix and Amazon) – Kehoe and Mateer (2015) examine this for the UK market. Independent producers have consequently had to develop new ways to compete and succeed in this highly competitive environment. Since academics involved in Practice-as-Research also need to reach audience to maximise and demonstrate impact, we argue lessons can be learned from examining these strategies.

In this paper, we consider various ways that independents have sought to increase audience size and enhance revenue generation. Through interviews with film and television practitioners, we have identified new marketing and exhibition methods that have enabled them to compete in this 'disrupted' marketplace. Many of the techniques discussed can be adapted by academics undertaking PaR to enhance audience reach and thus demonstrate 'impact' and 'benefit' to research councils and other institutional stakeholders. Thus, lessons can be learned from industry that can enhance academic research.

Measures of success and impact

In the UK, the Research Excellence Framework (REF) is viewed as the main indicator of the value of research at both institutional level, rating the universities themselves, and at national level, by providing 'accountability for public investment in research and […] evidence of the benefits of this investment' (REF 2021 n.d.). A key component of this is the formal assessment of research outputs as well as their 'impact' beyond the academy.[1] For an academic conducting Practice-as-Research, there is normally an additional requirement that a project be clearly situated among other research works and contextualised to show novelty and a contribution to the greater body of knowledge. Unless there is an aspect that is overtly unique (e.g. an experimental technique used in production, a new form of narrative, etc.), meeting these requirements can be challenging, particularly for more commercially-oriented or 'mainstream' outputs where the novelty or significance may not be visible on screen. Without the creation of additional traditional academic publications that detail how the work meets these requirements, it is questionable whether such outputs will be considered as legitimate research.[2] On the other hand, demonstrating 'impact' is arguably more straightforward for commercially-focused PaR as the REF considers this through the evaluation of 'impact case studies' using measures similar to those often used in industry.

For REF 2021, panel criteria include indicators such as 'engagement', 'independent citations in the media', 'employment' and 'financial figures' in assessments of case study submissions, (ibid). There is an increased emphasis on the use of quantifiable data – including 'numbers', 'percentages and rates', 'measures of change', 'time periods' and 'currency' – to better enable clearer like-for-like comparisons between case studies. These criteria seem to match well against metrics often used to assess the success of commercial film or television works:

- *Reach*: screening attendance, number of viewers, audience size
- *Significance*: published reviews, feature articles, audience focus group data
- *Economic Benefits*: jobs or placements created, box office revenue, ancillary revenue generated
- *Societal Benefits*: changes in policies or laws, actions taken by viewers, awareness raised

Chapter 4 of Gunter's (2000) seminal book on media research methods provides a useful overview of specific techniques designed to evaluate the exposure of media content. Jensen (2013) and Bertrand and Hughes (2018) both expand on his work, discussing a range of tools to evaluate media in a variety of contexts.

The importance of visibility

Central to generating impact is 'visibility,' which is essential for any film or TV programme, irrespective of whether the work is for research or commercial consumption. In the past, the options for exhibition of independent content were limited to traditional theatrical release, terrestrial broadcast, festival screenings and/or physical media (e.g. DVD or tape). Simply obtaining public release in some form suggested a base level of importance and impact. Indeed, prior to the advent of digital production technologies, the cost of production was sufficiently significant to limit the amount of product made.

Knight and Thomas (2011) provide a useful analysis of distribution approaches and marketing practices for independent and 'art' films starting in the 1970s. These often involved a 'do-it-yourself' approach to distribution and exhibition in order to reach their target audiences directly, bypassing the traditional 'gatekeepers' who controlled access to theatrical or broadcast venues. Although the period their work covers ends just as Video-on-Demand was gaining significant public take-up, they noted that ' … although operating online offers a potential global reach, given the abundance of material on the internet, establishing a presence and identity is still crucial.' (ibid, p269).

Today, the advent of new types of media-capable platforms including phones and tablets as well as the reach of VoD and other more flexible means for consumers to access product, would suggest that the potential for independent producers (and those involved in PaR) to gain visibility for their work is greater than ever before. However, lower production costs facilitated by new and more accessible technologies has led to record levels of content of all types being produced. Even smartphone cameras have evolved to the point where they can be used for commercial projects – Erbland (2018) provides an overview of feature films shot on phones including Sean Baker's *Tangerine* (2015) and Steven Soderbergh's *Unsane* (2018). This has resulted in an extremely crowded content marketplace in which it is increasingly difficult for independent work to be found and therefore seen.

The state of the UK marketplace

Although cinema attendance in the UK has remained essentially stable for the period 2007–2017, at roughly 170 million admissions per year, the number of films released has notably increased to an average of 15 each week (BFI 2018). Of the 760 films released in this country in 2017, 64% screened at fewer than 50 sites with 34% at fewer than 10 (ibid). This, coupled with the fact that typically only around 7% of UK cinemas show non-mainstream features (BFI 2017), confirms that theatrical exhibition is now very difficult for the majority of independents to secure.

During the same period, Video-on-Demand has taken off. Netflix has seen its subscriber base increase by nearly 800% since 2012, to nearly 160 million members (Richter 2018), and Amazon has shown roughly similar growth, surpassing 100 million subscribers to their Prime service earlier this year (Spangler 2018a). More films are now consumed on VoD than theatrically but interestingly this has not encouraged audiences to consume a wider range of material (i.e. there is no greater diversity in audience tastes nor a demonstrable willingness to try new types of product despite easier access to it). Coupled with the widely held view that 'the marketplace is over-saturated' (Ryder in Distributing Films Online 2017), this underlines the significance of the challenges independent producers face in reaching their target audiences.

The Myth of self-distribution

Given the power of online media and the possibility for direct control of revenue streams, self-distribution would appear to offer a desirable and logical approach for both independent producers and those involved in practice-as-research. Knight and Thomas (2011) suggest that it should be possible to adapt methods used previously to best exploit the current landscape. However, examples of successful self-distribution by filmmakers have nearly always involved relatively large cash injections (or even 'buy outs') from established industry third parties. Veteran independent producer and Raindance founder Elliot Grove describes a typical case:

> One of my favourite self-distribution stories is Lee DeMarbre's 2001 classic *Jesus Christ Vampire Hunter*. He followed up a successful string of festival appearances with a tour of the Northeastern States where he booked the film into a string of late-night cinema screenings. Following that, he managed to get the film distributed by Lloyd Kaufman's Troma label, and most recently it is showing on a string of Internet aggregators like Netflix. Lee has managed to create a revenue stream for his film over a decade-plus span. (Grove 2018)

Thus while DeMarbre did devise and execute an exhibition strategy that circumvented some aspects of traditional gatekeeping, negotiating access to little-used late night slots in key theatres, it was the acquisition by a recognised distributor that enabled much broader visibility and facilitated easier audience access to his film. Considering this in terms of Practice-as-Research, the film's 'impact' was ultimately reliant on conventional dissemination. It might be asked why producers do not opt to self-distribute their films to retain ownership and control over their product. In part, this is because distribution and marketing are significantly different tasks to production, requiring specialist skills that producers lack. Involving an established company to do this work is highly attractive, even if potential revenue is reduced. For those involved in PaR, the idea of involving a third party to assist in exhibition may seem unrealistic but the prospective benefits suggest that it could be highly beneficial and thus worthy of exploration.

Examples of film projects that have achieved significant levels of revenue or visibility solely through self-distribution, without any outside assistance, are scarce. Likewise, industry often (unfairly) views self-distribution as an indication that a work is not of sufficient professional quality to merit public release. Tom Kerevan, producer of the independent horror film *Tear Me Apart* (2015), noted that self-released films 'are not considered proper movies' by industry because they do not have a more traditional release pattern (interview, October 22, 2018). Indeed, many films of quality (as demonstrated by prestigious festival presence and awards) fail to secure distribution deals, often due to market forces. Acquisition executives will pass on a film if it is not directly aligned with their company sales or marketing objectives, even if they admire it. Self-distribution may be widely seen as a last resort, but when all traditional channels have been exhausted, it can become a necessity. The effort involved in making any film is significant (not to mention the investment of money and time) so the prospect of not having any substantial visibility is unacceptable.

The rise of VoD outlets suggests that the possibilities for distributing television or film projects are widening beyond traditional broadcast or classical theatrical exhibition models. However, to get a work on a high-profile platform such as Netflix or Amazon, or even non-subscription platforms such as iTunes, still requires the platform to select the work. Indeed, access to these platforms by independent producers typically requires the involvement of an 'Aggregator'[3], such as The Movie Partnership, Distribber or Quiver, which adds yet another layer of gatekeeping.

But platforms do exist for truly independent self-distribution. Companies such as Ooayala and Deluxe provide customisable online systems that can enable individuals or organisations to create their own VoD platform with full control of viewer access, content and monetisation. However, the cost of these is prohibitively high for most independents, and they do nothing to promote visibility. Marketing falls wholly to the producer and, as the difficulties of niche VoD services such as Afrostream (Briel 2017), DramaFever (Spangler 2018b) and FilmStruck (Spangler 2018c) demonstrate, securing audience to cover costs can be difficult, even for highly resourced organisations. The challenges in self-distribution are substantial for independent filmmakers and are arguably even greater for those involve in PaR, where project resources are typically more limited and skewed toward production rather than distribution.

Considerations for gaining visibility and generating impact

Despite the challenges, independent producers have developed creative ways to generate initial interest in their projects then leverage this to gain larger exposure that ultimately can build audience. Although specific approaches vary, they usually involve a mix of innovative forms of screenings followed by more traditional release mechanisms once a certain level of visibility has been achieved.

Jack Tarling, producer at Shudder Films, has simple advice – 'make the best film that you can' (interview, June 1, 2018), a reminder that the quality of a project has a significant – but not absolute – impact on potential visibility and strategies needed to generate impact. Tarling always targets cinema-based distribution. 'If the film is strong enough to go theatrical, it will. Good theatrical means that the rest (VoD, TV and other platforms) fall into place.' (ibid) He argues that the 'big streaming giants look at theatrical as "free publicity"' and that high profile VoD represents the main source of audience (and revenue) for independents.

Tarling and Manon Ardisson produced the feature *God's Own Country* (2017), one of the most successful British independent films of 2017 having grossed over £2.5M theatrically (IMDB Pro n.d. a). Developed as part of BFI's iFeature programme and with support from Creative England, the project ultimately followed a conventional release strategy that relied heavily on the strength and topicality of the story (a young homosexual farmer's world is changed when he falls in love with a Romanian migrant worker). It premiered at the 2017 Sundance Film Festival, where it was nominated for the Grand Jury Prize for World Cinema (Dramatic) and Director Francis Lee won the Directing Award. It also won the Männer Jury Award as Best Film at the Berlin International Film Festival (IMDB n.d.). These successes led to it being picked up by major distributors Samuel Goldwyn Films and Orion Pictures for US theatrical release (Tartaglione 2017) and Picturehouse for the UK (Grater 2017). Keen to extend the film's visibility to maximise the theatrical run, the filmmakers targeted numerous other international festivals, including those with LGBT themes. In total, *God's Own Country* was nominated for 33 awards, including a BAFTA, with an impressive 29 wins (IMDB n.d.). Tarling noted that positive press and reviews 'made distributors confident in theatrical.' Indeed, sustained high box office averages resulted in a longer UK theatrical run than had been planned, which 'gave VoD (providers) confidence that there was demand.' (interview, June 1, 2018) The film first appeared on Amazon as transactional VoD before being picked up by Netflix (as subscription-based VoD) after a 90-day window. Tarling noted that 'there was no need to do bespoke marketing' because of the volume of positive press exposure. All that was required was to promote the film's success as widely as possible and social media, particularly 'superfans' active on Twitter, played a vital part in this (ibid).

Tarling attributes the success of *God's Own Country* to the quality of the film itself, the universality of love stories and the timeliness of the topic. But he is also aware that such a hit is rare and that independent projects typically require much more effort to gain visibility:

> You need to motivate the audience. Is your film going to motivate people to go to the theatre? Films can still have value without much theatrical (exposure) but there must be (an attractive) element be it topicality, timeliness or a well-known event. (ibid)

Even though *God's Own Country* received immediate critical and festival success (which is much more the exception than the norm in independent film), the producers still needed to exploit and promote the publicity generated. Their approach was strategic and sought to build visibility using a variety of vehicles based on their understanding of both their film and their target audience. For those engaged in Practice-as-Research, the approach is directly transferable. Understanding the potential appeal of the work, identifying and targeting audience for it, generating initial visibility and then strongly promoting any exposure received to leverage wider visibility, can maximise its reach and impact.

Tom Kerevan and his colleagues at Cannibal Films had three aims for their first project, *Tear Me Apart* (2015), a £60 K micro-budget feature film:

> a) make as much money back for our investors as possible […], b) get the attention of the industry, make people take note (of us as emerging filmmakers) […] and c) get it out to as many people as possible outside the industry. (Kerevan in Distributing Films Online 2017)

The filmmakers prioritised paying off investors first. They developed a VoD-focused strategy involving Amazon and using social media to raise awareness. Over a six-month period, they developed a focused PR campaign including creating a companion website for the film and purchasing advertising on Facebook, both of which linked directly to Amazon where users could rent or purchase the film. While the approach generated traffic, the revenue created through Amazon only covered the cost of the Facebook advertising. But when the film moved to Amazon Prime, the algorithms promoted it to a point where it 'took off', creating a small but steady revenue stream that would eventually repay investors. Cannibal Films had approached independent distributors worldwide but there was little interest as the film had received no theatrical visibility. They rejected an offer from a US Sales Agent and decided to live with the 'long tail' of income from Amazon even though it meant repayment would take longer than hoped (Kerevan, interview, October 22, 2018).

Kerevan notes the imperative of having a clear understanding of objectives for any project before starting – 'Why are you making this movie and why are you making this now?' (ibid). Those involved in Practice-as-Research need to ask similar questions, particularly given the growing requirements to demonstrate impact and the value of the investment by research funding bodies. Considering impact strategies during project development can help fulfil project aims more effectively and efficiently.

Independent filmmakers often regard theatrical release as the 'holy grail'. However, competition for commercial screen space is fierce. As Samm Haillay, producer at Third Films notes, 'distributors seem to be getting more conservative' (Haillay in Distributing Films Online 2017) with traditional 'pick-up' significantly less common for independents. Yet, as Andee Ryder, producer at Misfits Entertainment indicates, theatrical exposure continues to play a vital role in visibility:

> Theatrical campaigns help drive traffic to on-demand and home entertainment but is expensive and requires sufficient (print and advertising) investment to make it worthwhile otherwise it is wasted money. (ibid)

To get around the traditional 'gatekeepers' that control theatrical access, particularly in the absence of an adequate marketing budget, many producers are turning to a 'road show' model. Here, the producer identifies key locations of target audience members and then develops a 'tour' of the film with a limited number of screenings at each 'stop' – we suggest that this type of approach is readily applicable to Practice-as-Research projects as well. On-demand cinema providers such as Ourscreen, which secures cinema screen space once a specific number of tickets are pre-sold, and independent-friendly schemes such as Picturehouse 'Discover Tuesdays' involving the City Screen chain, which are comparatively easy for producers to secure, give projects access to commercial venues albeit for limited periods. Revenue generated is usually split between the venue and the filmmakers but often 'the goal is not about money, it is about visibility', explains Haillay (interview, May 21, 2018). 'The trick is to raise awareness and word of mouth' that can ultimately drive traffic to VoD or, ideally, enable full distributor pick-up. However, it is vital to 'be aware of the release schedules of the studios to avoid competing with high-profile mainstream and "tentpole" films' (ibid).

Approaches to road shows vary. For *Edie* (2017), the filmmakers 'four walled'[4], heavily publicising the project to their target audience of senior groups and old age pensioners. They were able to generate several sell-out shows from which they secured distribution by Arrow Films (Grove, interview, October 16, 2018) with the film generating nearly $1M in box office revenue (IMDB Pro n.d. b). The documentary *A Plastic Ocean* (2016) employed a different type of road show model. Although backed by Netflix, the film was created in support of a non-profit organisation (Plastic Oceans 2018). To raise awareness of both the film and the environmental problem it examines, publicity gained through its premiere at the Raindance Film Festival in London was leveraged to secure a screening at the United Nations. This led to screenings to government officials in numerous countries. More relevant to independent producers and those involved in PaR, the filmmakers also actively supported the creation of regional websites to target local environmentalists and grass roots organisations. Groups could register interest in obtaining a screening copy of the film and once a critical number was reached (typically 50), the filmmakers would send a DVD or DCP copy for local screenings for a small fee (Grove, interview, October 16, 2018). Effectively the road show was facilitated by the niche audience itself, which in turn generated further word-of-mouth thus driving further take-up.

For a film 'road show', the producer must fulfil the role of a distributor, including hiring a theatrical booker (or booking directly), aiming screenings appropriately, developing meaningful partnerships that can directly support the project, personalising audience outreach to create film 'experiences', and extending engagement with viewers beyond simple screenings. There is no reason why these methods cannot also be used in support of Practice-as-Research. But the approach does necessitate careful consideration of where a project is situated within the marketplace – is it 'activism', 'art' or 'commerce'? The distinction is crucial to positioning the work in a way to maximise public understanding and engagement (and ultimately impact). 'Activism' in this context centres on raising awareness for a cause. In that instance, identifying and targeting stakeholders to generate and grow awareness is paramount and can help for the audience itself to promote the film. If the work is 'art' then the distribution route should mimic gallery methods with the project travelling in smaller, more considered ways with a 'launch' followed by a 'tour' showcasing the work in arts-focused venues effectively developing a 'slow burn' increase in visibility. This is an established model used extensively for PaR. However, if a work is framed as 'commerce' then the approach needs to be more aggressive as the success of mainstream films is largely dependent on creating 'buzz' and expanding it as quickly as possible. Unlike art, commercial projects usually have a limited period in which to create impact. In PaR approaches are typically more reactive than proactive and festival success is often seen as the only significant factor in the level of impact possible. While time demands on academics and researchers might dissuade them from taking on distribution tasks, if PaR is truly going to be of value and generate impact, they are essential.

In order to give their projects visibility in an overcrowded marketplace, some independent producers have devised creative approaches to marketing that are distinctive yet cost-effective. Third Films' feature drama *Blood Cells* (2014) co-directed by Joseph Bull and Luke Seomore, who is also an established musician and composer of the film's score, uses music prominently in the story. As part of their road show, Haillay decided to trial two screenings featuring a live orchestra followed by Q&A with Seomore. Both quickly sold out, netting about £1,700 each, which more than covered the cost of the musicians. Haillay subsequently looked to expand this approach for another project with Seomore, *Heaven is Dark* (in pre-production as of this writing). Here the plan is to tour the film to three UK cities per week during a four-week period. Each screening will feature live orchestral accompaniment as well as Q&A with the filmmakers. The tour will conclude with one high-profile 'gala' screening based on a Picturehouse 'Discovery Tuesday.' The goal is to generate 'buzz' to drive traffic to VoD, the main source of potential revenue.

Although the film has not yet started production, Haillay chose to pitch the strategy to a high profile specialist Video-on-Demand platform[5], citing the success of the screenings for *Blood Cells*. He projected that, depending on the venues, sell-out events could net between £2,000 and £2,500 each, generating up to £30 K for the tour. Offering a 50:50 split of the tour revenue, Haillay secured financial support for the theatrical road show as well as a guarantee for promotion and distribution through the VoD service (ibid). The deal has allowed him to obtain the remaining production funding required. This example shows that identifying and understanding the unique aspects of a project during development can not only help in the design of an effective strategy to generate impact after completion, it also can strengthen the producer's ability to get the project made.

However adding value needs to be done in a manner that directly complements the work, otherwise the effort can be misplaced. To promote their zombie action film *Redcon-1* (2018), Intense Productions arranged a road show of over 30 screenings featuring Q&A with the filmmakers, including 22 dates in Vue cinemas across the UK. The company also contacted colleges and universities offering to run a masterclass titled, 'How to Make a Micro-budget Film & Sell It', seeking to leverage the saleability of their team, Carlos Gallardo (producer of the celebrated 1992 micro-budget feature *El Mariachi*) in particular. The goal was to raise awareness of the film directly with their key target audience (16–24 year olds) and generate additional funds to enable further promotion (Grove, interview, October 16, 2018). It is hard to assess the overall effectiveness of this approach, particularly the take-up of the masterclasses, but box office figures of under $25 K worldwide (at the time of writing, IMDB Pro n.d. c) and lukewarm critical reception suggest it has not been particularly successful.

Strategies to add value hinge on fully understanding how that value can be exploited. For example, Cannibal Films used different types of online presence to entice visitors to rent or purchase *Tear Me Apart* through Amazon. But the filmmakers also sought to strengthen this by developing a series of similarly-themed Kindle-based short stories. Kerevan (interview, October 22, 2018) noted that the idea was to link the e-book sites to Amazon Prime to enable easy click-through to the film but after committing to the approach they learned that no such linking provision exists. Compounding problems, although a URL was included at the bottom of the description for each item with seemingly unmissable text, they did not realise that Amazon's system hides this unless a 'Read More' link is clicked. Even when the text is revealed, the user must copy and paste the link manually into a browser. As a result, even though there was a good level of take-up in the e-book stories, Kerevan speculates that little of that translated to actual film views. This meant the effort to add value was ultimately ineffective as it had not been sufficiently thought-through (ibid).

Being able to reach target audiences is important, but to generate maximum impact, producers need to secure advocacy as well. Increasingly 'superfans' and 'social media influencers' are seen as an essential part of marketing campaigns. Haroun Hickman, an online 'community building' specialist, explains that next-generation marketing companies such as Zyper use sophisticated approaches to generating awareness of product and promoting purchase (interview, May 31, 2018). These start with the creation of a profile of a 'persona' indicative of a member of the target audience, considering lifestyle patterns and behaviours at a deeper level than conventional demographic analysis. From this, the marketing company contacts members of their own 'community' who fit the core profile and incentivise them to promote the brand through their own personal networks. These networks typically are small enough for the selected community members to be seen to be providing personal recommendations about the product authentically yet are large enough to propagate leads effectively.[6] These marketing companies charge clients per 'fan' with the success of the promotions being assessed by cost-per-engagement metrics considering 'likes', 're-tweets', 'shares', 'comment levels' and other evidence of audience activity on social media (ibid). While it is likely beyond the means of those involved in Practice-as-Research to engage this type of commercial service, the general approach used is still germane if the subject of the work has associated communities or networks. The success of both *God's Own Country* and *A Plastic Ocean* was due in large part to audience members actively spreading positive word-of-mouth and promoting the works themselves organically. While the producers did not hire influencers, the basic approach is the same – create a multi-platform social media presence, actively promote the project, identify followers and supporters, and nurture their ability to act as advocates on the project's behalf. By fully understanding who the core audience is for a work, it should be possible for any producer, PaR or otherwise, to develop awareness and organic advocacy in the same way if project 'champions' can be found. Likewise, research impact can be demonstrated by the same metrics used by marketing companies in assessing the efficacy of the online campaigns.

Maximising impact for Practice-as-Research

In order to maximise impact for PaR, academics need to keep traditional research questions in mind alongside the considerations outlined above, specifically:

- What is novel or unique about the project that has relevance to research?
- What is the problem or area being addressed and how is knowledge being advanced through the practice?
- How does this project relate to prior works and related research? What is the context?
- What is the potential for impact? Who are the beneficiaries?

It is important that these be considered as early in the project as possible.

David Hickman is a veteran television and film producer as well as an academic at the University of York. He produced and directed three episodes of the highly acclaimed 2011 television series *Slavery: a 21st Century Evil* (Al Jazeera n.d.). The project highlighted continuing practices and policies that effectively support slavery in a number of countries, with Hickman's episodes considering Haiti, India and Pakistan. The project was selected as a finalist in the 'Best Limited Series' category at the 2012 International Documentary Association awards and also chosen by his department as an 'impact case study' for REF 2014 as Practice-as-Research. The impact of the project was significant – over 35 million people viewed the series across Al Jazeera's terrestrial, cable and online channels; at least four people were known to have been freed from bonded slavery; and $3M was secured for the creation of a shelter for bonded labourers in Lahore – and this was acknowledged by the REF panel (Hickman, interview, May 31, 2018). However, Hickman noted that it was 'hard to detail the research behind filmmaking in conventional academic terms' after a project has been completed. 'The activities involved in pre-production (were) directly related to academic research – sourcing subjects, developing means of enquiry, contextualising discoveries, etc. – but my methods were seen as "non-standard"' even though they were wholly consistent with professional documentary production. This illustrates the importance of considering academic research requirements as early as possible in the PaR process. As Hickman noted:

> If I had known the project would be submitted to the REF, I would have planned it with impact in mind from the start. I would have kept a clear contact list to be able to get back in touch with (participants and other stakeholders) after the project finished to (better chronicle impact). […] I would also make sure to publicise the work being done through all stages of the project by creating a (running) 'making of' website. (ibid).

His experience highlights the need for academics undertaking PaR to define the types of impact they feel the project can generate and consider ways to gather evidence before the project starts. These should be rooted directly in the novelty of the research outcomes. Hickman also stressed the importance of 'evaluating and communicating (research) findings through the whole process', logging benefits and linking them directly to stakeholders (ibid).

As Hickman acknowledges, 'the nature of impact and what it means (to PaR) is better understood now. The (review) criteria for REF 2021 are clearer and fairer' (ibid). However, some fundamental issues remain with regard to institutional consideration of media-focused work, which need to be considered by those involved in PaR. In the UK, the academy has a narrow definition of 'authorship' that is overly restrictive when considering film and television production work. Presently only the director (or in certain instances the writer) is considered to be the actual 'author'. Yet, this does not recognise the nature of film production and excludes producers, who arguably have at least as much influence on the development and realisation of a project as the recognised authors, and arguably have more influence on the ultimate impact a project can generate given their involvement in marketing and distribution. As it currently stands, academics with producing roles in PaR projects can only be considered for inclusion in REF if they have created additional research outputs examining the work. The actual media artefact, no matter how significant, cannot be submitted on its own due to the current definition of authorship.

Conclusions

In this paper we have considered Practice-as-Research for film and television in light of the changed media landscape caused by 'digital disruption'. We argue lessons can be learned from the experiences of independent practitioners in trying to have their work seen in this disrupted environment and that these can be adapted to help those involved in PaR generate and demonstrate research impact.

As the links between research, industry and government policy become more pronounced – as exemplified by the Arts and Humanities Research Council's Creative Economy Programme (AHRC 2018) – there is an increasing need for the academy to recognise and embrace industry activities and practices to further the objectives of both areas. We are hopeful that other researchers will begin to explore the synergistic links between them and expand on our comparatively limited work.

Notes

1. The third component of the REF, assessment of the research environment, is not directly relevant to this paper and thus is not considered here.
2. There has long been a divide between research in classical arts subjects (e.g. visual arts and music) and those that are performance-driven (e.g. theatre, film and television). The latter have often been seen as 'inferior' given a seemingly vocational focus and an emphasis on practice that many scholars feel lacks academic rigour (see Nelson 2013).
3. Aggregators are companies that, for a fee, will arrange exhibition on VoD platforms that would not normally deal directly with individuals or small companies. They are effectively film 'sales agents' but solely for online distribution.
4. 'Four Walling' refers to hiring a cinema for a limited period of time effectively purchasing tickets for all seats and then reselling them directly to audiences (Wasser 1995)
5. The name of the company is being withheld due to commercial sensitivities as of the time of writing.
6. Hickman reports that these networks typically have a follower base of 1,000 to 3,000 people.

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No potential conflict of interest was reported by the authors.

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Directing for Cinematic Virtual Reality: how the traditional film director's craft applies to immersive environments and notions of presence

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ABSTRACT

Virtual Reality (VR) has been an area of research for over 40 years yet only recently has it begun to achieve public acceptance. One key to this has been the development of 'Cinematic Virtual Reality' (CVR) where media fidelity approaches that found in feature film. Unlike traditional VR, CVR limits the level of control users have within the environment to choosing viewpoints rather than interacting with the world itself. This means that CVR production arguably represents a new type of filmmaking. Grammars for filmmakers have developed significantly resulting in a rich vocabulary available to use to create compelling stories. Relatedly, researchers into VR have also begun to understand mechanisms behind compelling engagement within VR. This paper looks to find a bridge between these two previously disparate media. It is argued that the concepts of 'suspension of disbelief' and 'presence' can be linked via 'transportation theory'. The applicability of existing filmmaking directing techniques for the creation of CVR projects is then explored. Existing film production methods are considered in a manner adapted to establishing 'presence' in a CVR space. Finally, areas for future exploration are considered in light of the immaturity of CVR as a medium.

KEYWORDS
Directing; cinematic; virtual reality

Introduction

The immersive medium of Virtual Reality (VR), referring to the presentation of first-person experiences through the use of a head-mounted display and headphones that enable users to experience a synthetic environment as if they were physically there, arguably began with Sutherland's (1968) work nearly 50 years ago. In the early1990s computer technologies had advanced to a point where the commercial potential of VR was seriously explored. There was significant investment by established manufacturers such as Silicon Graphics, Sun Microsystems and Evans & Sutherland as well as the creation of numerous VR start-up companies such as VPL, Division and Virtuality. However, the technology was ultimately not sufficiently mature nor at a low enough price point to enable viable take-up so commercial exploitation stalled. Schnipper's (2014) article, 'The Rise and Fall and Rise of Virtual Reality' includes an insightful section by Robertson and Zelenko (2014) with interviews with key players of the time. Only recently, with the emergence of inexpensive high-

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powered computer processing and display systems, has VR begun to become commercially viable and to be adopted by the public. Central to this take-up has been the development of so-called Cinematic Virtual Reality (CVR).

While a formal definition of CVR is still being developed, the emerging consensus is that the term refers to a type of immersive VR experience where individual users can look around synthetic worlds in 360°, often with stereoscopic views, and hear spatialised audio specifically designed to reinforce the veracity of the virtual environment (as a note, there are presently no initiating studies or foundational articles that can be seen as seminal at this point). Unlike traditional VR in which the virtual world is typically generated through graphics processing and audio triggers in real-time, CVR uses pre-rendered picture and sound elements exclusively. This means that the quality of these assets can approach that found in high-end television or feature film.

CVR programmes began to appear in 2015 propelled in part by major initiatives by Google, Jaunt VR and *The New York Times*. Google (2017) launched a major push into VR including the introduction of Cardboard, which enables many mobile phones to be used as a low cost head-mounted display. Jaunt VR is an online CVR distribution portal founded in 2013 and backed by major investment from Google, Disney, the Chinese media conglomerate CMC and others (Spangler 2015). Its stated mission is to, ' … put realism back into the virtual reality experience, lending an uncanny sense of presence never before possible' (Jaunt VR, 2017). In late 2016, *The New York Times* launched 'The Daily 360' (2017), a free online site that releases CVR programmes on a perpetual basis, making them arguably the largest producer and distributor of CVR content to date. In all three instances there has been direct engagement with Hollywood. Despite the fact that CVR take-up is still relatively low and projects to date are largely experimental, this has also involved the participation of major actors such as Natalie Portman, Don Cheadle and Ruth Negga (in the series *Great Performers: LA Noir*, 2016) and established film directors (detailed below) to help raise the medium's profile both publicly and within the film industry.

While CVR programmes in various genres have begun to be created, including advertisements for fashion (Gaultier 2016) and travel (Lufthansa 2015) as well as sports-based promotions typified by Mountain Dew (2016) and GoPro (2016), the majority of projects are either non-fiction, for example, *Fighting 'Cholitas' Wrestlers* by Bracken, Shastri, and Mullin (2016) and Starr-Dewar's *Rapid Fire: A Brief History of Flight* (2016), or action-based narrative, for example, Lewis' *Escape The Living Dead* (2016) and Lin's *HELP* (2015), which claims to be the first live-action CVR movie. Programme durations vary widely from short clips of under a minute, such as Koppel and Mullin's documentary short *Rebuilding a Church Crushed on 9/11* (2016), to medium form projects of approximately 20 minutes, such as the BBC's *Click 360* episode (2016), to multi-part dramatic series, such as Liman's *Invisible* (2016), which consists of five episodes of roughly six minutes each. Standard lengths have yet to be established but the majority of programmes are currently no more than seven minutes.

The user's ability to move autonomously within the virtual world, a core attribute of traditional VR, is restricted in CVR to an ability to choose an angle within the environment from which to view the scene – the inability of users to actually interact with elements contained within the virtual world is the primary difference between the two media. While both are immersive, CVR experiences are effectively linear presentations with the duration of each experience dictated by the length of the media assets employed. As a result, the methods associated with experience creation (i.e. production) for CVR arguably represent a new type of filmmaking. Considering CVR in this way suggests that some long-established filmmaking techniques could be adapted to this new medium. Indeed, it is interesting to note the involvement of established filmmakers in several of these projects – Doug Liman is best known as the director of *The Bourne Identity* (2002) and *Mr. & Mrs. Smith* (2005), Justin Lin directed *Fast & Furious 6* (2013) and *Star Trek Beyond* (2016), and Eric Darnell (*Antz* [1998], *Madagascar* [2005]) directed *Invasion!* (2016), which is the first Pixar-style CVR project to be released. The ability to experiment and explore new techniques in their primary feature film genres – Liman and Lin predominantly direct action films; Darnell high-end animation features – motivated each to work in the new medium (see interviews by Robertson [2016]; Roettgers [2015] and VR Film Pro [2016], respectively). Each has cited his interest in CVR as a new storytelling vehicle but also recognises that there are fundamental differences between directing for film and for CVR. Liman's comments (in Robertson 2016) are indicative:

> … we had to rethink the way we were telling stories, because when you just take a traditional scripted scene out of any TV script or movie script and shoot it in VR, it's going to be less compelling than what was shot in 2D. You'll feel like you're watching a video of a play. VR should be more emotionally involving, but that doesn't happen automatically by just taking a VR camera and sticking it onto what would be a traditionally blocked scene for 2D

Research into the application of filmmaking techniques to VR has been undertaken since the 1990s but on a rather limited basis. The work of Bates (1991) is notable and relevant to this paper in that he discusses the need for a '"deep structure" for the virtual world' to enable users to fully engage with the experience as well as the importance of 'suspension of disbelief'. He argues that the development of VR production techniques and grammars is analogous to that of technical filmmaking methods used in areas such as lighting, camera positioning and sound. Bates' effectively proposes a way for VR grammars to be considered by drawing on existing constructs but does not look more specifically at the grammars themselves. As a note, the use of 'grammars' in this paper refers to the use of certain production methods to create an identifiable style (e.g. deep-focus and realism; continuity editing and 'Hollywood' filmmaking, etc.) as often discussed in traditional film theory.

Formal exploration of CVR, from both technological and experiential perspectives, is beginning to emerge taking into account the specific differences between CVR and VR. Chang (2016) considers the similarities and differences between traditional filmmaking and those for 'VR Film' (his term for CVR) but his exploration is quite brief and draws little on established research on film theory or production. Cho et al. (2016) explore different approaches to user engagement with CVR-based stories through manipulation of first person (i.e. the user being directly addressed by a story character and thus present within the narrative) and third person (i.e. the user purely observes the action) perspectives; however they do not directly relate this to filmmaking methods nor describe their techniques for eliciting specific user reactions in detail. Syrett, Calvi, and van Gisbergen (2017) report a formal study into how 'narrative comprehension', essentially the understanding of story and character, is affected by the use of CVR as a storytelling medium. They note that, while some elements of a CVR environment can be distracting, participants generally could follow plot and empathise with characters. While they did not consider specific filmmaking techniques, their results nevertheless indicate that ' … it is a challenge for the director to guide the viewer's attention' (Syrett, Calvi, and van Gisbergen 2017, 206). Nielsen et al. (2016) address this issue directly, considering means to guide the user's attention within a 360° space to ensure that they are looking in appropriate directions at appropriate times to receive key information during CVR narratives. While their work draws to some degree on basic filmmaking theory, particularly the role of diegetic and non-diegetic cues as discussed by Bordwell and Thompson (2012), it is quite narrow in scope and does not consider film directors' methods nor how they might be applied.

Existing research into VR lacks sufficient consideration or understanding of the role of the film director and the formal strategies utilised by them in cinematic storytelling. Therefore, this paper seeks to provide a bridge between VR and filmmaking research in consideration of production methods. It is hoped to provide new insight into how existing techniques can be adapted to create effective CVR experiences and begin to develop directing techniques specifically for this new medium.

'Transportation' theory

'Transportation' is defined by Green and Brock (2000, 701) as 'absorption into a story (entailing) imagery […] and attentional focus' and an 'integrative melding of attention, imagery and feelings'. They suggest that someone who is transported 'may be less aware of real-world facts that contradict assertions made in the narrative' and may 'experience strong emotions […] even when they know the events in the story are not real' (Green and Brock 2000, 702). Although transportation theory was originally developed for analysis of engagement with written stories, it is designed to be platform agnostic – ' … the term "reader" may be construed to include listeners, viewers or any recipient of narrative information [irrespective of whether it is] fictional or nonfictional' (Green and Brock 2000, 702); 'The key psychological ingredients of the transportation experience are assumed to take place regardless of modality of communication' (Green, Brock, and Kaufman 2004, 312). Transportation is not unique to medium or genre and requires that the recipient be able to develop a compelling mental model of the narrative world and circumstance, including knowledge of character or subject; full transportation equals full concentration equals full engagement.

It is argued here that, since transportation theory can be used as a means of considering and measuring engagement across media, it is well suited to exploring the applicability of techniques to achieve transportation between film and VR – classically defined as 'suspension of disbelief' in film and 'presence' in VR. In both media, transportation is the primary responsibility of the director. By employing transportation theory as a bridging construct, it should be possible to more directly assess the effectiveness of and adapt difference techniques for promoting engagement across these media.

Transportation in film and 'Suspension of disbelief'

'Suspension of disbelief' has long been used as the primary term to denote viewer engagement with film and cinematic storytelling. Ferri (2007) presents a usefully detailed exploration of the concept from its evolution (noting its origins as a literary term by Coleridge) through to how audiences presently view (and become immersed in) film. Much has been written about the evolution of film theory and grammars, and the subsequent emergence of modern film 'vocabulary' through which filmmakers can communicate story in rich and increasingly sophisticated ways and thus transport viewers (see Bordwell and Thompson [2012] and Braudy and Cohen [2009] for seminal overviews). Directorial choices are central to imparting distinct styles that can directly affect how viewers engage with narrative and interpret story, and thus increase transportation. As discussed by Richards (1992), Weston (2003), Proferes (2013) and others, this starts with the director undertaking a detailed analysis of the script to:

- Formulate a specific interpretation of the story
- Define the overall theme and message based on the interpretation
- Define how information will be revealed – does audience learn as the characters (or subjects, if documentary) do? does the audience know more than the characters/subjects? less? etc.
- Define the overall objectives of core characters/subjects and the dynamics between them – whose story is it? what do they want? what do they need? who are the allies? enemies? etc.
- Extract story elements to inform realisation and creative production choices (i.e. the director's vision)

Creation of 'mood' or 'tone' is readily accomplished through strategic choices in setting, production design, costume, lighting, sound and other presentational attributes as well as through blocking, pacing and delivery of performances or portrayal of activity (if documentary). Film directors often also take advantage of existing audience knowledge about genre conventions, archetypes and stereotypes to support (or subvert) audience story expectations, helping to promote and enhance transportation. In the majority of film grammars, directorial choices have the specific objective of ensuring audiences engage strongly with story but not be distracted by technical means of presentation thus achieving 'suspension of disbelief' (see Bordwell, Staiger, and Thompson [1988] for a detailed exploration of this classical model of filmmaking). This is done by establishing the 'rules' of presentation early, not only in terms of look, sound and style but also in the handling of physical impossibilities – for example, that it is possible for people to fly, to walk through walls, to hear other's thoughts, etc. – to enable audiences to understand how to interpret what they are experiencing. Verisimilitude, particularly through the enabling of viewers to mentally construct compelling realities irrespective of the fidelity of pictorial or aural representations of story events, is necessary to achieve 'suspension of disbelief' and thus facilitate transportation in film.

It is argued here that the same consideration of directorial choices, viewer knowledge and expectations, and establishment of 'rules' of presentation is directly relevant to VR projects although the manner in which they are enacted may be somewhat different. Where film and VR principally differ is in the handling of 'continuity'. In film, continuity takes different forms – *continuity of viewpoint*; *continuity of motion; continuity of setting*; *continuity of sound*, etc. as described by numerous people such as Katz (1991) and Bordwell and Thompson (2012) – and is a main consideration in many theories to maintain 'suspension of disbelief' for film viewers. However, this model is predicated on the assumption that multiple camera angles will be utilised in a film presentation (i.e. it will be edited) which is not directly transferrable to CVR if contiguous recording is used. (Many CVR experiences are contiguous and presented as if in real-time although editing is beginning to be explored – Ijäs [2016] is one example of research in this area.) Still, it is argued here that continuity-led grammars can apply to CVR production. In part, this is due to the fact that a user in CVR is only able to look in one specific direction at any one time, meaning that other parts of the narrative environment are not visible, as is the case with action off-screen in film. Accordingly, various film directing techniques should be directly adaptable to a 360° presentation environment. This is explored in more detail later.

Transportation in Virtual Reality and the notion of 'Presence'

'Presence' is the term developed to assess the level of transportation within VR. Biocca (2002) defines it as a state where 'our awareness of the medium disappears and we are pushed through the medium to sensations that approach direct experience'. While this is useful as a broad definition directly related to transportation, Heeter's definition of three distinct types of presence (1992, 263–264) is more useful in the comparison of transportation across media as it addresses the different means of immersion possible in VR:

> *Social presence* refers to the extent to which other beings (living or synthetic) also exist in the world and appear to react to you […] Social presence may derive from conversing with other human beings, or from interacting with animated characters.
>
> *Environmental presence* refers to the extent to which the environment itself appears to know that you are there [e.g. via interaction with or modification of physical objects or setting] and to react to you […] If the environment knows you are there, that may contribute to you believing that you are there.
>
> *Personal presence* is based in part on simulating real world perceptions. You know you are 'there' because sounds and images in the virtual world respond like the real world to your head movements.

Of these three sub-definitions only the last is relevant to CVR given the lack of true interaction with the environment and the linear presentation used within the medium.

There is general agreement on key considerations in the design of virtual experiences to maximise presence and thus transportation, as discussed by Slater and Wilbur (1997). Three of these are directly relevant to CVR:

(1) The rules of interaction must be clear – how, where and when the viewer can move or change viewpoint
(2) Navigation must be simple and intuitive – enabling movement without distracting from visual or aural elements that facilitate transportation
(3) Movement within the environment must be smooth – with consistent increases or decreases in speed and no apparent visual artefacts when perspective is changed (e.g. seams between cameras used in creating 360° video)

While at first glance it would seem that the first and second are addressed almost by default given the limitations in CVR world navigation, it is argued here that they still warrant detailed consideration by the director, particularly if transitions between scenes are to be used. Unlike film, grammars for interaction and navigation are not yet mature enough to be considered standardised, thus it is important that they are considered in relation to other directorial choices made. As an example, navigation used in CVR projects such as *Invasion!* (2016), *Invisible* (2016) and *Great Performers: LA Noir* (2016) is completely transparent and does not use interface icons, relying solely on the viewer to physically orient his or her head to change the viewpoint of the scene. This arguably gives the best chance for full transportation although there is the risk that the viewer misses key action if the viewpoint is in the wrong direction. Other projects, such as *Escape The Living Dead* (2016), employ an opposite approach utilising an icon-based map to indicate to the viewer where to look at any given time. While this minimises the risk of the view missing important story points, it also makes the viewer acutely aware of the artifice of the viewing medium. The impact of interface design on transportation is an interesting area for further investigation.

Directing for cinematic virtual reality

Having looked at transportation in both film and VR the goal now is to apply techniques from the one medium to enhance production of the other. It is argued here that the core preparation tasks undertaken by a film director are applicable to the creation of a CVR project. However, 'realisation' must be considered slightly differently. Existing methods for film can be adapted to immersive presentation so long as they also take into consideration unique aspects of the CVR platform and are consistent with the needs of supporting presence. For example, potential issues with navigation in CVR were identified above. Yet, just as it can enhance a viewer's experience of a film, the effective use of drama and surprise can help to promote transportation in CVR through minimising the impact of these issues on presence. As Bouchard et al. (2008, 384) report, 'anxiety […] appears to have a direct impact on the subjective feeling of presence' so it follows that clever directorial choices in story interpretation and realisation to raise anxiety and evoke response to dramatic circumstance can help to facilitate transportation by masking potential issues unique to the CVR medium. In other words, the imparting of 'stakes' and 'jeopardy' in the viewers mental model of the story can enhance empathy with character circumstance and thus distract the viewer from the artifice of the CVR medium.

Earlier it was argued that continuity-led film grammars are applicable to CVR projects. Central to this notion are two key elements:

(1) The director's ability to predict and control the user's viewpoint within the virtual scene
(2) The idea of 'organic' direction

Film directors have developed several means by which they can control audience attention and subliminally guide viewer gaze around the frame. Katz (1991) discusses various compositional tools to achieve this, all of which include visual differentiation of elements in some way. (These techniques are also discussed by many others and build on those developed by classical painters.) Although some of these rely strictly on the limits imposed by a finite 'window' into the environment (i.e. the film frame), several are applicable in a CVR context and can be used to promote the viewer's direction of attention. These include:

- Differences in grouping, where one element of a scene is offset from other elements – such as in the isolation of Juror 8 (Henry Fonda) in the jury room of Lumet's *12 Angry Men* (1957).
- Differences in colour, where one element of a scene has a different look to others – such as the use of the girl in the red coat in Spielberg's *Schindler's List* (1993).
- Differences in scale, where one element of a scene has a different size to others – such as the use deep low angle two-shot of George Minafer (Tim Holt) with Isabel (Dolores Costello) in the drawing room in Welles' *The Magnificent Ambersons* (1942).
- Differences in shape, where one element of a scene has a different look to other (usually similar) elements – such as the pudgy Herbie Brown (Lou Costello) in the military line-up of fit soldiers in Lubin's *Buck Privates* (1941).
- Differences in visibility, where one element of a scene is more easily seen given lighting or focus (note that the opposite approach, where an element is distinctly harder to see than others, can also be effective) – such as the use of chiaroscuro lighting of the reporters in the screening room scenes of Welles' *Citizen Kane* (1941)
- Differences in motion, where one element has distinctly different movement to others – such as the chase through umbrellas in the assassination scene of Hitchcock's *Foreign Correspondent* (1940).

Techniques involving an understanding of human psychology can also be applied in a CVR context. These include the natural tendency to try to locate diegetic sound, be it expected or unexpected (i.e. a surprise), if the source is not immediately apparent. We also tend to look where other people are looking, particularly if we empathise or identify with them in some way or they are drawing specific attention to something within the world. All of these are effectively types of passive cueing.

Because of the lack of frame boundaries in CVR, these techniques are potentially more difficult to apply than for film. Practical research into this area is in its infancy, e.g. Nielsen et al. (2016), etc., however, it is argued here that through careful design and directorial choices, often using multiple techniques in parallel, this should be possible (if mainly applicable to narrative projects).

Central to this is the idea of 'organic' direction whereby production choices made are motivated based on a consistent interpretation of story elements, setting and character that are logically supported by script analysis. Each aspect of the production needs to reinforce others to create a coherent virtual world with clear 'rules' if transportation is to be achieved.

To use a film example, but considered in terms of CVR production, the transition from the objective chaos of the Omaha Beach landing to the personalised shellshock of Captain Miller (played by Tom Hanks) in *Saving Private Ryan* (1998) represents a highly principled directorial approach, much of which is applicable to CVR. Spielberg's stated intention for the sequence was to 'shoot the same way a combat cameraman shot World War II' (AFI 1999) to enable audiences to experience the horror of war with limited narrative intervention. This was at odds with the dramatic requirements of the script, which needed to show Miller getting caught up in the slaughtering of troops around him and then regaining control of his faculties to ultimately lead his squad off the beach. Spielberg did not want to affect the audience's transportation into the battle and needed to find an organic way to transition from a (comparatively) objective presentation of the landing (where the viewer is actively choosing where to look) to Miller's emotional perspective (where the viewer's attention is on him and his plight). First, to enable the audience to ultimately pick out Miller from the slews of other soldiers landing on the beach, Spielberg made the choice that Miller would not be wearing his helmet, thus visually offsetting him. Helmets often come off in battle so the artifice of the intention of the choice is completely hidden by audience knowledge of the setting. Second, Spielberg blocked the scene so that Miller was the only person approaching camera and the camera also moved to him. Given the movement is away from a particularly active part of the battle where many are being killed, this too represents an organic choice motivated by situation. These choices are wholly consistent with the 'reality' Spielberg sought to portray yet also facilitated his control of viewer perspective, empathy and attention. In both this scene and CVR, there is a need for transparent direction and internal consistency within the narrative world to maximise viewer transportation.

Were the sequence to be designed for a 360° CVR environment, the considerations and choices would need to be slightly different but the realisation of the sequence could be much the same. Assuming the scene to be in one shot without any editing (as is common in CVR), the blocking and positioning of action would take on more importance and the primary driver in controlling the user's specific angle of view. Through the timing of explosions (to promote head movement to seek sound sources), subject movement (to ensure certain soldiers 'stand out' visually and blocking their motion toward the area with Miller such that it promotes the user's view to get close to the area of significance) and the use of 'dead zones' (areas within the virtual environment where there is little or no activity or visual interest to promote the user to look elsewhere), the user's gaze could be controlled. The choice for Miller to have no helmet and to approach camera would be the same and should evoke the same dramatic significance. The use of camera movement to move toward Miller (as Spielberg did) could potentially be problematic as the user has no direct control over the change. However, if the move is subtle, and the dramatic engagement with the emergence of Miller strong, it may not adversely affect the level of transportation if the timing of the move seems to be motivated by other aspects of the scene (e.g. the approach of Miller).

Conclusions and future areas for research

This paper has explored the relationship between film directing techniques and CVR production drawing on transportation theory to better enable consideration of how techniques from one medium can be applied to another. The applicability of existing film grammars and directing methods was considered including how they might be applied were an existing film sequence adapted to CVR.

Research into this area (and into CVR in general) is comparatively new so the argument that film grammars can be applied to CVR is something that needs further (and more practical) exploration. For CVR directing methods to become more refined and mature, a number of important questions need to be considered:

- To what degree can film directing techniques be utilised in CVR production? When does the artifice of cueing become apparent to users and affect transportation?
- What is the relationship between the level of user autonomy and transportation within CVR?
- How can fixed screen, CVR and immersive VR versions of a story be compared to gain insight into the applicability of film techniques on CVR and VR experience development?
- What techniques from other media, such as traditional stage-based or participatory theatre, are applicable to CVR and how can they be used effectively?

It is hoped that insight gained through investigation into these and other related areas will enable CVR to become firmly established as a viable and effective storytelling platform.

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Notes on contributor

John Mateer has been working in film and TV for over 30 years and as an academic for over 15. He recently worked on feature films *The Knife That Killed Me* (Universal Pictures UK) as Executive Producer and *Macbeth* (GSP Studios) as Visual Effects Producer. His experience with VR started in the 1990s with a TV project he developed with Jonathan Goodson Productions (Paramount Studios). He was recently awarded a two-year Knowledge Transfer Partnership with Wild Rover Productions looking at enhancing competitiveness in VR production through the development of new production tools and business strategies to exploit emerging markets.

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