UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Developing a style at the intersection between analogue and digital animation production

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under the supervision of Professor Andrew Johnston and Dr Andrew Bluff

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Simon Rippingale, declare that this thesis, is submitted in fulfilment of the requirements for the award Doctor of Philosophy, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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DEVELOPING A STYLE AT THE INTERSECTION BETWEEN ANALOGUE AND DIGITAL ANIMATION PRODUCTION

ABSTRACT

This research project applies practice-based research methods to explore the intersection between analogue and digital animation production. The aim is to develop a visual style combining the tangible qualities of filming miniature sets and the fluid flexibility of computer-generated animation techniques.

Case studies of two animation projects that developed and refined a motion control camera system are presented. The system involved integration and creative control between key-framed cameras in animation software and physical cameras filming shots on miniature sets using industrial robotic arms. Associated approaches to this hybrid style of animation production workflow are presented, including game engines, 3D printing, point cloud scanning and other techniques. The refined method of hybrid production can form the basis for future productions seeking to build upon this technical and stylistic foundation.

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This research project was supervised by Professor Andrew Johnston and Dr Andrew Bluff.

The research involved significant collaboration with many artists, researchers and technicians from the University of Technology Sydney (UTS) and the Australian animation and visual effects Industry.

The animation case studies were funded and produced in collaboration with the team at Jericho, a branch of the Royal Australian Air Force dealing with research innovation and academic engagement.

Both animation case studies were made in collaboration with artists and researchers Andrew Bluff and Louis Pratt and VFX students Alessandra Grasso, Ben Steek, Mai Pham, Emma Cooney, Carol Amadio and Aaron De Leon at UTS Animal Logic Academy. *Jasper* was made in collaboration with Mark van den Bergen, VFX Supervisor, and Gregory Naud, Lead Animator.

The miniature set shoot for each case study was filmed on a Kuka robotic arm at the Advanced Fabrication Lab, Faculty of Design, Architecture and Building, UTS, in collaboration with robot technicians Tran Dang and Gwyn Jones.

Jarli was co-directed by filmmaker Chantelle Murray and produced by Ryan Greaves, who led a team from animation production company Like A Photon Creative, Brisbane. This case study's story and screenplay were developed with writers Andrew Dillon, Jon Bell and Erica Harrison.

The roles played by key researchers, technicians and artists who made valuable contributions to this research project were:

	Case Study 1: *Jasper*	**Case Study 2: *Jarli***
Andrew Johnston	Research supervisor / Producer	Research supervisor / Producer
Andrew Bluff	Researcher	Researcher
Louis Pratt	Researcher / Art Director	Researcher / Art Director
Tran Dang	Robot Tech	Robot Tech
Gwyn Jones	Robot Tech	Robot Tech
Ben Streek	Researcher / Compositor	
Brycen Horne	Cinematographer	
Alessandra Grasso	Producer / Lighting Artist	
Mark Van den Bergen	VFX Supervisor	
Great Naud	Lead Animator	
Mai Pham	Concept Artist /Animator	
Ryan Greaves		Producer
Chantelle Murray		Co Director
Andrew Dillon		Writer
Jon Bell		Writer
Erica Harrison		Writer
Evan Papageorgiou		Cinematographer
Egan Wessener		VFX Supervisor
Tanya Vincent		Lead Animator
Evan Atherton		Mimic Supervisor

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LIST OF TERMINOLOGY AND ABBREVIATIONS

AACTA	Australian Academy of Cinema and Television Arts
AEAF	Australian Effects & Animation Festival
CG	computer-generated
CGI	computer-generated imagery
fps	frames per second
GPU	graphics processing unit
HDRI	High Dynamic Range Image. An HDRI is a panoramic digital image that covers the full 360-degree spherical field of vision and contains a large amount of data (typically 32 bits per pixel per channel). HDRIs are most often used to emit light into a CG scene.
Hybrid Production Style	shorthand for the animation production style central to this research project. Hybrid production style refers to the compositing of 3D animated characters with footage filmed using miniature sets.
pre-vis	pre-visualisation
RAAF	Royal Australian Air Force
STEM	science, technology, engineering and mathematics
UTS	University of Technology Sydney
VFX	visual effects

1 INTRODUCTION

This practice-based research project experiments with emerging technologies to explore the creative opportunities and navigate the technical challenges that arise when working at the intersection between digital and analogue animation production techniques. The objective of this research is to inform the practice of a hybrid style of animation production in which 3D animated characters are composited into visual environments created by filming miniature sets and props. By exploring this animation style, I have attempted to improve production techniques and further develop an aesthetic style within the field of contemporary animation. Central to this research project was an attempt to creatively and technically develop a specific animation production style that I had previously experimented with as a director working in this medium of animation filmmaking.

This thesis describes research into animation production conducted in two case studies. The outcomes of these studies are short, animated film productions exploring this hybrid animation production technique. Case Study 1 is a 2-minute short animation, *Jasper*, conducted in 2018 (see Figure 1.1). Case Study 2 is a 7-minute animation project, *Jarli*, conducted in 2020 (see Figure 1.2).

Figure 1.1: Production still from short animation Case Study 1: Jasper.

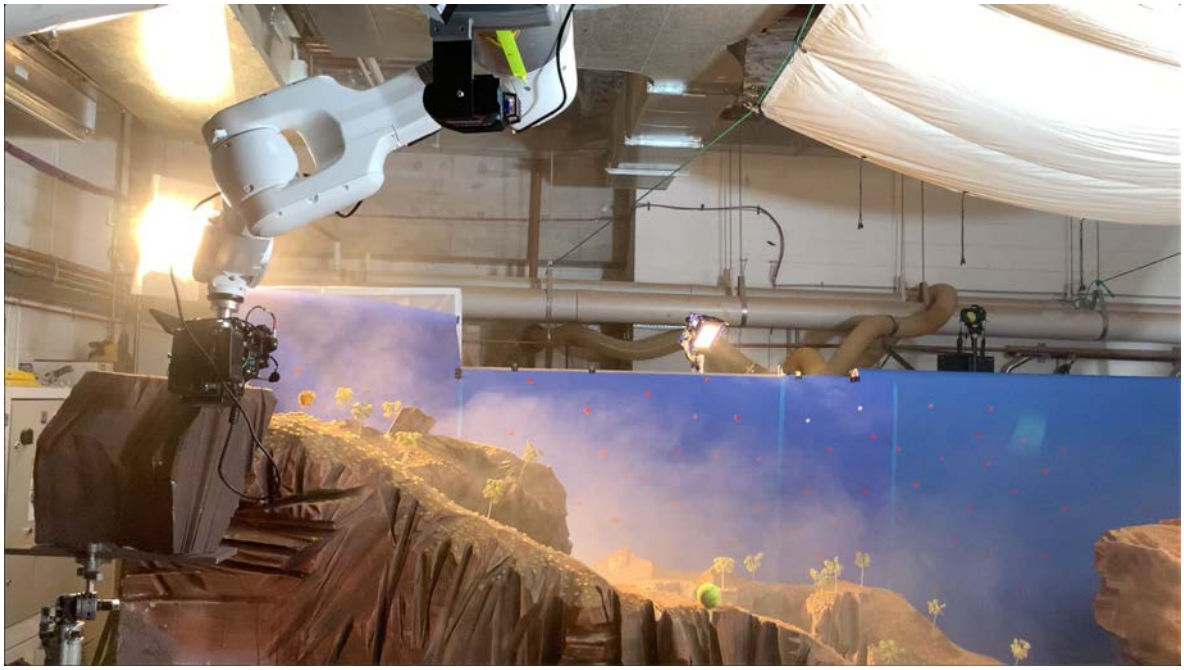


Figure 1.2: Miniature set shoot from short animation Case Study 2: Jarli.

The aims of this research project were to:

- produce two animated short films using practice-based research methods as case studies of a hybrid production style combining digital animation and miniature sets
- develop a motion control camera system involving integration and creative control between digital cameras keyframed in Maya animation software and physical cameras filming on miniature sets using a KUKA robotic arm (for a faster, creatively flexible system for designing and executing complex, multi-axis camera movement filming on miniature sets)
- explore other facets of the creative and technical practice of integrating 3D animation and miniature sets into an animation work to improve methods for working in this hybrid style of animation production (including game engines, 3D printing and point cloud scanning)
- further develop an animation visual style working between 3D digital animation and miniature sets builds that I have begun to develop as a director in this medium of animation filmmaking
- describe and document these practices in this thesis.

This thesis presents an animation research project using practice-based research as its central methodology. Practice-based research provides a framework for creative and technical exploration into animation production techniques stemming from the concept that creative practice is:

> a form of research and generates detectable research out puts and that creative practice and the training and specialised knowledge that creative practitioners have and the processes they engage in when they are making art—can lead to specialised research outputs which can then be generalised and written up as research. (Smith & Dean 2010, p. 5)

Practice-based research is a tool for researchers looking for insight and knowledge of creative practice and industries. A reciprocal relationship can be established between research into creative practice and undertaking the practice. A positive feedback loop between the creative process, the reflection upon and interrogation of that process, and further iteration of the creative process gives the researcher or creative practitioner useful knowledge and insight into their work.

Not only does this approach lead to tangible learning outcomes, but it leads directly back to improved creative practice. Creative practitioners who approach their work from a research perspective gain powerful tools and perspectives that feed into their future artistic works. Practice-based research follows the principals outlined by Linda Candy, who writes that 'any claims of originality and contribution to knowledge may be demonstrated through artefacts created during the research process such as artworks, musical compositions, performances and interactive new media installations' (Candy 2006, p. 1).

Furthermore, when research includes a creative artefact for its contribution to knowledge, the research is often undertaken to gain knowledge by analysing and reflecting upon the outcomes of practice. Common outcomes of practice-based research, particularly in creative fields, may be artefacts such as exhibitions, installations, performances, audio visual works and sculpture. These artefacts become an essential part of the reflective and informative process by which the researcher gains knowledge and insight into their research field (Candy, 2011).

1.1 Context

I worked as the researcher and director on both projects, and Case Study 2 was co-directed with Australian director Chantelle Murray. Both studies were part of an ongoing creative collaboration between the Royal Australian Air Force (RAAF), the University of Technology Sydney (UTS) Animal Logic Academy and the UTS Faculty of Design, Architecture and Building. Both studies were funded by the RAAF, were platforms for technological and creative research into animation production, and involved an element of social change. Story was an integral part of the creative process in both case studies. All creative and technical decisions were made in the service of story and research. Therefore, I have included story development as an important part of each case study to give context to the creative and technical approaches of each element of animation production.

1.2 Background

My first attempt at making animation using a hybrid production style came about after working with miniature sets on ambitious screen-based projects while teaching production design to screen studies students at a Sydney design college between 2008 and 2011. Miniature set builds were a practical scale for teaching production design to students because their small scale presents fewer logistical and budgetary obstacles. Students can be more ambitious and realise entire story worlds relatively cheaply. During the production of these creative projects, I observed, from a teaching perspective, the potency of the miniature sets—artists became engrossed in the creative design and building processes and as a storytelling medium. This effect was also observed in audiences when we exhibited the works.

There was an observable and tangible physical connection between the artists working on the sets and the story world they were creating, which translated into the final creative works. This connection lived beyond the film production in the exhibition materials. We showcased the miniatures, which students had worked on with amazing detail, on the college campus. The miniatures continued to draw audiences to their evocative story worlds beyond any connection with the screen works for which they had been built.

Inspired by my experience working on these projects, I began exploring in my work combining miniature story worlds with 3D animation to create a crossover production style positioned between stop motion and computer-generated (CG) 3D animation. I was interested in developing a style that was a bricolage or hybrid of moving image-making techniques and set out to make a technically ambitious animated film using this process. The production was difficult, and I immediately understood why few animation productions attempted this technical approach. However, by 2013, I had completed an animation project, *A Cautionary Tail*. The final moving images of this film looked and felt a little like stop motion, with a tactile, 'real' physical quality to the image. Digitally animated characters added another layer to the look and gave shots the flexible, fluid quality of 3D animation.

There was some interest from the Australian creative community in the project's production style. The film was well-received and won an Australian Academy of Cinema and Television Arts (AACTA) Award for best animated short in 2014. It was nominated in the Dendy Awards at the Sydney Film Festival, presented at several design conferences, film festivals and colleges, and featured in design and visual effects (VFX) publications. The creative community's interest focused on the look and style of the production design. During this period, I was hired as a stop motion animator on a commercial project because the producers had been impressed by the quality of what they had mistakenly thought was stop motion animation.

In *A Cautionary Tail's* screening events, I often received feedback from audience members such as 'the stop motion seemed very smooth' or 'the production environments almost feel like they were handmade'. As a director, I enjoyed how the images of this hybrid style created a visual uncertainty in the eyes of many viewers. Many people, including those in the film industry, were unsure what they were viewing—whether a stop motion film or a 3D animation.

Moving cameras are essential to filmmaking. In the language of cinematic storytelling, the camera is a character, and how it moves is as important as sound, music, colour, performance and design. Considering this, a major detraction to the final work in this first attempt lay in the difficulty aligning moving cameras in both the digital and miniature set workspaces efficiently and with creative freedom within the production budget and schedule. Another detraction was the team's inexperience in creating animation images in this style, as there was little precedent in the film industry.

I was interested in developing this hybrid animation technique and exploring it in my work. I gained a valuable perspective on this animation approach by making some obvious mistakes. I saw an opportunity, with some research, to push these techniques further and generate knowledge and production techniques that other animation practitioners could reference if considering a similar production approach.

1.3 Animation style

As a central aim of this research project is to further develop techniques for a visual style that I had begun to explore as a director working in animation filmmaking, it is useful to describe this design style in more detail. The case studies in this thesis were testing grounds to develop this visual style on a creative and technical level, enhance this production style's tool set capabilities, facilitate creative opportunities and possibilities, and overcome commonly encountered obstacles and pitfalls.

Throughout this thesis, I describe this style as a hybrid of 3D animation and miniature set builds. When successful, the results are a collaging of miniature realism and 3D digital animation to create a moving image that draws selectively upon what I feel as a director are the best qualities of 3D digital animation and stop motion animation. The result is a moving

image with tactile and tangible qualities that gives the audience a visual connection to a real physical environment, which was filmed moving in real-time, illuminated by real lights and with volumetric qualities in the on-set atmosphere before a moving camera.

In this filmmaking style, the design and fabrication of miniature story worlds tend to drive the production's tone and visual aesthetic. This tone is also set by how miniature sets are photographed by moving cameras under studio lighting in real-time, rather than frame by frame, which lets light behave more naturally on physical objects and reflect and refract within the camera lens (see Figure 1.3). Consequently, all other visual elements, such as digital characters and props, follow this aesthetic direction and are designed, modelled, rendered and composited to give the impression that they belong to this physical, miniature story world rather than the opposite.

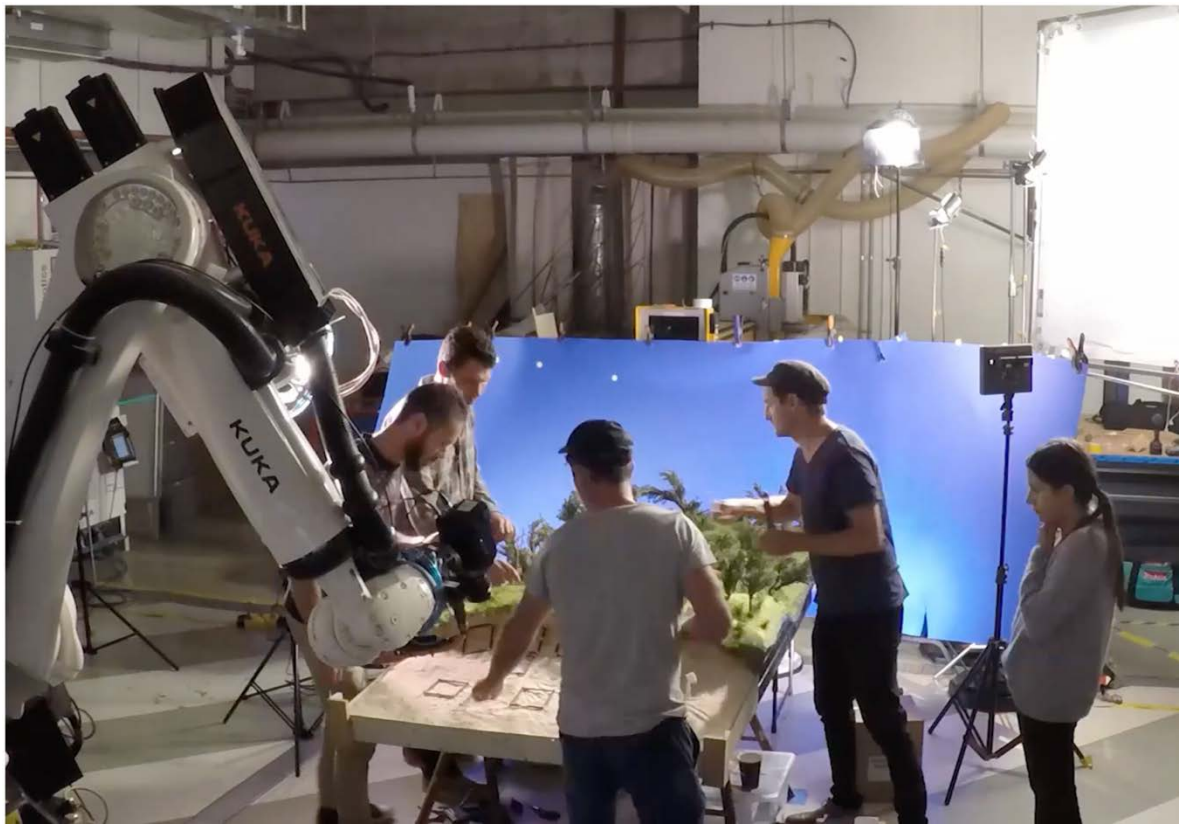


Figure 1.3: Crew on miniature set shoot of short animation Case Study 1: Jasper, 2018.

Miniature sets are also designed to draw on the randomness and chaotic forms of nature, letting natural and found objects dictate design direction, particularly when the story takes place in the natural world. This visual style leans away from the established contemporary animation world design aesthetic towards a miniature realism in the story world environments while keeping one foot in a more established animation industry visual style with the shapes and proportions of character design. Miniature sets and props are designed and fabricated to not push the set forms into the recognisable shapes and silhouettes of the aesthetics qualities established most notably in the visual style of animation studios such as Disney, Pixar and DreamWorks. These studios have set the tone for global animation culture and design language in the commercial box office media space.

In this hybrid production style, I aimed to allow the design of shapes to follow an aesthetic quality closer to how materials behave in the natural world. To a certain extent, this style direction dictates the shapes and forms of the production's 3D digital elements, most importantly with the story's characters, who dominate the centre of frame in most images.

It is an important facet of this approach to animation that the creative team have tangible access and connection to the story world as a physical object. Artists can work on, photograph, discuss and workshop shots and sequences while standing around a physical space. The charm and story allure apply to artists working on the productions in a way that translates into the final images on the screen.

I have also drawn influence from the practice and aesthetic qualities of stop motion filmmaking. I attempted to control the quality and quantity of the jittery, staccato visual qualities of this production method to taste. In developing this hybrid production style, I wanted to draw from and push against those particular qualities of stop motion animation.

Likewise, with CG 3D animation, I want to draw upon the charm and subtlety of character animation in this medium. Well done animated works created in 3D have a strong emotional pull; however, the lush digital lighting, surfacing and rendering can create an overly perfect result. The images are beautiful but missing mistakes, unexpected shadows, strange lighting refractions in the lens and unexpected over or under exposures.

The development and refinement of this visual style was an important part of this research project. I aimed to create a recognisable visual style that has a visual sensibility that I hope stands apart from the work of other contemporary animation productions.

1.4 Research questions

During my research into other animation productions, I referenced several feature animations that explored this hybrid production style at some stage of their early development but abandoned the approach in favour of another method. I experienced a degree of reticence or reluctance to use this approach when pitching and developing ideas for animation productions with producers and production companies.

The reasons for this reluctance could be summarised as follows:

- It is easier to produce all elements within an integrated 3D work space. A camera can be animated in any way without needing any match moving or shot tracking. Undertaking this hybrid production style adds a significant layer of production difficulty in match moving.

- Although there are time-saving advantages of using miniatures, the aesthetic qualities gained are not always perceived as adding significant value to a story world or creative approach to warrant the extra effort.

- Dealing with the design, fabrication and set dressing of miniatures adds significant logistical difficulty to an animation project, especially when they must be packed up and transported to a studio space and prepared for filming.

These perceived difficulties and technical challenges framed my research question for the case studies. Although some questions changed from the first to the second case study, the overarching research questions remained:

- **Camera movement**: Could the research team produce animation using the hybrid animation production style, filming shots on miniatures on-set while not compromising the design and realisation of multi-axis camera movement and rotation? Could we design and improve on a technical pipeline to realise these moving camera shots that allowed improved creative flexibility and iteration of camera movements while shooting?

- **Emerging tech (e.g., 3D printing, point cloud scanning)**: What are the benefits or drawbacks of using a range of emerging technologies and technological platforms to enhance the creative and technical processes of this hybrid production style? Which platforms added value to the production process regarding creative flexibility and technical facility?

- **Animation style**: Could we use this hybrid production style to demonstrate an animation outcome that stood out and was stylistically distinct and recognisable within the genre of contemporary animation?

1.5 Video links

Jasper, Vimeo link: https://vimeo.com/293461406

Jasper Behind the Scenes, https://vimeo.com/294056966

Jarli, Vimeo link: https://vimeo.com/695909564 (password Unaipon)

Jarli Behind the Scenes, Vimeo link: https://vimeo.com/647191611

1.6 About the researcher

I am a director and animator based in Sydney, Australia. My work has been nominated for three AACTA awards, twice for short animation and once for visual effects, winning the 2014 AACTA Award for best short animation. My work has featured as a finalist in the Dendy Awards at the Sydney Film Festival and won a gold award at the Australian Effects & Animation Festival (AEAF) Awards (see Appendix A for details). I am currently a PhD candidate at the UTS Animal Logic Academy, where I received the Faculty of Engineering and Information Technology HDR Excellence Award in 2018.

2 LITERATURE REVIEW

To give context to research into this miniature/3D hybrid stye of animation production, this literature review references examples from cinema and animation storytelling that have influenced the direction of this research. This research project aimed to explore specific production techniques to create animation with a particular aesthetic quality which sits in between the visual qualities of hand-made miniatures and CGi 3D animation. The examples referred to in this literature review help contextualise these aesthetic choices, drawing from a broad cross section of animation and visual effects cinema during the last 150 years.

Cinema is one of the more recent and rapidly shifting art forms in human history. The constantly changing technological approaches to its production have been integral to its rapid evolution as a cultural and aesthetic language. In the less than one hundred and fifty years since the Lumière brothers screened their first movies to audiences near Paris in the 1890s, cinema storytelling has transformed from flickering black and white images silently projected onto white sheets to the immersive virtual reality experiences with full body haptic suits of the 2020s. Relative to film making in the 2020s, cinema production in the first half of the 20th century was prohibitively expensive and exclusive. In the Golden Age of Hollywood (the 1920s and 1930s) cameras and lights were big, heavy and expensive, while running a sound stage required the financial backing of studio and distribution enterprises. Now, in the 2020s, anyone with a smartphone and an internet connection can write, produce, experience and share cinema storytelling. Movie-making culture and language have adapted to many technological shifts in their short history. From black and white to colour; from silent movies to the beginnings of sound recording; television broadcasts; from film to video tape to digital; from 35mm film projection to VHS video rental, DVDs and streaming services in the 2010s, cinema culture and language has absorbed and reflected these shifts into an increasingly diverse and rich audio-visual language.

2.1 Overview

This literature review discusses screen works relevant to this research project as follows:

• the contemporary culture of animation and visual effects

• miniature set design as a story-telling device

• the beginnings of screen-based moving images produced and distributed for wide audience consumption in the last decade of the 19th century. Here I reference some of cinema's pioneering visual effects artists, auteurs and animators and discuss how an early conceptual and theoretical divide in the development of cinema culture and aesthetics still influences contemporary approaches to cinema and screen-based story telling.

• how early technical approaches to animation and visual effects movie making incorporated a collage of many disparate modes of production. I discuss how this collaging was used to interesting and innovative effect during the Golden Age of cinema in Europe and the United States. I look at the aesthetic and technical choices made during the production of the first modern feature-length animation and visual effects-driven movies in the 1920s and 1930s, such as *King Kong, Metropolis, The Tale of Prince Ahmed* and *Snow White and the Seven Dwarves.*

• the emergence of the contemporary era of visual effects-driven block busters and how this brought about digital visual effects and CGI animation technology. I discuss the ways in which digital visual-effects technology created a rapidly growing, global creative industry and opened up unprecedented visual possibilities for cinema storytellers. I discuss the effects this is having on cinema culture and aesthetics and its relevance to my own area of research in the field of animation.

• I then consider two examples of animation production, specifically the works of stop-motion production company Laika and the short animation *The Gruffalo* (2013) by Studio Soi. I discuss the ways in which these examples innovated yet retained the warmth and tangibility of more pre-digital, that is, analogue, modes of animation production while using emerging technologies and digital movie-making processes to achieve their final images. Here I identify a gap in the practice and exploration of both traditional, analogue forms of production and contemporary, digital modes.

2.2 What makes good cinema

For the purposes of this literature review specifically and this research overall, I outline below some of the key qualitative criteria against which I discuss screen works, while taking into account that these criteria were filtered through my own subjective evaluation, experience and cultural background.

• Critical Reception.
I divide critical reception into four: (1) the reception at the time of a screenwork's initial release, (2) the ongoing critical reception, (3) the enduring legacy of a screenwork and (4) the enduring legacy of screen works in public media discourse. While the responses of critics to any screen work at the time of release are often wildly varied, critical opinion usually solidifies over the months and years after its release. If a screen work continues to divide opinions years or decades after its release, then this itself could be seen as a measure of the enduring quality, interest, or originality of that work.

• Box Office Success
This measurement uses box office success or failure to assess the value of a screen work as a financial venture. This is a rough but useful measurement of how many people paid to see the work and may also indicate other value factors such as word of mouth. It is probably the most important metric for the success of a cinematic work from the perspective of the studios or producers who created the work. However, this measure may be more difficult to use in relation to works I reference that were created and distributed for online streaming services. This is because data reflecting the number of viewers to have seen a work seem to be available only for very successful and frequently streamed works.

• Review-aggregation Websites for Film and Television
I also reference online platforms such as IMDB, Rotten Tomatoes, Cinemascore or Metacritic, which use a variety of algorithms to aggregate and average the scores of critics from media outlets around the world into a single figure. These figures often find themselves at odds with box office figures. However, these tools produce a varied picture of cinema quality, not least because they often featuring 'classic' critical favourites from both the 20th and early 21st centuries.

• Personal Critical Evaluation
I refer to my personal critique of the creative value of a screen work, based on my interest in cinema and history and culture, particularly in the field of animation and VFX-driven cinema works. Under this evaluation, I include references to

works that have established an enduring place as a reference point in the cinematic cultural landscape and conversation, despite receiving poor critical reception and/or box office success at the time of their release.

• Technical Proficiency

In cases where it may be useful to do so, I evaluate screen works that display a high level of technical proficiency in the execution and realisation of moving images, despite the less successful other elements of the work, such as screen writing, directing, acting and storytelling. In other words, it is useful at times to refer to interesting animation and visual effects sequences that shine in what may otherwise be uninteresting movies.

• Film Festival Awards

A commonly-used measurement of the success of a cinema work is the winning of film festival awards. These are often the most celebrated measure of success for a film production and are a significant part of cinema culture. Although festival awards are, arguably, not a particularly useful measure on their own, due to the political nature of festival judging bodies and an increasing awareness about the lack of diversity and representation in the organisations behind awards institutions, these awards often reflect and align with the cultural relevance or critical success of a screen work.

2.3 Animation and VFX

Because of their close relevance to this research, this literature review focuses on movies driven by animation and visual effects and specifically how rapid changes to film production technologies have changed and influenced cinema language and culture. This includes the advent of digital visual effects technology, which has changed the way movies are written, designed and produced, and, finally, experienced by audiences.

Making movies has always been a juggling act between business, technology and creativity. On the one hand, movie making is a business-orientated endeavour that places the biggest possible financial return above critical reception. There is a client/provider relationship between movie makers and audiences and studios fund the types of movies that their market research shows people want to see—and the more expensive the film is to make, the more risk averse the studio will become.

As a result, many people feel that much of Hollywood's recent output can at times seem repetitive, both in narrative and in visual production style, a sort of 'recycling of fantasies of spectacular apocalypse, conflict, destruction and resurrection in various generic registers from action and disaster to science fiction to the endless disinterment of comic book and earlier televisual and film superhero franchises' (Crogan, 2017. p. 337).

The movies that have earned the highest grossing box office returns in cinema history (Box office mojo, 2021, Rotten tomatoes, 2021) are a list of big-budget, technologically-innovative digital visual effects and animation-driven stories. The list includes science fiction movies like *Avatar* (2009) and movies from Disney's *Star Wars* and Marvel superhero franchises. Contemporary movie audiences enjoy big, loud, visually spectacular, colourful, fantastical stories set in fictional story worlds. Perhaps these movies are not the highest accomplishments, or the most subtle examples of the art of cinema, but they draw the biggest audiences to watch them. People around the world love to immerse themselves in digitally-simulated, fantastical stories that transport them to other-worldly landscapes populated by fictional creatures performing physically impossible feats.

On the other hand, it is also true to say that movie making is a fundamentally creative endeavour that supports the creative careers of writers, actors, directors, animators, musicians, cinematographers, editors, and thousands of other artists, right up to the studio executives. It is an endeavour run by creative people working in one of the most culturally influential art mediums ever developed.

2.4 Miniatures in storytelling

An important part of the creative direction behind this research project draws on the medium of hand-made miniatures and their potency as story-telling devices. Miniature worlds as standalone objects, even without any text or character elements, seem to be automatically imbued with the promise of a narrative. An empty miniature set seems to invite the viewer to tell their own story, from their own imagination in this world. Each time we have displayed miniature sets in an exhibition environment, people entering the space crowd around the set. They crouch down, point, and speak in lowered voices, as if the scale shift has caused some sort of warping of their spatial awareness.

Miniatures are also a very effective and immediate way to communicate visual ideas and bring a creative team together into a story world, acting like a fast track to an animation artist's imagination. Standing around a miniature set with a team of animation and VFX artists, talking about the shots that we will be shooting and animating in that miniature space, immerses those artists into the look and feel of the scene. The miniature is 'perceptually close to our experience of the fantastic. Neither the miniature or the fantastic exists in the natural world; each is co-created by the observer' (Buchan, 2011. p. 87). Susan Stewart writes about the use of miniatures in artistic narrative expression in *On Longing: Narratives of the Miniature*: 'There are no miniatures in nature. The miniature assumes an anthropocentric universe for its absolute sense of scale.' As a narrative tool, miniatures are 'linked to nostalgic versions of childhood and history, (and) represent a diminutive, and thereby manipulatable, version of experience' (Stewart. 1992. p.71).

2.5 Hybridity and Bricolage

In this section, I discuss the concepts of hybridity, bricolage and collage and the ways in which these ideas have been a useful theoretical framework within which to consider the visual direction taken by the case studies discussed in this thesis. I consider the animation work in these case studies to be hybrid both in the sense that they bring together different animation production techniques, tools and materials and in the way that they draw from and create both live-action and animated visual aesthetic qualities. My creative team and I drew from concepts of collage and bricolage in that we brought together different production methods and tools, and relied on the aesthetic value of found objects, rather than creating everything from scratch.

• Bricolage

The research team drew on an eclectic range of animation and VFX filmmaking processes, tools and materials to produce the animation works discussed in this thesis, and, as such, it has been useful to consider this process as a form of bricolage.

In his 1962 work *The Savage Mind*, French anthropologist Claude Levi-Strauss identified characteristics and patterns in the ways that cultural narratives and mythologies are developed. In doing so, he used the term 'bricolage' to describe the process of drawing from whatever was at hand and combining those elements to create something new. The bricoleur is someone who 'works with his hands and uses devious means compared to those of a craftsman' (Strauss 1962, p. 11), who puts pre-existing things together in new ways and makes do with whatever is within reach.

It has been interesting and useful to consider the animation work undertaken for the case studies described in this thesis as a form of bricolage in the way that the team drew from both contemporary and more traditional VFX filmmaking techniques while using a wide range of both physical and digital tools and fabrication materials. The way in which the production design team used found objects in the fabrication of miniature sets, including such natural elements as sand, rocks, dead grass and other found materials, feels particularly relevant to bricolage. We also used a wide range of fabrication tools, working in both a digital and a physical design space.

In his work, Levi-Strauss set out either to make a definition or to construct a binary between the role of the engineer and the bricoleur. The bricoleur creates things, including narratives and objects, drawing on improvisation from whatever is accessible. The engineer, in contrast, uses a more scientific process, crafting exactly what is necessary from an established tool set. The engineer uses tools specific to, and built for, the task at hand or creates new tools necessary for the task. However, in Levi-Strauss's binary construction, the engineer acts in a way that would commonly be described, in media and popular culture, as an artist or craftsman. Levi-Strauss suggests that cultural mythologies, on the other hand, function in a similar way to his descriptions of the bricoleur, and that modern western science functions in a manner closer to that of the engineer.

> The 'bricoleur' is adept at performing a large number of diverse tasks; but, unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project. His universe of instruments is closed and the rules of his game are always to make do with 'whatever is at hand', that is to say with a set of tools and materials which is always finite and is also heterogeneous because what it contains bears no relation to the current project, or indeed to any particular project, but is the contingent result of all the occasions there have been to renew or enrich the stock or to maintain it with the remains of previous constructions or destructions. (Levi-Strauss, 1966 p. 11).

Jacques Derrida set out to deconstruct and build on this argument. In his lectures 'Structure, Sign, and Play in the Discourse of the Human Sciences', he argued that it was not possible for anyone to be the 'absolute origin of his own discourse' (Derrida, 1966). Instead, he argued that notions of the true craftsman or the engineer in this construct were a fictional construction of the bricoleur, saying that, in fact, all creative actions were some form of bricolage and that the engineer was a fiction created to give context to the bricoleur.

> The bricoleur, is someone who uses "the means at hand", that is, the instruments he finds at his disposition around him, those which are already there, which had not been especially conceived with an eye to the operation for which they are to be used and to which one tries by trial and error to adapt them, not hesitating to change them whenever it appears necessary. The bricoleur's foil is the engineer, who creates out of whole cloth without the need for bricolage—however, the engineer is merely a myth since all physical and intellectual production is really bricolage. (Derrida, 1966)

Discussing the bricolage concepts of both Levi-Strauss and Derrida, Nasrullah Mambrol (2016) articulates Derrida's argument as follows:

> The bricoleur would not be as exciting and inventive if the engineer were not so dreary and unimaginative. As soon as we cease to believe in such an engineer and as soon as we admit that every finite discourse is bound by a certain bricolage, and that the engineer is also a bricoleur. (Mambrol, 2016)

Derrida extended the direction of this argument to include any practice or discourse, saying, ‘If one calls bricolage the necessity of borrowing one's concept from the text of a heritage which is more or less coherent or ruined, it must be said that every discourse is bricoleur.’ (Derrida, 1966)

• Collage

For the purposes of this thesis, the term ‘collage’ has a far more general meaning and application and has been less important in the conceptual framework of this animation study, so it is outlines and defined only briefly here. Collage is a term used in the visual arts and other creative mediums to describe the bringing together of disparate creative elements and joining them to create something new. Artists like Pablo Picasso, Georges Braque and Hanna Hoch, as early proponents of this technique, used collage to fundamentally change the way society in the 20th century viewed the use of found materials and how they related to ideas of creativity and authorship of art. The effects of their work on visual arts can be directly related to the aforementioned tension between the bricoleur and the engineer, namely, that the idea of an artist who creates great works from nothing is essentially a myth. All art draws from its surrounding culture, from the available tropes, ideas, techniques, tools and materials, whether this is done consciously or not.

2.6 Hybridity in Film and Animation

From the very early stages of this practice-based research project, the research team considered the chosen animation production style as a hybrid, a bringing together of 3D, CGi animation with miniature set builds and digital set extensions.

It is important to acknowledge that all animation and cinematic works could be considered hybrids to some extent. From this perspective, the director's role is to bring a range of hybrid creative elements together in concert and to weave them into some sort of deliberate and consistent storytelling style. The director constructs a narrative by bringing together an actor's performance, a cinematographer’s framing and lighting, a writer's words, a composer's score, an editor's timing and shot choice, a production designer’s set design.

On a less literal, more conceptual level, movies are also a hybridisation of the real and the fantastical. Jean-Luc Goddard, the French-Swiss film director, screenwriter, and film critic for the French film journal *Cahiers du Cinéma*, wrote: ‘All great fiction films tend toward documentary, just as all great documentaries tend toward fiction . . . He who opts wholeheartedly for one necessarily finds the other at the end of his journey’ (Godard, 1959). This idea describes one of the many theoretical approaches of the French New Wave’s use of cinema’s hybrid nature and its ‘embodiment in the combination of documentary and fiction, realism and stylization that, it acknowledges mutually film’s ‘objective’ recording function and its ‘subjective’ manipulability….’ (Grist, 2013). Every filmmaking genre brings together the real and the fantastical. Even in the most gritty, ‘realistic’ social dramas, the audience is required to suspend logic and believe that the camera can leap to a completely different point of view in a single frame. One moment we are in an intimate close-up, then suddenly we are 180 degrees at the other side of the scene and observing the scene from a bird's eye view, all without the dramatic action missing a beat. The continuity language of shot-to-shot story cinematic storytelling is a fiction, no matter how heavily the style of the work leans towards ‘realism’.

The term ‘hybrid animation’ is often used to refer to animation works that are a specific combination of traditional 2D moving image elements with 3D CGi animation techniques. In the context of this research project, however, I use the terms ‘hybridity’ and ‘bricolage’ to refer to an animation practice that draws from all and any available materials, tools, techniques and modes of image production, and composes them together to create a final work. I also use the term

'hybrid' to mean the way in which this animation style works visually within the tension between the real and the fantastical in cinema's visual language. In animation, this tension is defined using somewhat different conceptual parameters. The most obvious difference is that animation movie audiences enter into the story experience already accepting that an animated image is not 'real'. Animation is the conceptual opposite of 'live action'. The origins of the term 'animation' are found in the Latin word *animare*, which means 'to give life to'. This suggests that 'the illusion of movement has been given to inanimate forms.' (Selby, 2013, p. 9) Therefore the very term 'animation' or 'animated' implies that principal story elements are inherently inert objects that need to be brought to life by the film-maker's craft and tools.

In contemporary cinema language, the term 'animation' is often used to distinguish the format from 'live action', the implication being that principal story elements, while animated, are not real. With each decade of 21st-century cinema culture, this distinction is becoming more and more blurred. An increasing proportion of contemporary live-action movies contains significant animated screen content. Further, this animated content is presented in such a way as to play convincingly next to these live action elements, asking the audience to see the animation as an integral part of the live action.

Adding to the blurring between live-action and animation content is the increased use of motion capture techniques, whereby the performance of animated characters is derived from close collaboration and overlap between the performance of an actor and the work of an animation artist and thus can be considered bricolage. The animation production team draws upon the performances of real-life actors and integrates the natural physicality and real-time nature of those performances as data to be fed into the creation of the animated characters. In its early animated movies, Disney Animation studios used rotoscoping, or tracing of live action footage, as a precursor to motion capture, and could also be considered a hybrid animation process.

Walt Disney is reported to have said to rotoscope artist Kendall O'Connor, who had been tasked with rotoscoping filmed footage of dancer Majorie Belcher as a reference guide for animators: 'You're lucky! we have class is called action analysis for the animators. We run stuff a frame at a time and stop it, you know, so they can analyse the action of animals or people and all that. But they only get an hour of it a week or something you know because it was not production, it with education. Here you get it coming at you all day long - here you can see precisely how this human action works'. (Kaufman, 2012, p.44, 45)

Despite the increased use of hybridisation between live-action and animated content in contemporary cinema, the visual charm of movies that are entirely animated often derives from knowing that what we are watching has no basis in reality. No one expects us to believe that what we are watching is anything other than a construction of the creative team's work. Animation is therefore a kind of visual parable of the real world. Rather than trying to present to an audience as real, an animated film presents a visual story world that works in parallel to the form of subjective reality we all experience day to day.

In attempting to deconstruct and then describe the visual appeal of the animation production method I have chosen to explore in this thesis, it has been useful to consider where these works might be situated in the tension between the real and the fantastical. Despite the work being entirely animation in genre, it is hybrid in the way it draws on both visual forms, creating an impression for me that the audience sense that what they are looking at is real. Although the story worlds are filmed in real time, the characters are completely constructed animation and move in a way that is obviously in the realm

of the fantastical. The characters are animated with a stop-motion aesthetic, as though they were filmed elements. As an example, we set out to give the impression that hair and cloth behave as if they were real, physical (but miniature) objects under the same lighting conditions.

This conceptual tension between live action and animation has been central to the practice-based research approach I have undertaken in the case studies for this thesis and central to this process are the use of miniature sets. The miniatures are illuminated by real lights and captured by cinematography in real time, rather than stop motion. Dust, light refractions, lens flares and light bounce all behave as if these shots were captured during live-action cinematography, despite the miniature scale, creating visual effects that are both real and unreal. The objects are real, we see them filmed in real time, yet the scale is unreal. They are physical representations of the world rather than the actual world. At the same time, they are dressed and furnished with real dirt, dust, sand, sticks and twigs. It seems real, and in this way, I conclude that the use of miniatures brings a tangible and surreal flavour of tension between the fictional and the documentary to this hybrid animation style.

2.7 Early animation and VFX movies

A theoretical distinction was drawn at the very inception of cinema culture between using the camera to describe and document a recognizable story world that audiences could relate to emotionally and intellectually, and using the camera to create fantastical story worlds into which audiences might escape from their everyday lives. This has often been described in discourse on film aesthetics as the Lumière/Méliès dichotomy.

The 'contrasting approaches of the Lumières and Méliès is central to film and is repeated through the years in a variety of guises.' (Monaco, 1977, p. 233). On the 28 December 1895, a date many film historians consider to be the birth of cinema (Cousins, 2011, p. 23), the Lumière Brothers attracted the first movie audiences in history to their cinemas with spectacularly moving renditions of 'real life' on screen. Cinema emerged from experiments with the first motion picture photography, begun several years earlier by Eadweard Muybridge as a powerful new tool with which to document, curate, edit and compose a film maker's ideas about the world and present them to a mass audience. The first endeavour of film makers was to show audiences the world they knew come to life on a screen in a dark room.

Almost immediately others saw the opportunity to take a different approach to the new medium. Georges Méliès, a performing illusionist specialising in sleight of hand, saw motion picture photography as a medium through which to capture visual magic tricks. He constructed an elaborate artifice in front of the lens. Méliès was 'a great delver into cinema's magic box, turning the realist films of Lumière into theatrical fantasies' (Cousins,2011, p. 27). His images were created in a studio with controlled lighting, sets, costumes, makeup and the very first visual effects on screen. Unfortunately, much of the celluloid film he processed was destroyed by fire and the few surviving results are treasures of early cinema. One of them, called, *Le Voyage dans la Lune* (1902), follows a group of explorers on their journey to the moon in a cannon-propelled space craft. The film was shot entirely in a studio, using cardboard and canvas sets, elaborate costumes, miniatures, puppetry, compositing, editing tricks and every camera illusion Méliès could use.

In two of cinema's early visual masterpieces, *The Cabinet of Dr Caligari* (1920), and *Nosferatu* (1922), directors Robert Wiene and F.W Murnau respectively brought the then contemporary movement of German expressionism to the screen, using beautifully directed and highly stylised imagery. They put forward the idea that cinema could be more than stories told with motion picture photography and like painting or sculpture, could also be an expression of visual art movements.

The 1920s and 1930s saw the first animation- and visual effects- driven works of cinema in a feature length format still used today. In Germany, Lotte Reiniger's *The Adventures of Prince Achmed* (1926) drew from techniques very similar to Javanese shadow puppetry to create what is considered one of the oldest surviving feature-length animated films (Cousins, 2011, p. 108). Early avant-garde animators and abstract, experimental film makers Walter Ruttmann, Berthold Bartosch and Carl Koch also worked on the film.

It was in the Unites States that Walt Disney produced the first truly modern feature length animation, *Snow White and the Seven Dwarfs* (1937). The film went massively over budget and Disney had to mortgage his home to finish the work. But the end result was a critical and financial success and went on to be considered one of the great classics of pre-World War II cinema and a pioneer of feature film storytelling. The film was arguably the first real masterpiece in a new industry only just finding its feet. The film was one of the first, if not the first, feature length film to be created completely by cell animation. Over a hundred thousand images were hand-drawn and painted by teams of artists and animators and sequenced on film at 24 frames per second on a scale never before attempted (Hollis, 1988, p. 4).

The production of *Snow White* was halted by the challenge of creating a convincing central character in Snow White herself. The technical difficulty of animating the human-like heroine at a level that Walt Disney and his team felt they needed in order to connect emotionally with the audience was simply not being achieved and animation tests were failing. The production team realised that they needed to reference a higher degree of reality back into their fantasy and to navigate a new path between artifice and documentary, to collage different modes of production and explore new ways of producing cel animation. Animator Ham Luske undertook the task. 'What he did,' animator Dick Hummer later observed, 'was really a sensational advance in the history of animation for serious human characters' (Hollis, 1988, p. 29). The Disney team looked back to previous experiments by Polish-American animator Max Fleischer to use rotoscoping, the process of filming an actor and tracing over these frames for timing and blocking reference.

Much of what we see of Snow White on screen in the final film used this process. Rotoscoping allowed for a sense of the real, the tangible. It allowed the film makers to portray the emotional story of a real human navigating her way through a terrifying adventure and ordeal. While the rotoscoped animation results drew fire from some critics, the movie was a box office and critical success. It has become one of the defining classics of modern animation and VFX driven feature film making.

In 1935, during early production on *Snow White*, Walt Disney wrote a letter to the Chouinard Art Institute (now Cal Arts) asking him to help train new and improve old Disney animators. He wrote:

> The first duty of the cartoon is not to picture or duplicate real action or things as they actually happen—but to give a caricature of life and action—to picture on the screen things that have run through the imagination of the audience to bring to life dream-fantasies and imaginative fancies that we have all thought of during our lives or have had pictured to us in various forms during our lives... I definitely feel that we cannot do the fantastic things, based on the real, unless we first know the real. (Disney, 1935)

Audiences at its Hollywood premiere rose to a standing ovation. *The New York Times* wrote, 'It is one of those rare works of inspired artistry that weaves an irresistible spell around the beholder'. (Hollis, 1988, p. 31). *Snow White* was the first

movie in which performance capture was used as a central story telling device and 70 years later James Cameron would take this same device and use emerging technologies to push it to a more refined creative level in *Avatar* (2009).

As Walt Disney's animation team found an innovative way to navigate the dichotomy of reality and fantasy to achieve a greater emotional engagement with audiences, I will next refer to the work of some other significant artists, directors and production companies, and the academic and technical discourses around the production of their works and their impact on audiences. I also discuss the works of artists who have delved into the intersection between digital and analogue modes of animation production in ways that have informed and inspired the direction of my own research.

By the late 1920s and early 1930s, on either side of the Atlantic, a golden era of cinema as an industry had emerged. Despite, or perhaps because of, the financial hardships of the Great Depression and political turmoil in Europe, audiences paid to go to the movie theatre in numbers never seen again. Five times as many people flocked to the cinema per capita as do now. Ticket sales drove the technological and creative possibilities forward on an industrial scale and studio production complexes the size of small towns emerged in southern California. Movies began to move past the shadowy, flickering, experimental films of the first decades of early cinema and a lush, marketable, visual aesthetic was established. Directors begin to create moving images for mass audiences and the romanticism and escapism of contemporary cinema became recognisable. During the 1920s, cinema became 'both the most popular international form of entertainment and a serious chronicler of the human soul.' (Cousins, 2011, p. 61). Cinema had already established genres along the same lines as literature and theatre, but new technological possibilities and innovation brought visual effects and animation techniques to the forefront of cinema production.

In Germany, Fritz Lang's *Metropolis* (1926) and in the United States, Merian C. Cooper's *King Kong* (1933) were both benchmarks of early science fiction and fantasy cinema story telling. Both are critically acclaimed, technologically pioneering examples of the emerging industry of animation and visual effects film-making and both used early compositing techniques to bring together disparate visual elements and production modes. These included a collage of visual production techniques, bringing stop-motion photography, in-camera matte paintings, live studio action filmed on enormous and elaborate 1:1 scale sets, rear screen projections, miniatures, mirrored projections and other visual effects elements together into the one frame to create moving images that have become culturally iconic, such as Fay Wray struggling to free herself from her sacrificial altar as the towering Kong crashes out from the jungle and leers down at her, or Rotwang's transformation of his love, Maria into the robotic Maschinenmensch, which comes eerily to life amid pulsating orbs of energy.

Fritz Lang crossed the Atlantic to New York to do research for his upcoming German Expressionist sci-fi epic, *Metropolis*. The city had a profound effect on his production of the movie and while in the USA, Lang experienced the American production style and technical facilities firsthand. He witnessed the shooting of Universal's *The Phantom of the Opera* (1925), and was impressed by the massive set in which, 'The great French Opera in Paris was reconstructed'. He visited the set of *The Lost World* (1925), where he studied Willis O'Brien's ground-breaking stop-motion effects. (Minden et al, 2002, p. 8). Both inspired and appalled by New York, Fritz Lang returned to Germany, where his crew developed many pioneering visual effects processes on a scale that had never been seen in European cinema.

Lang's visual effects supervisor on the film, Eugen Schüfftan, developed various visual effects for *Metropolis* that would influence a generation of visual effects artists to follow. Miniatures were used extensively throughout the production.

These included stop motion photography, glass matte plates, camera cranes using a swing system and, most notably, a process developed using mirrors to create the illusion that actors were occupying miniature sets. In the miniature city shots, these mirrors were angled and shaped such that other visual elements, like crowds, other stop-motion photographic plates and actors could be composited in real time into the one photographic image. 'A mirror was placed in front of the camera to reflect objects behind, or next to the camera, such as models of buildings or landscapes. This mirror was either half transparent or placed at an angle that allowed the camera to film both actors and models at the same time' (Minden et al., 2022, p. 17). This technique came to be known as the Schufftan process and was seen again only two years later in Alfred Hitchcock's movie *Blackmail* (1929).

Lang was horrified to find that Adolf Hitler and Joseph Goebbels loved his film. In a now famous meeting, Goebbels told the director that he would arrange for Lang to be made an honorary Aryan despite his Jewish background. 'Mr. Lang, we decide who is Jewish and who is not,' Goebbels told him. Lang left Germany that very night and followed the path of many other Jewish cinema artists who fled Germany to continue their careers in the USA, greatly influencing the decades of film-making culture in Hollywood that followed.

The production techniques used in *King Kong* (1933) were researched and developed by pioneering visual effects artist and stop-motion animator Willis O'Brien, who had experimented with techniques involving animatronic stop-motion puppetry on the earlier *The Lost World* (1925), a stylistic forerunner to *King Kong* (Shay, 1982, p.18)

Throughout the movie, (*King Kong*) the visual elements in each shot were composited using a variety of image-making techniques and the final image was a collage of various methods. Most of the scenes on the island were a mixture of miniature sets shot against glass matte painted foregrounds, with rear projection screens used to insert actors into the frame at the desired scale. Further use of glass matte paintings provided foreground elements. Images from the film are now an iconic part of cinema culture and the techniques developed shaped the way movie visual effects and animation were produced in the following decades, right up to the advent of digital technology.

For example, In the sequence in which Kong battles a dinosaur, actor Fay Wray was inserted into the image via a rear projection screen. Stop-motion photography captured the image of Kong hauling up the rope vine by which Wray's character was attempting to escape. The miniature ledge setting was backed up by a glass painting of the trees and sky and water was rear projected onto the painting. A travelling matte system enabled actors to pass in front of the stop-motion animated Kong. Gas bomb explosions were superimposed over the completed animation footage (Shay, 1982, p. 33). In the famous Empire State Building sequence, 'Live action shots of real aircraft in the distance were combined with closer shots featuring miniature biplanes suspended on wires and moved one frame at a time by visual effects artist Orville Goldner while O'Brien animated the actions and reactions of his bullet-ridden ape.' (Shay, 1982, p. 37)

In order to create the effective illusion of interaction between live-action footage of actors and the giant creatures that featured in the movie, which were created using animated puppets and filmed using stop motion, Willis O'Brien and his team developed and refined a wide range of in-camera compositing techniques.

The compositing effects were achieved by exposing part of the film frame then running that same piece of film through the camera again and exposing the other part of the frame with a different image. This technique was used right up into the 1980s in, for example, the George Lucas *Star Wars* movies.

In more complex images, where a travelling matte plate was required on a moving image, cinematographer Carroll H. Dunning used filtered blue and yellow lights that were photographed into the black-and-white film. The Dunning process, as it came to be known, allowed film makers to combine two strips of film at the same time, creating the final composite shot in the camera. This technique was used in the final climactic sequence of the movie, where Kong was fighting aeroplanes while clinging to the top of the Empire State Building.

2.8 The beginnings of digital visual effects in cinema

As my area of research involved integrating and compositing digitally animated elements with miniature sets, drawing reference from the more recent decades of digital animation and visual effects production has been particularly relevant and valuable.

Although digital imagery had been developing since the 1940s and 50s, with various early forays into cinema in the 1970s and 80s, it wasn't until the early 1990s that computer-generated imagery really began to emerge as a new visual aesthetic, driving a cultural shift in the way that movies were designed, written, produced and received by audiences.

Director James Cameron's *The Abyss* (1989) and *Terminator 2: Judgement Day* (1991), which were made with eight-time Academy Award-winning visual effects artist Dennis Muren, opened the doors of possibility for computer-generated visual effects and film makers began to use these tools extensively in movie production.

By the end of the 1990s, studios were financing more and more movies drawing on the new toolset provided by the use of digital visual effects and movie makers 'vied to achieve greater and greater breakthroughs in digital computer imagery – both in terms of technological significance and of spectacle' (McClean, 2008, p. 43).

Then Steven Spielberg employed computer graphics to amazing effect in *Jurassic Park* (1993). In the T-Rex break out in the rainstorm sequence, the film contains, what is still considered one of the most technically well-executed visual effect in cinema. Spielberg's original intention was to use stop-motion visual effects artist Phil Tippet to create the dinosaur sequences but when he saw the digitally-animated tests from the CGI team at Industrial Light & Magic the results spoke for themselves. Tippett, who was sitting next to Spielberg at the screening, apparently declared, 'I've just become extinct'—a line that ended up in the shooting script. However, Spielberg kept Tippett on board to work with the digital team as an animation supervisor on the movie's dinosaur shots, helping the digital animation team lend their characters a sense of physicality and weight, work for which he won a second Oscar.

In an interview with Animation World Network @ FMX 2018 Professional Spotlight series, Tippet described his experience as an industry-leading VFX artist who navigated the transition from pre-digital creature animation to supervising and directing digital workflow on many successful Hollywood productions. He described the eagerness of studio executives to adopt CGi into their VFX production schedules as being a case of, 'We'll do it with CG, which means we can push it down stream. We don't have to think about it in the production context so much, you know it can be worried about later on, so the art or the craftsmanship has been commodified, and used and abused. You know, not by everyone. There are directors such as (Paul) Verhoeven or Guillermo Del Toro, who understand the craft and appreciate the artistry that goes into things. The studio's position is often that there are these guys that push buttons and make things move around and stuff like that.

But you wouldn't treat Gary Oldman like that. They (the VFX artists and animators) are actors that have something to say and something to deliver'(FMX, 2018).

2.9 Computer-generated imagery

Technical innovation has always driven change in cinema language and culture, and the emergence of computer-generated imagery has been one of the most profound technical shifts in the way movies are made; it not only changed the way visual effects and animation elements were produced, it also changed the way movies were written, designed, filmed, edited, distributed and screened to audiences.

In the early decades of cinema, the difficulty and expense of 35-millimetre film shooting and processing made the world of movies an exclusive club of industrial-scale studio producers. The possibilities widened in the second half of the century with smaller, lighter cameras that required less and less light, reflected in the introduction of the more documentary-styled handheld shooting aesthetics of post-World War Two European cinema. However, the introduction and cheap availability of digital cameras by the 1990s made film-making technology and equipment available to a much wider array of storytellers.

The advent of digital cinema production has also given a voice to a wider array of cinema storytellers and artists. After decades dominated by the relatively monocultural voices of Hollywood cinema, the 1990s saw an increase in cinema production and distribution from around the world, creating one of the most diverse movie-making periods in cinema history. Movies from Latin America, Africa, Europe, Southeast Asia were globally distributed with critical and box office success. To an increasing extent, digital tools levelled the global playing field. 'Using crews of two people rather than 10 or more, editing on home computers and dubbing in the simplest of sound suites meant that the world of film production was no longer a charmed one into which only the lucky few could enter' (Cousins 2011, p. 434).

The same can also be said of computing power. The average person shooting a video on a phone in 2021 holds more sophisticated digital film making capability in their hand than the biggest movie studios had access to in the 1980s. Sean Baker's comedy drama *Tangerine* (2015), which premiered at the Sundance Film Festival to critical acclaim, was shot entirely on an iPhone—and many other productions have followed. While digital technology has been a fundamental shift in cinema culture, some argue (as they have with the advent of every major technological shift) that this is the end of cinema. Patrick Crogan describes the culture of digital visual effects as being in a kind of self-perpetuating downward spiral. 'The meteoric growth of digital imagery in animation, visual effects, TV series and cinema over the last thirty years has been spectacular and given rise to a fast moving, fluid industry where innovation and technological advancement is hard to keep up with. However, 'Big budget, visual extravaganzas seem to be becoming both innovative and utterly conventional at the same time' (Crogan, 2012, p. 1).

The widespread adoption of digital technology has had more impact on the creative processes culture of the animation and VFX industry than any other sector of cinema. While the increased technological power and capability of visual effects studios to render to market images and stories containing VFX that are more visually spectacular in scale and scope seems to be increasing every year, the saturation of VFX-digital content can, at times, seem to undermine the story value of the work being created. 'Hollywood cinema as a profoundly animation-driven form of spectacular entertainment characteristic of global digital media in the era of hypercapitalism' (Crogan 2012, p. 1).

Digital technology has not only made film making more accessible to a wider array of voices, it has also offered previously inaccessible visual possibilities for film makers. 'In many ways, this is the most significant impact of [digital visual effects] for film makers: access to the impossible – the making real of images previously limited to the representational arts, the mind's eye, the writer's pen' (McClean, 2008, p. 226).

2.10 Contemporary animation works

I was drawn to this research into animation primarily as an aesthetic choice. But this research project could also be seen as a response, or a reaction to the change in cinema culture towards digital animation production. At the same time, combining miniature sets and digitally-animated characters with set extensions produced by game engines while filming using robot arms would be impossible without new technologies, especially if you want to use the full scope of camera movement as part of the storytelling process.

I therefore refer next in this literature review to a list of short films, animation production studios, directors and commercial projects that have created screen works that stylistically push against a shift to an all-digital production aesthetic while embracing new technologies and production paths in order to achieve the final image.

These animation productions all used production pathways similar to the hybrid style explored in this research project. As with my case studies using these techniques, the aesthetic choices allowed these works to draw from older, analogue animation and visual effects production methods from the beginning of cinema history, such as miniature set builds and stop-motion techniques and traditional hand-drawn cel animation, and use new technologies to integrate these methods with digital animation.

The artists, production companies and individual films and commercial works cited here are examples of animation productions that relate strongly to my area of research and interest in animation in that they all drew on emerging digital technologies to realise images on screen that reference and celebrate analogue, physical and pre-digital methods.

In all the following examples, the extensive use of contemporary digital film making tools opened doors to a much wider array of creative possibilities in terms of the hybridisation of animation production styles and facilitated a resurgence of creativity in stop motion, hand-drawn cel animation and puppetry, even if in a more niche corner of the movie-making ecosystem.

2.11 Laika

Laika is a leading stop motion production company based in Oregon, USA, known for its critically-acclaimed and financially-successful animated stop-motion movies, including *Coraline* (2009), *ParaNorman* (2012) *The BoxTrolls* (2014), *Kubo and the Two Strings* (2016) and *Missing Link* (2019).

Laika, along with Aardman in the UK, is one of the only surviving movie studios to continue producing and distributing stop-motion works that are both critically acclaimed and beautiful films that audiences enjoy. In order to achieve this, they have developed interesting and innovative ways to engage digital production methods into their stop-motion work flow. Their movies have been a useful reference point for my research into the various production techniques that they developed in order to create a unique hybrid of analogue and digital production pathways.

Many of the interesting and innovative techniques that they use were initially explored in the production of *Coraline* (Selick, 2009), based on the book of the same name by Neil Gaiman, and the film was nominated for Best Animated Feature at the 82nd Academy Awards and won Best Feature at the Annecy International Animated Film Festival in 2009.

Director Henry Selick and his production team's push in this direction was motivated by creative direction which wanted to find ways of infusing animation production with a richer balance of real, physical tangibility and computer-generated images. According to Selick, 'After working on *Moongirl* (2005) and seeing everyone sitting all day at their (computer) terminals, I just wanted to get back to touching and lighting real things. The physicality of stop motion became even more attractive' (Selick, quoted in Fordham, 2009, p. 42).

In the production of *Coraline*, Laika's technical team made extensive use of 3D printers to print frame-by-frame face replacements, allowing the facial animation to be designed in 3D animation software, then printed and placed as a physical model in each frame. This innovative use of digital fabrication tools to create new ways of interfacing with more traditional analogue animation methods produced a unique hybrid of image styles. However, the technique also required large libraries of face frames for each shot to be printed, painted and catalogued, followed by the very time-consuming task of removing the edges of these face prints from each frame of the final image, on top of the already big task of puppet wire removal in stop motion. Laika have continued with the process and their hybrid production techniques have been refined further, to really beautiful effect in their more recent feature animations, *Kubo and the Two Strings* (2016) and *Missing Link* (2019).

2.12 Aardman Animations

The other successful production studio to use contemporary digital tools and techniques to facilitate the practice of stop-motion film making is Aardman Animations in the UK. Director Nick Park leads a team of artists whose screen works maintain the nostalgic, handmade charm of stop motion, but makes extensive use of digital tools to shoot, composite and edit, thus maintaining stop-motion film making as a developing art form in the era of digital animation.

Both Laika and Aardman use digital SLR cameras to capture frames, and both, especially Laika, use green screen extensively to isolate characters, allowing the team to capture elements of each shot in layers and these elements are then composited with digitally-generated set extensions. Like Laika, Aardman are celebrated for being practitioners of the more antiquated, anachronistic, hand-made mode of animation practice, but they are actually taking advantage of every contemporary digital technology they can in order to achieve their desired aesthetic outcome.

One of Aardman's most interesting genre-merging animation works is the *Creature Comforts* (1989–2003) series. The original short film (which won director Nick Park the Academy Award for Best Animated Short Film in 1990) and the series that followed a decade later are interesting hybrids of stop motion and mockumentary in which audio from unscripted, vox pop-style interviews were matched with animated stop-motion zoo animals in lip synch, as if they were interview subjects. It was an innovative animation project that crossed a line between documentary and animation to create a strange, and very funny impression of plasticene stop-motion animals speaking candidly with domestic British attitudes.

Creature Comforts (1989–2003). Director: Nick Park, Aardman Animations.

This work blurred the boundary between a format that audiences were accustomed to experiencing in a documentary and what they were used to seeing in a stop-motion animation. The merging of 'real' candid, unscripted street interviews with the hand-crafted artifice of stop-motion animated plasticene models created a uniquely surreal mixed-media experience.

This format influenced the animation team behind Wes Anderson's stop-motion movie *Isle of Dogs* (2018). Each actor's stop-motion character was animated to match audio from behind-the-scenes interviews with the cast. The resulting animated sequences created an interesting tension between things recorded from the real world and artificial constructs created by artists for the final film.

2.13 Wes Anderson

Director Wes Anderson was an interesting reference point for this research project. In both of his stylistically unique stop-motion animated films, *Fantastic Mr Fox* (2009) and *Isle of Dogs* (2018), he developed story worlds that made use of miniature set builds and stop-motion puppetry as an aesthetic medium; he also used a digital production pipeline, making extensive use of green screen compositing and digital set extensions. His films tapped into a type of hybrid cinematic aesthetic between the realness and warmth of miniature set story worlds that clashed in look against a type of surreal, yet almost naturalistic delivery style from a cast of actors recognisable from his distinctive live-action films.

In the following excerpt from an interview with journalist Michael Spectre from *The New Yorker*, Wes Anderson discussed the appeal of a handmade look in his animation work:

> MS: I don't know about you, but I've just never seen a movie that looks like this before. This is some combination of real movie stop motion, I was taken aback by that.
>
> WA: It's fast. There's a lot going on fast, which you sort of don't think they could accomplish. So that surprising. My breath was taken away a bit when I saw it (the final film). But don't those sorts of movies have a kind of - it's like a hand drawn drawing versus something and it's been computer designed. There's a little personality somewhere in it that's just,

> maybe it's a little warmer than something that is made by computer. Having said that, I like a lot of the computer animated things come out. But something that's made by hand, sometimes you can, like, if it's plasticine stop motion and you'll see a thumb print on one of the characters. I'm not saying that's why you like a thing but that might be part of the life of the thing that's been handmade, and we are currently in a draught of handmade feeling things. They communicate some kind of life that other methods don't necessarily communicate. Which is how I feel about hand drawn drawings. (Anderson, 2009, p. 87).

During production on *Fantastic Mr Fox*, to capture more naturalistic audio for a scene taking place in a field, Wes Anderson recorded the cast delivering their lines as they walked up a hill in the countryside, capturing the incidental atmospheric sound of wind and birds and their feet walking through grass in the sound recording.

> All we need (from the actor) is the voice, so we're kind of doing whatever we need to do to make just the voices work. And part of that is trying to make it go someplace where it's a bit of an adventure to record it or trying to create some situation where it's inspiring to the actors. (Anderson, p. 40)

Similar sound recording techniques were used in Gore Verbinski's animated feature *Rango* (2011). This merging between real, almost documentary style audio recordings and the obvious artifice of a designed miniature world speaks to the tension between the real and the constructed that has existed in cinema aesthetics on some level since the beginning of the medium.

Working with miniature sets, using either stop motion or VFX sequences as a creative medium, has always involved cinematographers bringing in real-world cinema language and scaling it down. This is not always as simple as it sounds and can be a technical challenge for cinematographers. Examples of these challenges can be found in the creative use of depth of field when shooting miniatures and in the movement of the camera.

In *Isle of Dogs*, Wes Anderson's famously symmetrical shooting style translated seamlessly to stop motion and miniature set design, illustrating how his approach to the medium is quite different from that of both Laika and Aardman, who frame and storyboard sequences using a very established cinema language of shot-to-shot framing.

In 2018, cinematographer Tristan Oliver, who worked previously on Laika's *ParaNorman* (2012), on Aardman's stop-motion classics *The Wrong Trousers* (1993), *The Curse of the Were-Rabbit* (2005) and *Chicken Run* (2000), as well as on Anderson's stop-motion movie *Fantastic Mr. Fox* (2009), gave a series of interviews with the British Society of Cinematographers in which he described some of the frustrations of working with Wes Anderson. The director was adamant that he wanted his miniature set photography to have the same deep focus on-wide angle lenses that he loves (and is famous for) in his live-action films.

> TO: When we're shooting on digital stills cameras, Canon 1d x, so they have got a very good, full frame sensors. You put a 28-mil lens on that, and it's super wide. So, to get a close up on this guy, (indicates miniature dog puppet) we are at minimum focus and minimum focus on the lenses we use is about 20 centimetres. So you're focused on is it now at a conventional live action F stop, you know, if you're shooting at F2.8, pushing it to F4, you would not have his ears in focus. So, because Wes loves a very deep focus, he wants the end of the dog's nose in focus and he wants the back of his head in focus and he wants the background in as well. So where do you go? Well, you know, you go to 16. And you can hear the lens starting to struggle.

And, and you'll send your images in (to Wes) and he'll go: Is that all you can give me? and you'll go well, I don't really want to go to F22, because these lenses really don't work very well at that level. And if you, if you look at the film, you will have been very aware of the amount of chromatic aberration there is in the fur, because what the fur does is it splits the light, you know you're getting diffraction in the fir. And on the lenses we use which we have to buy because we shoot for two years. I can't buy lenses that costs 25,000 pounds each. So, I'm fighting the quality of the lens, I'm fighting focus and I'm fighting depth of field. So, you have to find a way to do that. And added to that is the fact that compared with this guy, that camera is the size of a small car. So, you're getting in the way of everything that's hitting this guy (indicates miniature dog puppet) our camera is the size of a small car. So, you're getting in the way of everything that's hitting this guy lighting wise, if it's coming from the front, because the cameras is still sizable, you know, so it's blocking. So, you know, we have to find ways of working around that. And making it look like we haven't taken that trouble.

INTERVIEWER: So, you're pouring a lot of light onto the set.

TO: I mean, it's not a huge amount, because what I've got is I've got complete control over my shutter speed. So, I can expose for two seconds if I need to, in order to find my F16 or even my F22, so that's not the problem. It's everything else. It's the physics that is the problem. And quite often, you know, if he's very insistent, we'll drop a green card behind the foreground characters, shoot them, take them out and shoot the background as a player.

INTERVIEWER: For the most part, Wes likes to do things in camera?

TO: He does like to do them in camera, but I often think of that, that claim as being a little misleading. I will say there is more VFX addressing of issues than he would like us to think.

INTERVIEWER: It's not as romantic as…

TO: It's not always as romantic. Right. And but you know, some things are beyond Newton, you know, Physics. Sometimes you just can't get past it.

Later in the interview Tristan Oliver was asked about working with Wes Anderson's framing style:

TO: 'I think what we're making is essentially a picture book. So, you turn a page and you look at a beautiful illustration, and you look all around it, you know, he's not a filmmaker who tries to draw the eye to a particular point in the frame, so as to carry the action. It's more of a tableau, it's a tableau, exactly. And when you turn the page, even though it might just be cut to a different angle within the scene. It doesn't necessarily have to have that level of continuity. It can just be another beautifully composed image'.(British Society of Cinematographers)

This interview was a useful reference for some of the technical challenges my team and I faced in our own case studies in bringing the aesthetic and cinematic language of cinema into the medium of miniature story worlds.

Isle of Dogs (2018). Director: Wes Anderson. Studio Babelsberg, Indian Paintbrush, American Empirical Pictures.

2.14 Commercial Work

Short films, television programs and online commercials have always been a creative space for testing and innovation in the area of animation and visual effects. Being shorter, these formats make financial risk less prohibitive, and often developing film makers with new ideas are able to test and experiment technical and creative concepts when developing their careers in the production of shorter works.

2.15 Invention of Together

Buck Design's short animation *Invention of Together* (2018) has been an interesting and useful reference point for this research project. The creatives at Buck design are leaders in the field of motion graphics design, illustration, art, design and technology, and this animation work uses a similar production process to my own area of research with miniature sets composited with digital elements. Creative director Joe Mullen from the Los Angeles branch of Buck uses this style in a way that really embraces the small scale of the sets. Unlike Wes Anderson's push for deep focus, which at times seems to be fighting against the scale of miniatures as a medium, *Invention of Together* embraces the short depth of field as a production design and screen composition parameter. As with most interviews with crew and creatives working on this method of animation production, a Buck press release reads: 'We wanted the sets to feel alive- so we filled them with real things - like fish, and caterpillars and fog and water - everything was real … except the characters which were lovingly created by Buck's CG team.'

In an interview for ACM Siggraph blog post in 2019, Joe Mullen made a range of interesting observations (relative to my own creative process) about the challenges that the team faced getting their animation style to work in the miniature set medium:

> We were inventing a process we had never done before, marrying practical environments and moving cameras with CG characters. It turns out that creating animation that's not overly exaggerated and 'cartoonish' can be quite difficult. It's almost as if the animators had to unlearn everything they'd been taught about human performance, particularly in the commercial world. ... We had to work through how to have fewer big actions, but still keep the characters alive with all the subtle micro-actions, shifts in weight, and slight pauses and adjustments that bring the animation a little closer to the real world, making our CG characters feel at home in the tactile, practical sets. (ACM Siggraph, 2020)

Doug Wilkinson, head of CG for the project, described how animation details were strategically shifted from moment to moment using a variety of different frame rates in order to give a sense that the characters were really inhabiting the handmade miniature world. 'The environmental animation was shot on camera, mostly at high speed, so that we could change the frame rates later. This was to make some of the moving set elements, like the waterfall, feel as if they were on a larger scale'. Wilkinson also notes: 'The characters were done with 100% CG-based character animation, in a style and frame rate to give a handmade, but not stop-motion, look. It was important that the motion had a style that felt unified with the look of the rest of the environment.' (Stash Media, 2018).

The same team, along with Creative Director Joe Mullen, was behind the more recent Apple commercial *Share Your Gifts* (2018), which built on their creative process of using miniature sets and CG characters. This time, the team's budget allowed for sets on a bigger scope and scale. From my own film-making perspective*, Share Your Gifts* was a creatively and technically successful example of the potential of this medium.

2.16 Share Your Gifts

Share Your Gifts, (2018), a short commercial for Apple, also uses a hybrid style production process similar to the process explored in this research project in that digitally animated characters were composited into footage shot on practical miniature sets. This was one of the more successful examples of this production approach and has been a significant influence on my upcoming projects using this style of animation.

As associate Creative Director of the animation project, Richard Gray stated: 'I love the combination of practical sets with CG characters. We get amazing performance from the characters, but we're still in this real, art-directed environment. It makes people connect with the work.' (*Making of Share Your Gifts*, Apple, 2018,)

Buck Executive Creative Director Ryan Honey stated: 'The sets could be made in CG, when you do, you're spending more time and more effort to make it look like it was hand-made.' (Making of *Share Your Gifts*, Apple, 2018).

Share Your Gifts (2018). Creative Director: Joe Mullen, Buck Studios.

2.17 Save Ralph

In the short film/commercial media space, the use of miniatures has become a medium favoured by directors and production designers looking to pull at the audience's heart strings and elicit an emotional reaction to the work. This intention was behind the decision to use miniatures and traditional stop motion in director Spencer Susser's *Save Ralph* (2021), which featured Taika Waititi and Ricky Gervais in a whimsical comedy style to highlight the injustices of laboratory testing on animals.

In an interview in the behind-the-scenes video on the project, director Spencer Susser stated: 'I don't believe this would work in the same way if it was all computer generated. There's something that's so special about tangible things moving – you can't fake that' (Bluetongue Films 2021).

2.18 The Gruffalo

This short (27 minutes) animated film The Gruffalo, (2009) directed by German directors Max Lang and Jakob Schuh at Studio Soi in Berlin and produced by Magic Light pictures with broadcast partners the BBC, was also a very useful reference for my chosen area of research and animation production style. *The Gruffalo* was created using miniature set builds for all environments and these were then composited with digitally-animated and rendered characters to create a visually distinct and unique hybrid of both modes of production. The end result was critically and commercially successful. The images were very well crafted and the technical execution of the style was excellent. The storytelling style was also a tonally perfect adaptation of the original text. *The Gruffalo* was nominated for Best Animated Short film at the 83rd Academy Awards and win the award for best TV special at the Annecy International Animated Film Festival 2010 and the audience award at the 2011 Toronto Film Festival.

Co-director Jacob Schuh, referring to Axel Scheffler's illustrations from the original children's book, stated: 'Axel's drawing have a lot of, let's say, human stain. You can see every wash of colour and every brush stroke and his ink and his nib work, so with a CG application all that is often lost. What we wanted to try out was to have a three-dimensional world, a three-dimensional deep dark wood, but not lose that tactile quality of Axel's drawing's'. Co-director Max Lang described the approach as combining 'The real feeling of the build set and the freedom of movement with 3D animation' (Magic Light, 2021).

An area where *The Gruffalo* leaves room for improvement from my own perspective as a director interested in developing tools for this style of animation production is the design style of miniature sets, in that the final result looks and feels very similar to the digital production design process. Unlike some of the above-mentioned shorter commercial works, where production teams really leaned into the nuance and imperfection of miniatures as a genre, there was little room in *The Gruffalo* for error or happy accident. All organic surfaces and materials were made from artificial materials and so give the feeling of a world designed by humans. In this way I feel that the final result lacks a kind of realness, as though the production could have achieved a very similar result using a completely digital pipeline.

This is one of the key areas in which I feel my research angle has something valuable to add to the conversation about this style of animation production. If a production team is to make miniature sets, that is, to physically construct all sets and

environments in the real world, then it is important to do this in a way that takes full advantage of the benefits of these production choices. Rather than just mimicking the look of digital design, the team should embrace the benefits of physical, analogue set design and build. The advantages of this, as I see them, are discussed in detail in chapters 4 and 5, that describe the two case studies created for this research.

In interviews with *Computer Graphics World* in 2011, Jakob Schuh described the decision-making process that led Studio Soi down the path of building physical miniature sets for all their environments:

> Axel Scheffler's illustrations in the children's book have a very tactile, handmade feel to them. I always thought that the warmth and organic detail of his brushstrokes and his pencil work were essential to the feel of the story. The miniature sets were sort of a three-dimensional equivalent of that. Also, that level of detail would have been very hard to achieve in CG within the framework of our budget and timeframe, and even if we had somehow managed to pull it off it, the ideal result would have been something people have become well acquainted with in productions much bigger than ours. (*Schuh,* 2011)

These production details about *The Gruffalo* are very relevant to my own research because the production team arrived at the same conclusion about using digitally-animated characters, rather than stop motion, with their miniature sets. My reason for using CG animation instead of stop-motion was mostly that the performances in CG were particularly rewarding to direct. One can collaborate with the animator a lot more easily, and discuss and hone the performance. 'All of that is possible with stop-motion as well, but for both the director and the animator, it's often just a bit less fun of an experience,' (Schuh, 2011). Here Schuh is more or less arriving at the same conclusion that I did in my research topic, namely, that digitally-animated characters are a much more effective way of achieving good creativity and communication between writers, directors and animators. While this can be done extremely well in stop motion, as studios like Aardman and Laika have shown, the iterative nature of digital animation allows for much more back and forth conversation between storytellers and animators.

Also relevant to my research, Shuh goes on to describe the technological and budgetary challenges of this particular mode of production. Budgetary limitations and delivery timelines meant: 'The building and shooting of the miniature set had to happen simultaneously with the animation. This parallel workflow required a lot of planning and pretty solid previsualisation' (Schuh 2011). Here he describes what I consider to be a significant gap in knowledge. 'A place where emerging technologies such as real time engines, 3D printers and robotic arms for motion control can significantly improve upon the process. Also, the integration of the characters into the shot footage wasn't always easy. I'm not convinced we overcame the latter problems, but we've learned a lot for future projects'. (Schuh 2011).

The final result of *The Gruffalo* is in the same general visual genre of my own area of research, the big difference being that I feel this movie, and other completely stop-motion productions, does not take full advantage of the design possibilities in miniature production.

The Gruffalo 2009. Directors: Max Lang & Jacob Schuh, Magic Light Pictures.

2.19 CGI in cel animation

Two Studio Ghibli movies used a unique collage of production techniques to find an interesting middle ground between analogue, hand-drawn cel animation and computer-generated imagery from a different genre of animation, even though they were not the first to use this approach. In the Disney cel-animated feature *Beauty and the Beast* (1991), key sequences of the film were first constructed in CGI then used as reference for the final frames; however, as Studio Ghibli has become the world's leading cel animation production studio, its use of this technique has been explored with more depth and refinement than anyone else.

2.20 Studio Ghibli and Princess Mononoke

Studio Ghibli, known for having created some of the world's most appreciated and celebrated hand-drawn cel animated features, began to experiment with compute- generated imagery in one of Hayao Miyazaki's most celebrated works, *Princess Mononoke* (1997). The final frames of the film, like those of nearly all of Ghibli productions, were hand-drawn. The 2004 documentary *Princess Mononoke: Making of a Masterpiece* describes the film's production process that incorporated computer-generated animation into approximately 10 per cent of the film. The computer animated parts were designed to blend in and support the traditional cel animation and were used mainly in images consisting of a mixture of computer-generated graphics and traditional drawing. The production team took advantage of digital film-making tools to provide perspective, parallax and the editable and more easily iterative nature of a 3D animation pathway to give an enhanced cinematic quality to the animation and the movement of the camera through hand-drawn environment layers.

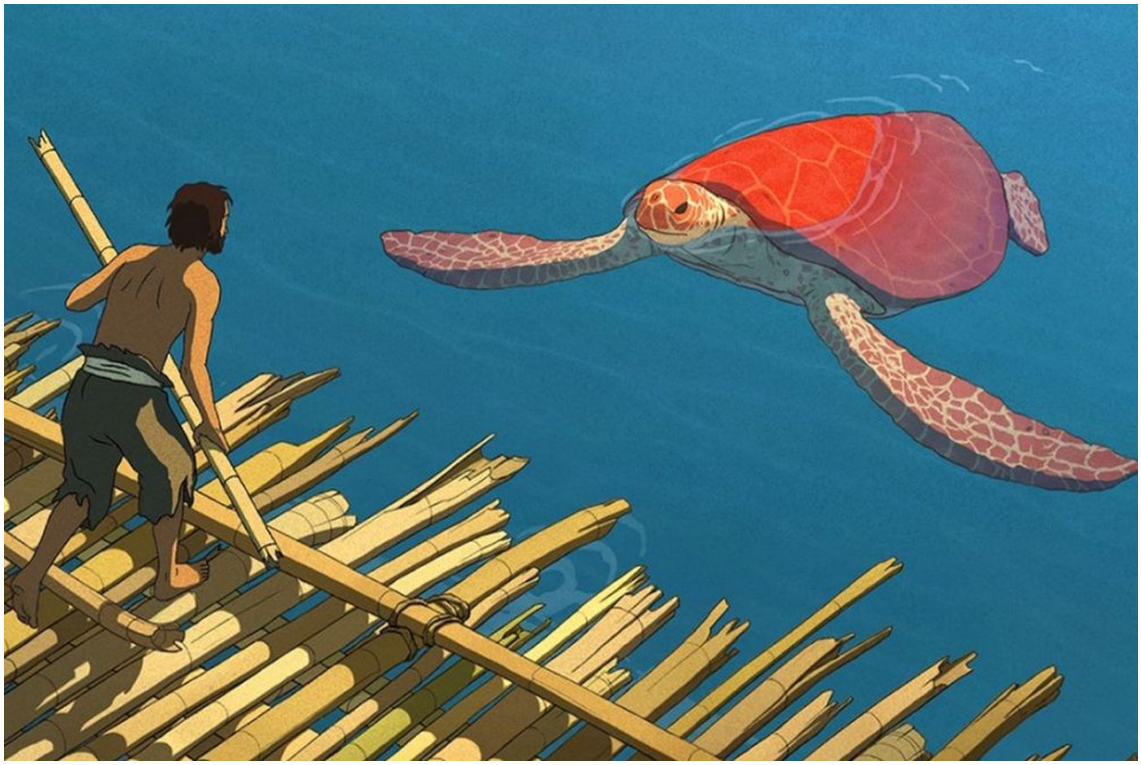
2.21 The Red Turtle

The use of hand-drawn elements combined with a subtle use of CGI was used very effectively in *The Red Turtle* (2016), an animated film produced by Studio Ghibli and directed by Dutch animation artist Michaël Dudok de Wit, who had previously made the Academy Award-winning short film *Father and Daughter* (2000). *The Red Turtle*, which was nominated for Best

Animated Feature in the 2017 Academy Awards, was almost entirely hand drawn, using TV paint cel animation tools, including backgrounds and all the human characters. Several elements of the film were rendered in CGI with a look to match the hand-drawn feel of the characters. Most notably a large bamboo raft and the Red Turtle character. This was done so as not to limit the angles and detail on these two very important story elements. Dudok de Wit describes the reason for this decision as follows:

> I thought Yes, we need a marine creature to make the story stronger. We used a hybrid process, we drew all the characters, they were hand drawn just like we've always done, but the turtles were all CG animation. And the reason is the shape is very hard to control if you draw them with a pencil, because they are a solid shape, but they are also curved everywhere. I really want to tell people when you watch this film, I hope you can just let yourself be carried by the story and not question anything - a bit like you let yourself be carried by music. (On Animation, (2017).

It is an approach I have been experimenting with on another short animation study in collaboration with Amsterdam-based animation and VFX artist Ben Streek for an upcoming feature film project with Australian director Robert Connolly.



The Red Turtle 2016. Director: Michaël Dudok de Wit, Studio Ghibli.

2.22 Literature Review Conclusion

In this section I have discussed a number of movies and animation productions that explored the use of miniature sets and digitally-animated characters in a variety of combinations. I have also examined movies that used other approaches to hybridity and a collage of moving image-making techniques in their productions. I have shown that there is a long history, back to the very start of cinema history, of film makers photographing real elements and combining them with animated visual elements to tell their stories visually.

I have also demonstrated that, while a number of productions have used a hybrid style of animation similar to my research topic, bringing these elements together is still a relatively unusual form of movie making and that creative opportunities and technical challenges remain for those who wish to explore this style further as a creative discipline.

3 RESEARCH METHODS

3.1 Introduction

In Chapter 2, the literature review, I established some historical context by looking at some early cinema history, where film makers found innovative solutions to creating animation and visual effects using a variety of combinations or collages of different image making styles. Next, I referred to animation works that, despite the overwhelming shift in cinema technology and culture towards digital modes of production, had pushed back against this shift and used analogue and physical production modes such as miniature sets, puppetry and hand-drawn cel animation. I discussed the ways in which these productions made innovative use of digital technologies to achieve a more practical production path and quality outcome within their chosen production pathways and that these films enjoyed a significant degree of critical and/or commercial success.

I also referred to animation works whose creators had chosen a hybrid production path that was similar to my own animation workflow, compositing characters created in 3D animation software with physical miniature set builds.

I highlighted some of the areas in which I felt my research team could improve on the technical approach that these productions used and established that there is space for further research into the technical and creative possibilities of this mode of animation production, especially considering the possibilities offered by many new and emerging technologies in the animation and visual effects industry. With the new technical tools come possibilities for improvement and opportunities for new creative approaches to this hybrid production style.

Consequently, the aim of this research project was to explore ways to expand the creative possibilities and technical facility of this hybrid animation production style to generate knowledge and insight through creative practice as a form of qualitative research. In the following pages I outline the research frameworks and the methodologies that were used in this project.

First, I breakdown the theoretical frameworks behind my approach to the chosen research methodology. This section outlines the principals of practice-based and practice-led research, as well as reflective practice. I discuss interpretations and understandings of these terms and the ways in which these methodologies were used in the context of animation research and development.

Next, I outline the research strategies that were used in this project, showing how I translated these theoretical frameworks into practice. I then examine the various research outcomes, which are presented as a series of case studies. In this section I look at animation production in relation to practice-based research and how the creative dynamics specific to my chosen area of animation production translate into this type of research.

Next, I discuss the methods used for gathering research data and the methods used to document and examine my creative practice. I also outline the use of interviews and the strategies used to conduct the interviews. I also examine the role of

the researchers in this project and the ways in which creative collaboration and the problem-solving skills of animation and visual effects artists were drawn upon as a research methodology. I also discuss in this section the ways in which creative self-reflection plays a significant part in the research outcomes of the overall project.

This chapter also covers the relevant ethics considerations that were taken into account during the project, particularly in the use of interviews with the artists working on the case studies created in this research.

3.2 Theoretical frameworks

This research project was undertaken using several methods, central to which was the use of practice-based research.

The use of this research method stems from the idea that creative practice is itself a form of research and generates detectable research out puts and that creative practice and 'the training and specialized knowledge that creative practitioners have and the processes they engage in when they are making art – can lead to specialized research outputs which can then be generalized and written up as research' (Smith & Dean, 2010, p. 5).

Practice-based research is increasingly recognised as a tool for researchers looking to gain insight into and effective knowledge of creative practice and creative industries. Through practice-based research, a reciprocal relationship can be established between research into a creative practice and the undertaking of the practice itself. As I demonstrate in this thesis, a positive feedback loop between the creative process, the reflection upon and interrogation of that process and then further iteration of the creative process all give the researcher/creative practitioner useful and applicable knowledge and insight into their work.

Not only does this approach lead to tangible learning outcomes, it also leads directly back into an improved creative practice. The creative practitioner who has approached their area of work from a research perspective gains powerful tools and perspective that feed straight back into the making of future artistic works. This use of practice-based research follows the principal outlined by Linda Candy, who writes that, in practice-based research 'any claims of originality and contribution to knowledge may be demonstrated through artefacts created during the research process such as artworks, musical compositions, performances and interactive new media installations' (Candy 2011, p. 36).

In *Interacting: Art, Research and the Creative Practitioner*, Candy describes the term 'creative practice' as 'the act of creating something novel with the necessary processes and techniques belonging to a given field of endeavour, whether art, music, design, engineering or science' (Candy 2011, p. 33).

Theoretically, therefore, research can be undertaken in any form of creative practice, whether a physical artwork, a performance, a sculptural installation or any other form of creative endeavour. In this research, I focused on the production of screen-based animation works. The information and outcomes that may be generated by practice-based research can be 'very illuminating about the theoretical and technical insights practice (can) produce, and the significance of creative work and its surrounding practices as a form of research and contribution to knowledge' (Smith & Dean, 2010).

Research into creative disciplines can, at times, to be difficult to separate from the process of simply undertaking creative activities within those disciplines. When it comes to the outcomes of creative practice, for example physical artworks,

installation, performance and, in my case, screen-based works, the distinction between an outcome of a practitioner's creative endeavour and the creation of a research artefact can also be difficult to establish.

One of the key differences is that a creative practitioner may be instinctively undertaking a form of research and development as part of their process of creating new work. Any resulting knowledge created, while it may be significant, is evident only in the artefacts created. It will not have gone through the discipline of research data gathering, reflection and writing. Without a methodological framework and a data gathering process (amongst other things), any knowledge and insights gained through their creative practice will not have been recorded, processed and compiled. Further, this knowledge will not be readily available to the creative community, either within or more broadly outside their chosen field of practice and consequently, this new knowledge cannot contribute significantly to the existing body of knowledge in the field.

This is not to suggest that there is not significant value in the artefacts of practice-based research themselves. In fact, these artefacts are intrinsic to the knowledge-gaining process of this mode of research. In many cases in practice-based research, the resulting creative outcomes are indeed evidence of the research and the primary source of any knowledge gained. 'Research within creative practice is inextricably bound up with creating works and investigating the implications of them' (Candy 2011, p. 39).

Therefore, it is important in this chapter to clearly describe both the distinctions and the significant cross-over between creative practice and research into that practice.

Practice-based research is an emerging research methodology and there is some debate within academic and research communities about how best to define and review this method. The emerging landscape of creative practice as research has led to a wide use of terminology in universities and research institutions around the world. For example, 'practice through research', 'mixed-mode research practice', 'practice-as-research', 'practice-based' and 'practice-led' research are all terms that have come into use.

For the purposes of my research methodologies, I use the terms 'practice-based' and 'practice-led' research. The types of research that fall under these two terms can have significant overlap, but in order to have a clear understanding of them as they are used in this outline of methodologies, I define them as follow:

3.3 Practice-based research

'When research includes a creative artefact as the basis of the contribution to knowledge, the research is practice-based. This type of qualitative research is undertaken in order to gain knowledge by analysing and reflecting upon the outcomes of practice. Common outcomes of practice-based research, particularly when undertaken as part of research into creative fields of endeavour, may be artefacts such as exhibitions, installations, performances, audio visual works, sculpture and other creative outcomes. These artefacts themselves become an essential part of the reflective and informative process by which the researcher gains knowledge and insight into their field of research'. (Candy, 2011).

The artefacts produced through practice-based research themselves become both the focus and the results of the research. At the same time, these artefacts do not represent the outcomes of the research in their entirety but rather encompass a large proportion of the outcomes. Practice-based research includes documentation of knowledge beyond the artwork itself in a range of different formats. These can include text-based analysis of the research, reflection upon the practice, interviews with collaborators and artists involved in the creation of works and documentation in other media forms, such as video and audio and they all form an essential accompanying reference to the artefacts produced.

3.4 Practice-led research

If research leads primarily to new understandings about the nature of practice, it is practice-led. This type of research is concerned with finding new understandings about the nature of research practice itself and seeks to add to and advance knowledge and give insights into a given mode of practice.

In practice-led research, the researcher develops a methodology that is specific to the medium in which the practice takes place and that is grounded in in an understanding of its historical and theoretical disciplinary context. The results of practice-led research are usually text-based, rather than focusing on artefacts or other tangible outcomes of research. They are an analysis of the research practice itself, and as such usually appear as text distinct from any artefacts produced by practice.

3.5 Reflective Practice

This research project will also apply forms of reflective practice as a methodology for developing beneficial relationships and methods of inquiry between research and creative practice, drawing on these relationships to gain insights into and new knowledge about the creative discipline.

Although an idea that is evident in the concepts and texts going back in history to Roman and Buddhist philosophers, reflective practice as a term is understood in a contemporary practice-based research context through the writings of (among others) Donald Schön and his 1983 work *The Reflective Practitioner* (Schön 1983).

Schön uses the term to outline the phenomenon by which creative practitioners naturally and instinctively engage in a form of reflection as part of their creative process. Reflective practice refers to the way in which a creative practitioner constantly assesses, reassesses and adjusts their techniques and creative approach as they work, in a constantly calibrating system that feeds information back into the approach to creative work.

Schön suggests that this type of ‘reflection-in-action’ produces a ‘tacit’ form of knowledge as a by-product of the production of creative artefacts, and that ‘reflection tends to focus interactively on the outcomes of action, the action itself, and the intuitive knowledge implicit in the action’ (Schön 1983, p. 56).

Reflective practice is therefore a valuable method for researchers working in a creative discipline and is at the forefront of theoretical frameworks in which to discuss the relationship between practitioners in the creative industries and ways in which research might be applied to explore the boundaries of knowledge within their field of work further.

Through the use of reflective practice, the researcher not only engages in analytical reflection on their experience designing and producing artefacts but can also draw on the reflective experience of creative collaborators and of audiences.

Kathleen Vaughan describes the relationship between creative practice and research in her essay 'Mariposa: The story of a work of research/creation, taking shape, taking flight'. She says, 'More and more, what interests me in the common connection between art and research is the philosophical, even the methodological link.' She goes on, 'Embodied and embedded within a work of art, almost holographically, is a reservoir of knowledge and understanding, the "research" of the work as conducted by the artist' (Vaughan, 2010).

Reflective practice can be divided into two main branches: 'reflection-on-action' and 'reflection-in-action' (Schön 1983). These two forms of reflective practice are distinct from each other in important ways that can be defined as follows:

• *Reflection-on-action*

Reflection-on-action takes place once action within a creative process has been completed, or at least a significant portion or segment of work has been completed. This form of reflective practice is a retrospective analysis of the results of a creative practice or discipline leading to the creation of a research artefact. This form of reflection focuses 'interactively on the outcomes of action, the action itself, and the intuitive knowledge implicit in the action.' (Schön 1983, p. 56)

In reflection-on-action, for example, a case study is documented and analysed, and the knowledge and insights gained can then be fed back into and inform the creative process in a subsequent case study. Reflection-on-action as a form of analysis may take the form of questions about how processes might be improved upon or done differently.

At this point it is useful from the perspective of looking at reflection on action as a part of research into animation production, to redefine reflection-on-action more specifically as a reflective process undertaken before a production is under the stresses of full production mode, at certain key points during the creation of new work, or as part of a reflective process once the final artefact is created.

• *Reflection-in-action*

Reflection-in-action takes place as the action is unfolding and involves real-time responses to creative challenges as they arise. In this form of reflection, surprise is an important element. In more detail, one of the key features of a creative process and therefore of reflective practice on that process is to set up conditions for the practitioner to experience an element of surprise at the process outcomes. As Schön describes in his book *Educating the Reflective Practitioner*, 'Surprise leads to reflection within an action-present. Reflection is at least in some measure conscious, although it need not occur in the medium of words' (Schön 1987, p. 29).

Reflection-in-action is a useful and effective research methodology into animation production as the process of directing animation with a team of artists involves making many small creative decisions frequently throughout the day and each decision needs to be made from within an overarching thematic perspective. Every conversation is a series of decisions based on tacit knowledge and an instinct for how the end project should come together.

> When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case. (Schön 1983, p. 68)

Research conducted within the context of animation production is subject to a completely different dynamic to research outside of production. The working dynamic of production is definitely more stressful. In a production environment, for example, there are people on set who need to know the answer to many questions every minute, so time for introspective reflection is minimal. It is, however, critical that new tools and production pathways are tested in real-world film-making scenarios.

Because the case studies in this research involved animation production, scheduling and budget restrictions required a considerable portion of the research and development process to take place well before production itself, so that the case studies would not be brought to a halt during production. Once a production has forward momentum and artists and crew are scheduled and engaged in the work, it is very difficult to pause it.

David Lynch advocated the use of meditation as a method for maintaining a reflective perspective when under the pressure of a film production. He described his process of reflection-in-action thus: 'Every film, every project, is an experiment … an experiment to get it all to feel correct. When you meditate, that flow increases. Action and reaction go faster. You'll get an idea here, then you'll go there, and then there. It's like an improvisational dance' (Lynch 2007, p. 29).

Time also becomes an important element in the effectiveness of this methodology and can greatly hinder the researcher working in film production. The animation director finds themselves having to facilitate the forward creative movement of the production by making many rapid creative decisions at each moment, often across multiple departments and with many different artists. Ideally each of these decisions can be made as part of a consultative, conversational process, but without the time to facilitate these conversations and consultations, scheduling demands force rapid decisions. As Neill Blomkampf described in *The Art of District 9*, 'You can plan and map things out as accurately as possible, but in the end, creativity will throw a spanner in the works. Things need time to grow and evolve, and sometimes that evolution means doing something one way, only to realize that it's better to go another way' (Falconer, 2010).

3.6 Strategies for practice-based research

When embarking on this practice-based research project, an important question the team asked was: 'How should this research be conducted so as to be as effective as possible in generating knowledge on the subject? What research strategies can we design with best outcomes in mind?'

In Keeping research in tune with practice. In *Interactive Experience in the Digital Age,* Andrew Johnston discusses the idea that when conducting practice-based research, it is important that the researcher stays clear about their intended audience for research outcomes. Any 'techniques, findings, theories or observations that arise from this work are evaluated in relation to creative practice and the relevance, utility and/or impact they have' (Johnston 2014).

To make sure that the results of this practice-based research project generated knowledge for other animation practitioners and visual effects artists in the industry, I had to consider a strategic approach to research methodology.

Johnston outlines a number of useful strategies below for a series of performances between live performers and interactive image projection systems. I list these points below and address each in the context of my own research project. They include:

• *Working with experienced and high-calibre artists.*
This is important in any creative endeavour. Setting aside the more obvious difference that an artist's creative talent and ability can bring to a project, the experience that an artist brings can have a very significant difference in research outcomes. Mistakes in animation and visual effects production can be very difficult to manage, and more experienced artists bring with them a wealth of knowledge in ways to avoid mistakes.

• *Iterative development in close collaboration with artists.*
Iterative workflows are important and applicable to animation production, and have been very important to this research project, as shown in the discussion on shot reviews and design reviews with crew members later in this chapter.

• *Meaningful examination of the impact of interactive systems on the creative practice and experiences of performers.*
This point can be tailored to my research project by re-phrasing it as 'Meaningful examination of the impact of the production methods on the creative practice and experiences of key artists and crew'.

• *Engaging performers in reflection on all aspects of the work, usually in interviews.*
Engagement with crew and animation artists is an integral part of the creative process for an animation director. Due to the pragmatic advantages of remote work and the expense of studio space and workstations, there is increasing pressure for this to be done via video communication platforms such as Zoom. However, having daily face-to-face conversations with artists is far more effective as a creative process.

• *Analysing data gathered during interviews as a final reflective step to generate theory linked to practice.*
A key method to address the above strategies, particularly considering the inherently collaborative nature of animation production, is to find a balance between strong creative direction and a meaningful consultative process with key creatives on the project. Freelance artists and visual effects providers often end up being instruments of the creative film making process. This consultation, a form of collaborative reflection-in-action, has been valuable to the outcomes of my research. It is also worth noting, hoever, that the pressures of animation production mean that this is not always possible. At times an artist must simply be hired to do a job in a certain number of days. It is the researcher's role to identify when and where this reflection-in-action would be most effective in terms of the outcomes of the research project.

It was also important to engage and document artists in meaningful reflection on their experience in the creative process. This took the form of interviews, but also included day-to-day informal reflection-in-action with key creatives, which were part of the ongoing conversation around technical and creative processes that were feed back into the work.

In the following section, I re-purpose Johnston's approach outlined above and describe the strategies adopted for the reflections:

3.7 Strategies for reflection-in-action

The strategies for reflection-in-action in the day-to-day creative process of animation production included the following:

• Having daily discussions with artists and creative decision making were conducted on a conversational, consultation-like basis, rather than my making decisions as a director and simply instructing artists to fulfil these requests. This was part of my directorial style and established the relationship between director, artists and crew.

• Recruiting and working with experienced artists in each creative role who had the reflective skills to engage in creative dialogue and were accustomed to working in this way.

3.8 The strategies for reflection-on-action:

Strategies for reflection-on-action in this research project can be broadly described as reflection on or assessment of the creative outcomes once the animation production was complete or, in other words, once significant production milestones were reached. This type of reflection could include:

• Discussion about and examination of the way in which artists interacted and engaged with the creative process. Reflection-on-action gave artists an opportunity to reflect on their role in the production and discuss ways in which they felt the production processes could be improved.

• Taking into account feedback and the general responses of audiences and industry peers at industry and public screenings and from other feedback platforms.

• Interviews with artists and technicians working on the animation productions. These are discussed in more detail in section 3.11.

Other considerations for using animation as a practice-based research tool.
It was useful to observe some of the unique characteristics that arose when applying a practice-based research methodology to the medium of animation production. In the following, I will discuss how the creative dynamics specific to this medium can be adapted and more effectively applied to our research methodologies.

No behind-the-scenes documentation of a movie-making process has ever featured artists describing the luxury and freedom of time allocated to really explore, test, try different approaches, reflect on the results and carefully chose the best path forward. Most, if not all, the time, movie making is a stressful and high-pressure environment in which to undertake creative research.

Despite this fact, as was discussed in the literature review, technical innovation has always been part of the fuel that drives cinema culture from decade to decade and as a result, movies with a different visual style and approach are usually laboratories and research projects for the technical pipelines that produced these images. Put simply, movies are in themselves research projects, especially visually ambitious productions. Against this fact is the contrasting reality that movies are made under the pressures and stresses of a production environment in which, out of simple economic

necessity, producers have organised the available funds and resources for the best possible cinematic quality with the least number of artists in the shortest amount of time possible.

Reflecting on these factors, I outline below some of the strategies that the research team used to navigate the tension between these two forces in our practice-based research methodology.

• *Case Studies*

Case studies were one of the principal methods used in this research project. These studies took the form of two short, animated films, were a central goal of the research and the most compelling artefacts of research. In fact, they form the bulk of the research outcomes. They have also been shown at a range of industry screenings, exhibitions, online and at festivals and other media events.

The outcomes of these case studies were two short films produced between 2018 and 2021. The first of these, *Jasper* (2018) had a range of distribution, including online, inflight programs and school programs. The second film, *Jarli*, had yet to be released at the time of writing this thesis. Both are described in detail in the following chapters.

Below I breakdown the animation workflow into a series of production stages and look at the ways in which these production stages relate to a practice-based research methodology.

• *Technical research and development.*

In both case studies, the technical research and development phase of the case studies took place as a separate process which took place before animation production, using both reflection-in-action and reflection-on-action as research methodologies. The efficacy of the technological processes used in the working environment of animation production was a key concern of this research. The technical research and development phase leading up to production was a less pressured environment in which to gain insights that then went on to inform decisions made in production.

• *Pre-production methods*

At this stage of the case study, researchers are anticipating things that are going to happen in production. For example, how do we design cameras and shots that will work well for the methods designed for on-set shooting? During pre-production, the outcomes of both the concept development and the technical research and development were translated into a production plan that would address the research aims and objectives.

• *Concept development methods*

The conceptual development of visual ideas to produce animation work takes the form of concept artwork. Drawing, sketching, writing and researching all inform the conceptual development process and define the visual direction that the work will take. This idea-generating process, along with story development and story boarding, is the first stage of the process in which we consider the visual elements that will appear in the final frame and what the camera will be doing. At this stage of the work, we first consider the specific technology platforms that we will need to bring those elements into the frame.

• *Production: On-set research methods*

Once the projects had entered the full animation production phase, reflection-in-action as described earlier became the principal means of conducting research in the onset production environment. This reflection-in-action took a variety of forms, including frequent problem-solving with the crew working as a team, and responding to positive and negative outcomes.

• *Shot reviews and screenings*

During animation production, shot reviews with the creative team and screenings with industry peers were an opportunity to conduct a type of reflection-on-action in the form of feedback, analysis of which elements were working well, and which elements required further development. These reviews were often conducted remotely, which, while facilitating a more geographically dispersed work force, could also diminish the potential for the benefits of back-and-forth conversation between artists and crew members.

• *Post-production methods*

During animation post-production, the compositors brought the visual elements together into the frames of the shot, giving the research team the first concrete feedback on the successes and failures of the process. Here we saw for the first time how choices made in pre-production and on set worked for the compositor putting the elements together. Were the chosen production paths successful or not? Were our choices good or bad? Here we saw what worked and what didn't.

3.9 Gathering data

Data was gathered during the research process using a number of different methods, as described below.

• *Iterations of creative elements.*

The various creative elements that were brought together into the final animation work were created iteratively and the iterations were archived in the working folders of the animation production database. This database could be referred to when looking back over the developing version of the production elements, such as character designs, production designs, animated shots and backgrounds and was a valuable record of how creative decisions developed the overall creative trajectory of the work.

• *Documentation materials*

Materials documenting the creative process come in a variety of forms, the most important areas of documentation in my research process being as follows:

- *Behind-the-scenes videos*

  These videos served as a vehicle for reflection and analysis, particularly when gathering the documentation media in the form of interviews, behind-the-scenes footage, conceptual design artwork and documentation of other creative and technical processes within production. This process involved collating documentation materials in the form of the many behind-the-scenes images and videos shot during the production, especially during moments of interest and when creative milestones were achieved. This footage was compiled into a video work that set out to communicate some of the key research trajectories during animation production. The compiling and editing process involved in creating these video works was a valuable form of reflection-on-action. The editing team arranged and communicated a coherent narrative on a video timeline that sought to clarify and communicate key

findings during the research process for audiences that were not necessarily involved in the creative process. These video works become themselves artefacts of the research process.

• *Shot reviews*

Shots were reviewed at all stages of creative development. As all creative departments deliver increasingly developed versions of each shot, the shots are reviewed by the creative team and decisions are made about how to improve on each element in the scheduled time remaining. This was a form of reflection-in-action, as these reviews often happened on a daily basis.

• *Screenings*

Industry events and screenings were an opportunity to showcase work with industry peers in the audience, to obtain feedback and criticism, gauge audience reactions and hopefully gain insight into the effectiveness of the research and whether it was meeting its aims and objectives.

Alongside the case studies themselves were several smaller works, in the form of exhibitions, digital artworks, installations and behind-the-scenes video works. Although produced as by-products of the central case studies, these secondary outcomes made up an important part of the research project.

• *Exhibitions*

We used the opportunity to exhibit animation production artefacts of each animated short film. These exhibitions were also a form of data gathering process in that they become a public interface with animation audiences and a chance to hear from children and their parents what they liked and did not like about the final animation.

3.10 Interviews

Interviews were conducted as a valuable opportunity for the researcher to 'debrief' with artists and technicians who had invested their creative energy, technical knowledge and passion into the animation work. The interviews were undertaken in a semi-structured, conversational style, allowing the interviewees to express their enthusiasms and frustrations about the way the work unfolded and about the final outcomes, with the perspective of hindsight. This was also an opportunity for me as the researcher to draw from the collective knowledge of the artists working on the project and discuss ways in which creative ideas, research methods and case study outcomes might be improved upon in future works.

All interviews were conducted within UTS ethical guidelines. Each subject signed consent forms that outlined the structure of the interviews in which they were participating and clarified the ways in which the information would be used, namely as part of a reflection-on-action process, as described earlier in this chapter.

These interview subjects were asked a number of general questions which acted as a framework for them to speak openly about their role in animation production and how their creative and technical processes may have been affected, both positively and negatively, by the research aims and objectives. We discuss a range of subjects, including the technical processes involved in the production and the creative decisions that were made. We discussed the nature of creative collaboration in this hybrid animation production style, the frustrations of things that did not go to plan, the creative successes and the unexpected benefits or drawbacks of working in this animation style.

• *Interview subjects*

Interview 1: Evan Papgeorgiou – Cinematographer on case study 2: *Jarli.*

Interview 2: Dr Andrew Bluff – Research supervisor on case study 1: *Jasper* and case study 2: *Jarli*.

Interview 3: Mark van den Bergen – VFX supervisor on case study 1: *Jasper*.

Interview 4: Egan Wesener – VFX supervisor on case study 2: *Jarli.*

Interview 5: Louis Pratt – Art director on case studies: *Jasper* and *Jarli*.

Interview subjects were divided into two main categories:

• *Creative team members*

These interview subjects were asked a number of general questions which acted as a framework for them to speak openly about their role in animation production and how their creative and technical processes may have been affected, both positively and negatively, by the research aims and objectives. These interviews were also used to gain insight into how these artists might consider a creative and technical approach this type of work in the future, looking at the choices that the team made with the benefit of hindsight.

• *Industry peers*

These interview subjects included some animation and visual effects industry professionals whom we interviewed to obtain third party opinions, ideas, critical feedback and other reflections on our case studies.

The interview process provided a valuable insight into the research outcomes of these case studies from the perspective of other artists, allowing me to cross-reference and gain knowledge, as reflected in the concluding chapter of this thesis.

3.11 Artefacts

As described above, artefacts were produced as a result of the creative practice as research and were integral to the outcomes of the project.

Our case studies produced the following artefacts:

- short, animated films
- several sculptural and physical installation works that were used to exhibit outcomes of the creative work. Two examples of these were miniature sets, which were shown in public on two occasions, and a working zoetrope, which was also exhibited publicly.

3.12 Ethical considerations

All of the interviews, appearances of key creatives in behind-the-scenes documentary videos and other data collected for this research were undertaken in accordance with the University of Technology Sydney's ethical guidelines. All participants in the case studies were made aware both verbally and in writing of the nature and significance of their participation and the ways in which their participation would be used towards this research project and this dissertation.

An ethical consideration which I found myself navigating in my role as both researcher and director of the animation project was talking to the various artists about how they could have done things better. I discuss my dual roles below.

3.13 The role of the researcher

It is important to briefly outline my role as the creative practitioner and also as the researcher in this project.
On the first of the two case studies, I was the director and principal designer of the project. As the team on this first case study was smaller than on the second, I assumed many other roles in the production, such as editor, production designer and storyboard artist, for example. This first case study meant that the core team of approximately five to 10 artists, depending on which stage of production we were at, worked closely together and performed interchanging roles with a lot of cross over and interaction. As the director and researcher in this project, I found that these two roles were not at all in conflict with the research aims and objectives of this project.

On the second of my two case studies, I assumed the role of co-director. This second study was made in collaboration with Australian Indigenous director Chantelle Murray and in collaboration with Brisbane-based animation studio Like A Photon. This case study was conducted with a bigger team working across several cities using remote communication tools. This was more of a challenge in my role as researcher and director and, as a research project, tested the aims and objectives of this research under the stresses of a production environment.

3.14 Indigenous storytelling

There were significant ethical considerations to factor into in the second of my case studies, *Jarli*. Making this short animation involved collaboration between myself and Indigenous creatives and story tellers. We conducted a writer's room with a number of different story-tellers, scientists, Royal Australian air-force personnel and producers. This facet of the creative process had significant impact on the way the animation story came together, including the creative choices made, the technical approach to the work and the research methods used. I address this topic in more detail in chapter 5, describing the *Jarli* case study.

3.15 Conclusion

In summary, this chapter describes the methods and strategies for conducting research into animation production techniques. I have presented the theoretical frameworks of these research methods, including important distinctions between practice-based and practice-led research and described methods for using reflective practice as part of an animation film-making project, involving both reflection-on-action and reflection-in-action.

I have described a series of strategies for practice-based research when working collaboratively with experienced and high-calibre artists and iterative development with those artists. This chapter also describes my examination of how the production methods impacted the creative practice and experiences of key artists and crew and the importance of engaging artists to reflect on all aspects of the work, usually in the form of interviews.

The animation production case studies were discussed as the key tool for practice-based research. These case studies took the form of short animation films encompassing the aesthetic and creative development of this production technique, as

well as technical research and development. These two case studies, *Jarli* and *Jasper*, are discussed in detail in chapters 4 and 5.

Lastly, I discussed methods for gathering data, including research diaries, the value of iterative creative elements, documentation materials in the form of behind-the-scenes videos, animation screenings, exhibitions and other artefacts and discussed the importance of interviews with artists and technicians who worked on the case studies as a means of reflection on the outcomes of case studies and forming research outcomes.

4 CASE STUDY 1: *Jasper*

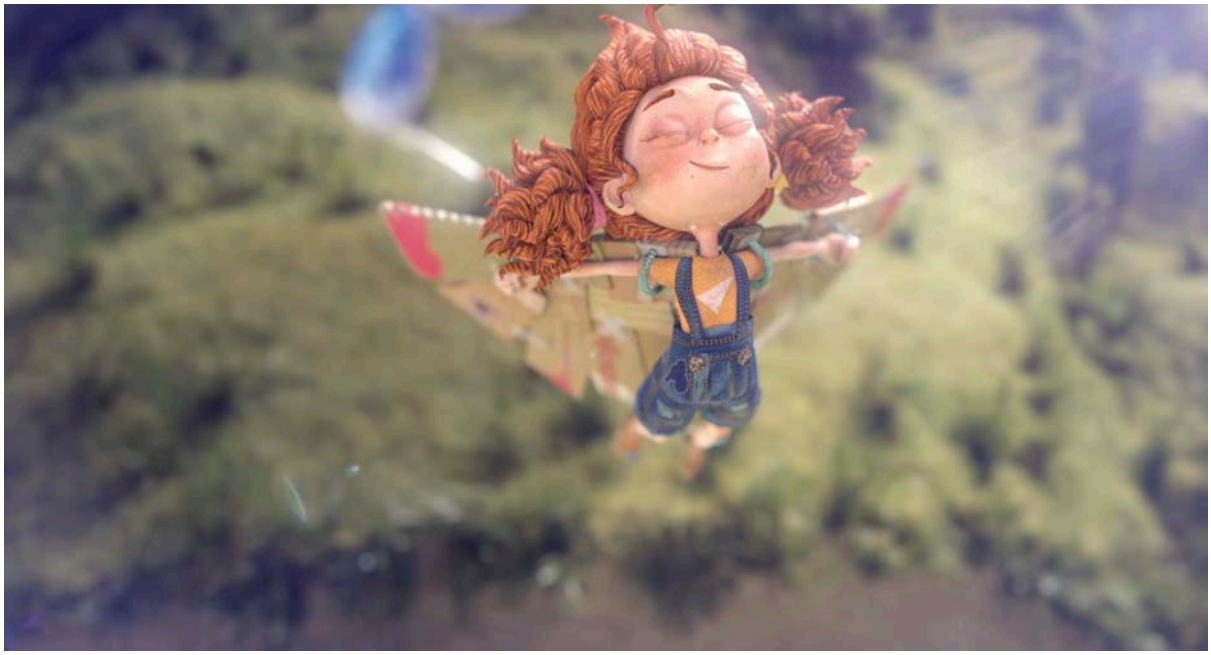


Figure 4.1: Production still from Jasper short animation.

4.1 Background

Jasper (2018) is a short, animated film made as a creative collaboration between the RAAF, the UTS Animal Logic Academy and the UTS Faculty of Design, Architecture and Building (see Figure 4.1 production still). It was the first of two case studies conducted as practice-based research into animation production. The project was part of Australia-wide initiatives to encourage more young women to engage with science, technology and maths subjects in their education. Our collaboration was intended to contribute more positive messaging for young girls and their future career choices using the aesthetics of animation feature film story telling as the vehicle for this messaging.

In mid-2017, a small group of representatives from various industry groups made a short presentation to a cohort of students, lecturers and other academics at UTS's Animal Logic Academy. Each was looking for different, innovative and creative approaches to various problems facing their respective fields.

In a presentation to the group at UTS, Wing Commander Jerome Reid, an industry representative from Jericho, a branch of the RAAF, described the problems that the RAAF had recruiting female pilots. Jericho had been tasked with exploring innovative and 'disruptive' approaches to dealing with this issue. From Jericho's perspective, this problem stemmed from the wider social phenomenon of young Australian women who, even at a very early age, were not drawn towards career paths in what have traditionally been male-dominated industries. This problem was compounded by a low number of young female Australian students studying science, technology, engineering and mathematics (STEM) at school. This low uptake appeared to amplify the social stigma that had initially caused the problem.

Jericho's concern was the negative ethical implications of this low uptake and that it contributed to young Australian women not having the same range of choices and opportunities in developing their careers. Jericho was also concerned about the phenomenon for a reason that directly affected their operations: The RAAF was missing out on the significant

talent pool coming through from just over 50 per cent of the Australian education system. They recognised that there was a valuable untapped resource of highly talented and motivated young women in all fields of endeavour relating to science and technology. Jericho's approach to this problem was to engage with creative practitioners and researchers at UTS to initiate projects that might find innovative solutions to the issue. I was in the room when these initial presentations were made at UTS Animal Logic Academy and had the opportunity to contribute to these early conversations and pitch initial creative ideas to the group (see Figure 4.2 for early concept art).

Figure 4.2: Early concept art for Jasper.

I learned that the RAAF had been using a recognisable advertising industry style, including inspirational voice over, gritty imagery of adventurous young women leaping in and out of helicopters wearing camouflage gear, accompanied by a rock guitar-driven soundtrack to try and inspire young women to become pilots and pursue an RAAF career. From my perspective, it resembled a *Top Gun* approach to the message. The RAAF's current messaging seemed to communicate to girls that they could be strong and tough, do anything and have exciting careers, just like boys. These messages seemed to wear their gender politics self-consciously and awkwardly. They were telling young girls that they *should* do maths and

science at school to broaden their career horizons, that they did not have to be weak like girls; they could be strong, like boys. To me, this messaging seemed to miss the point.

My creative pitch for the project drew on the aesthetics of feature film animation as a medium to tell a simple, character-driven story. I pitched the idea of using a story with no dialogue. I proposed using simple yet cinematic images showing a day in the life of a determined and slightly crazy little kid who dreams of flying (see Figure 4.3). Her aerial aspirations would be cute, funny, entertaining and relatable. She tries and fails but does not give up. Jasper's dreams of flight are universal; importantly, her gender is completely incidental to the story and is not referenced.

Figure 4.3: Early concept art for Jasper.

The pitch was well-received, and I assembled a team to develop a more detailed concept for a short, animated film that drew on aesthetic qualities and the cinematic story style of feature animated films I admired. We had the opportunity to workshop the concept with an Australian RAAF pilot, Jaqueline Killian. In relating her career path, she gave us insight into Jasper as a character. Jaqueline emphasised that Jasper should not have to be like anyone else to dream of flying and that women who fly planes want to be just that, women who fly planes (see Figure 4.4 early concept art). You do not need to be like somebody else; you can be yourself and have a fantastic and rewarding career in aviation. Jacqueline became an inspiration and reference for the project—to the point that we cast her as the voice of Jasper for the animation project.

Figure 4.4: Early concept art for Jasper.

From the beginning of our proposal for the *Jasper* project to the team at Jericho, it was intended that the story, themes, design and technical approach to animation production would be interrelated and mutually supportive elements of the project. I saw the opportunity for the project to be an effective platform for the hybrid animation production style I wanted to further research in my PhD project. A simple contained story format with a single location and one character, the absence of dialogue and the short duration of the film were an ideal platform to test and research a different creative and technical approach to animation.

4.2 Research aims and objectives

The research aims and objectives of Case Study 1: *Jasper* are to explore the opportunities from various emerging technologies to facilitate the use of hybrid miniature set and CG 3D animation production techniques. The aims were to:

- use practice-based research methods to produce a short, animated film exploring a hybrid production style combining digital animation and miniature sets with one character, one set and one location (to focus on achieving an ambitious production value for the final images)

- develop a motion control camera system involving integration and creative control of digital cameras keyframed in Maya animation software and physical cameras filming shots on miniature sets using a robotic arm (functioning as a creatively flexible system to design and execute complex, multi-axis camera movements on a miniature set uninhibited by technical difficulty, like in an all-digital creative environment, that are appropriate to and enhance the animation story beats)

- explore other facets of the creative and technical practice of integrating 3D animation and miniature sets into an animation work to facilitate and improve methods for working in this hybrid style of animation production (including game engines, 3D printing, point cloud scanning and other techniques)

- further develop an animation visual style working between 3D digital animation and miniature sets builds that I had begun to develop as a director working in this medium of animation filmmaking

• describe and document these practices.

4.3 Research and development and early testing phase

Before we began production on *Jasper*, fellow researchers Andrew Bluff, Mark Van den Bergen, Ben Streek and I made early tests of technologies and techniques. We were sure that motion control using a robot arm would be a high priority; therefore, we did early tests at UTS of mounting a Blackmagic URSA Mini on a Universal Robot UR10. This robot was too light for our camera and caused a slight shudder in the captured video image, especially when the UR10 transitioned from stationary into a movement or from a movement to a halted position. We also tested movement on the much bigger but more stable KUKA KR 120.

We made early tests of motion capture suits. Ben captured footage of animator Mai Pham performing blocking animation for the first pass of pre-visualisation on the project (see Figure 4.5 for Mai Pham's character designs). Although these tests showed promise, we decided that the foot slippage and the amount of clean-up required would hinder the more important research questions of the case study.

Figure 4.5: Character design for Jasper by Mai Pham.

We also made early tests of point cloud scanning and rear screen projection. In these early tests, point cloud scanning showed immediate and obvious potential for use in the animation production to align physical and digital workspaces. Our rear screen projection tests proved frustrating. Although we saw the potential for this technology to be used effectively in a hybrid animation production, we determined that we had insufficient studio space to light our sets and allow for a screen behind the set and the throw of the projector lens. The images we captured with a rear screen projected sky were not very satisfactory in quality of sky resolution. These techniques would be best served in a better-equipped shooting space with an array of high-resolution projectors.

4.4 Storyboard and concept design

Camera movement has always been an important part of the visual vocabulary of cinematic storytelling and is one of the things I enjoy about cinema as a creative medium. It was important for me, from the outset, to be able to say more with

the camera and design shots and have more freedom in the design of moving cameras than I had been able to achieve on past projects using this hybrid production style.

In the production of live-action filmmaking, motion camera work is grounded in the physical realties of what a cinematographer and their team can achieve moving a camera through a full-scale set or location. With the shift in cinema language and culture towards all-digital VFX-driven sequences, cameras have the possibility of freedom from these physical restraints. When a camera can do anything and everything, it is more difficult for the audience to attach motivation and gravity to these movements. The resulting sequence can feel strangely weightless and removed from gravity or consequence.

The last decade of the 20th century saw Hollywood directors use computer animated cameras to:

> simulate a camera floating over the recreated Colosseum in Rome in *Gladiator* [2000], and around the *Titanic* in mid-ocean. These magic carpet rides, or 'fly arounds', were crane shots for the digital age, the can-see logical conclusion of the innovations of R.W. Paul and Pastrone. Yet these were weightless and point-of-viewless moves, exhilarated by the possibility of CGI but devoid of feeling. (Cousins 2011, p. 458)

Over the last decade, filmmakers have become more careful and conscious when using a weightless camera style. They are designing digital camera movements with a more tangible sense of physical motivation. Along with the introduction of drone photography in live-action video production, this has helped introduce the aesthetic choice of a freer camera into the vocabulary of cinema.

I wanted to demonstrate that this chosen hybrid style of animation was not only a technically viable approach to animation production but that it could be a creatively flexible one. As such, it was important that the storyboarding team, director and cinematographer had creative freedom to design visually compelling, strong story telling images.

Storyboards for *Jasper* were designed by myself and Animal Logic Academy-based storyboard and concept artist Simon Ashton (Figure 4.6 shows first-pass storyboards). When interpreting the narrative concepts into storyboarded shots on a timeline, we wanted to use the full cinematic vocabulary, including the close-up, mid shot, wide shot, push in on an emotional expression, track with action, whip pan, extreme wide shot, and camera roll, tilt, pan and crane. While all these camera expressions are relatively simple in an all-digital animation workflow, when shooting with a good quality camera with heavy lenses on a miniature set, unforeseen obstacles can be difficult to anticipate at the storyboard stage.

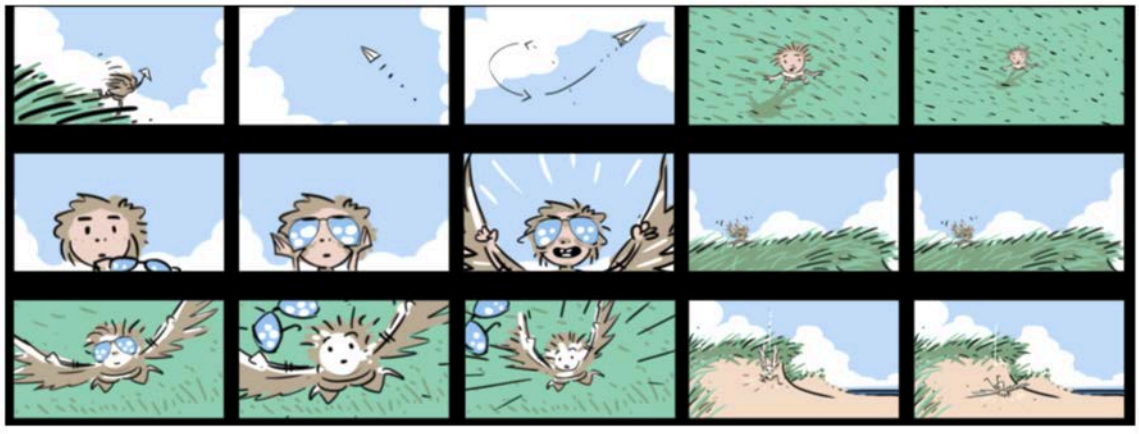


Figure 4.6: First-pass Jasper storyboards.

Introducing this camera movement vocabulary into the workflow of the chosen hybrid animation production style meant that the design of camera movement faced a very specific set of physical limitations and parameters. The camera is relatively huge when working with shot design on a miniature scale. Our camera was a car-sized object relative to the 125 scale we chose to build. The smallest tilt or pan of the camera is amplified. Blocking camera movements can be limited by set collisions, particularly if the camera needs to be low to the ground or floor of the shooting environment. The relative size of the camera means that lighting and shadows also pose a difficult problem.

In my experience of shooting miniatures, planning a shot on a miniature set almost always has to be done on the actual miniature itself. While it is useful to plan shots in a digital pre-visualisation process (as we did), usually, something does not work; something gets in the way. An unforeseen obstacle or angle forces the shot to be replanned—or often, another more interesting shot becomes apparent once lights and cameras are set up around the miniature set shooting environment.

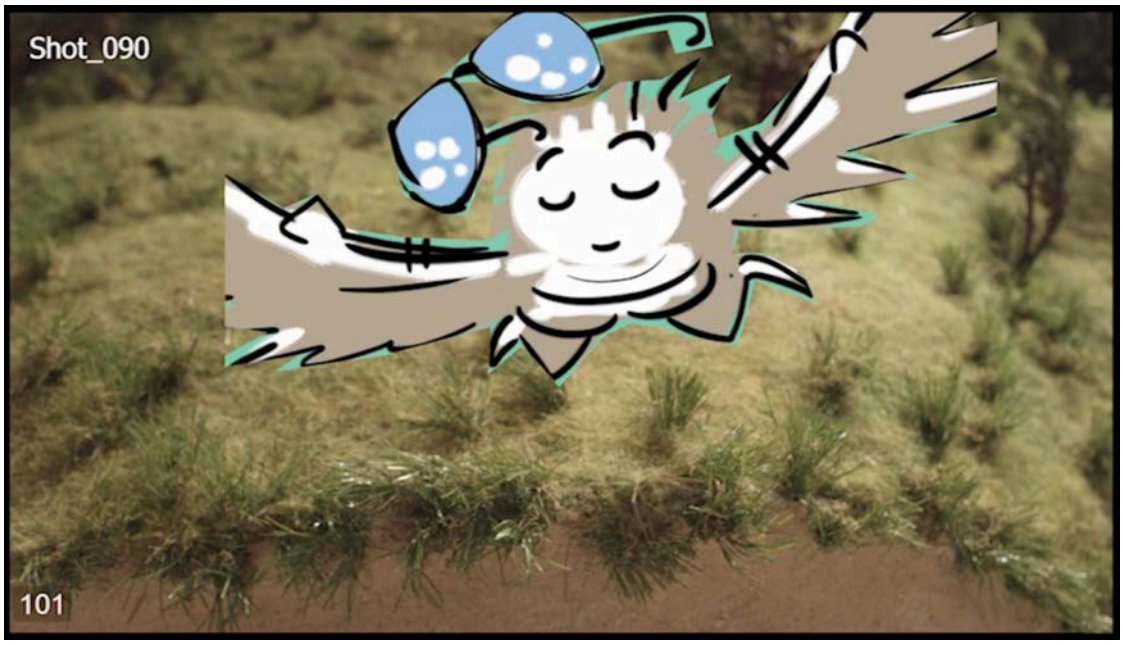


Figure 4.7: A storyboard from roughly composited against miniature set footage for animation reference.

When we began storyboarding, we wanted to embrace these creative parameters but not be limited in our choices of good storytelling camera movement. Simon Ashton had been working on big-budget, completely digitally animated projects in which there are relatively few limitations on shot design and camera movement. Therefore, there was a period of adjustment during which the pre-visualisation team had to translate these ideas into a practical miniature set scale. To expedite this process, Ben Streek began a first pass of pre-visualising our shot ideas using Unreal Engine and a camera roughly to scale with our Blackmagic URSA Mini. This pre-visualisation was a quick and helpful first pass that we fed into the final storyboard edit.

4.5 Production designing miniature sets

An important part of our research into using miniatures as a creative medium was to embrace the technical limitations of a smaller scale workspace, as well as the charm, warmth and physicality of working with this medium. We wanted to explore these limitations as a visual palette to animation production.

Fellow researcher Ben Streek had been using Unreal Engine to help us design the shape of the miniature in the first pass of pre-visualisation. We used terrain modelling tools in Unreal Engine to sculpt the first versions of the miniature set relative to the camera scale and established the scale to which we would be working at 1:25. Once we had established a working storyboard and the build scale for our miniature set, art director Louis Pratt and I began constructing the set at an art studio workshop in Marrickville, Sydney (see Figure 4.8).

Figure 4.8: Miniature set being scenic detailed for Jasper.

In my previous short film, *A Cautionary Tail,* one of the more successful creative elements of the production design was the use of repurposed and found objects in the miniature set. On that project, I experimented with organic design elements, such as grass seeded and grown into a miniature set, and incorporated many found objects and organic elements like weeds, rocks, dirt and sand into the production design. This approach was intended to give the story world a realness and tangibility, and I noted that audiences had noticed and responded well to it.

On that project, it was common to receive feedback from audience members noting that 'the stop motion was very smooth' or that 'the sets felt like they were handmade'. As the director, I liked how the images of this hybrid style created a visual uncertainty for many viewers. It appeared that many people, including people in the film industry, did not know whether they were looking at stop motion or 3D animation. Having tested some of these design ideas, I wanted to develop them as part of my filmmaking style.

When approaching the production design on *Jasper,* we wanted to embrace this visual approach and explore a design aesthetic that used the organic, random patterns of nature as an important part of the design process. As discussed in Section 2.16 of the literature review, I identified production design as an area where some previous animation productions using miniatures and digital characters had missed a creative opportunity. The animation productions I referenced used what I felt looked like a 'computer workstation' design aesthetic. This aesthetic was something I had often observed while watching the design practices of artists working in the animation and VFX industries. Many artists spend most of their working week in front of a computer workstation when designing organic, visual elements and natural environments. They use the internet as a reference database, which is a useful resource. However, often artists forget or are in working

environments that make it difficult to come out from behind their desks to collect real references, walk in nature and observe the natural world.

This design shortcoming can often translate into final images on the screen. When miniature set production designs look and feel as though they have been designed by people who do not go outside to gather references, the design sensibility can become very similar from one production to the next. Environments and worlds can feel like the same concept artists have designed them. From my perspective, this design approach defeats the purpose of using miniatures over digital design as a production design aesthetic. Some of the animation productions I have referenced seem to replicate the aesthetic of an all-digital style of art direction. Consequently, the final images are not strongly distinguishable from the look of a fully CG animation production.

The set for *Jasper* was built so all shots could be achieved on the one set to keep the case study within a contained, smaller animation production. The set was an exterior coastal landscape featuring three modular hill pieces (see Figure 4.9). These modular pieces had been designed and pre-visualised in Unreal Engine to provide various options when the camera was re-positioned for different shots, and we could have extra background elements within the frame.

Figure 4.9: Jasper set under construction in Marrickville, Sydney.

In *Jasper*, we wanted to leverage the aesthetic benefits of using miniature sets more effectively. The most obvious advantage of miniature production design is the ease with which artists can bring chaotic randomness into the design process that can be relatively easy to control. Artists working with their hands manipulating physical materials more effectively access the randomness of nature as a design principle than artists working at computer workstations (see Figure 4.10). This principal also applies to architectural interiors, where adding a little roughness, randomness, dust, scratches and dirt is integral to the creative process and very easy to augment.

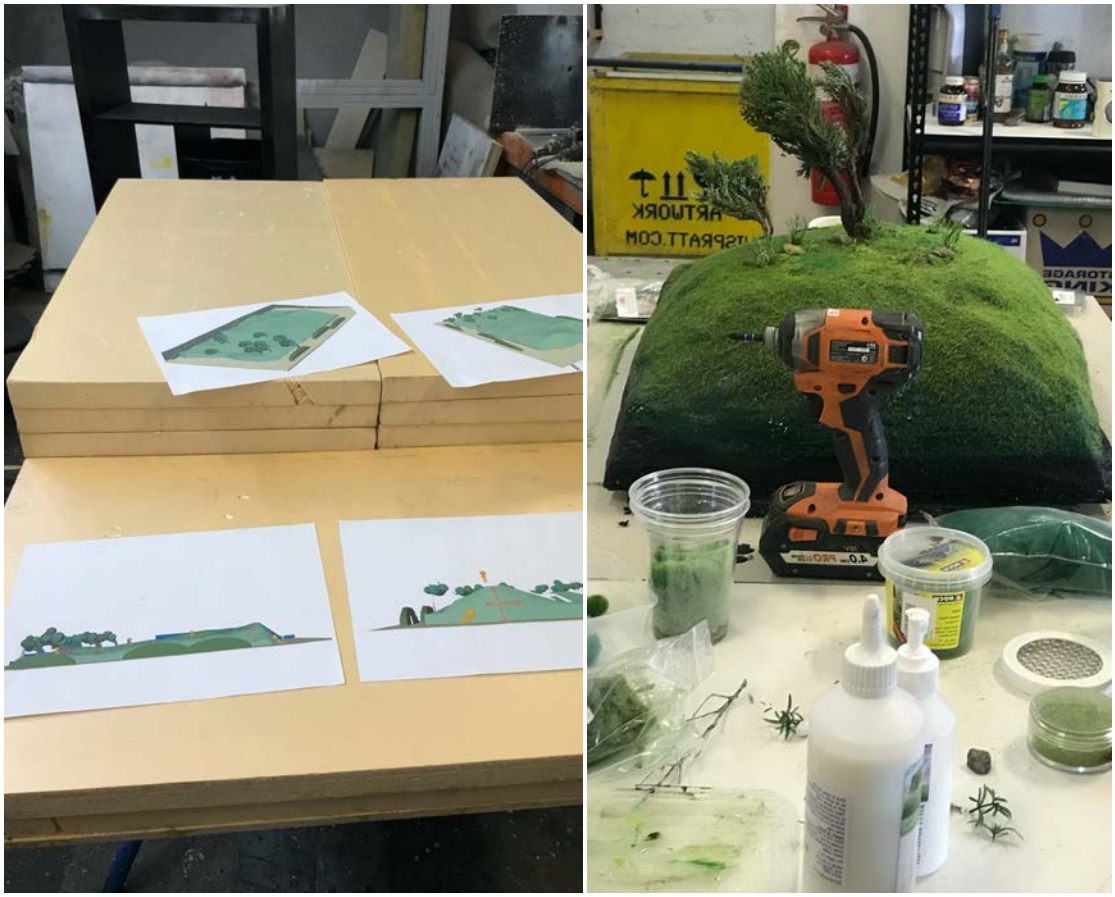


Figure 4.10: Jasper set about to be carved using designs based on first pass of pre-visualisation.

We wanted to explore the found object look of *A Cautionary Tail*. Therefore, to design the coastal bushland set, art director Louis Pratt and I went out into the bushland around Sydney and gathered pieces of wood, rocks and twigs. We used these elements to undergo an unstructured and organic design process (Figure 4.11 shows the landscape coming together).

Figure 4.11: The coastal forest landscape of Jasper starting to come together.

We collected random and interesting bits of wood and, without trying to follow any concept art, developed a process of collaging found elements to create a library of trees, from which we composed the coastal bushland environment. This process yielded a different result from sculpting trees with modelling materials to match concept designs. Our trees were modular and easy to pull from the ground and move, depending on where the camera was positioned for each shot.

4.6 Unreal Engine and Unity

Over the decades leading to 2020, the creative and technical disciplines of animation and VFX-driven cinema and film video game design have begun to merge. More filmmakers are considering the possibilities of game engine platforms like Unity and Unreal Engine in their production pipelines. Game engines allow digitally produced graphic image content to be rendered in real-time, significantly changing how VFX are conceptually developed and used as an on-set production design tool and a replacement for green screen production modes. As a part of this research project, the team on *Jasper* wanted to explore various ways these tools could be used at different stages of production in a hybrid animation production pipeline.

At the beginning of development on *Jasper*, researchers Andrew Bluff, Ben Streek and I reviewed the concept artwork and storyboards. We looked at each shot and discussed how to test integrating a game engine platform technology. While there is potential to push this hybrid style much further with the integration of game engines in future productions, on *Jasper*, we set out to explore some interesting and useful applications. The main areas we decided to experiment with were pre-vis of miniature set design, pre-vis of animation for the on-set shoot and set extensions.

4.6.1 Pre-vis of miniature set design

The design process of our miniature set, on which we wanted to shoot all the shots from the film, began with the story team working back and forth between storyboards in Unreal Engine to shape a first-pass design of the miniature set. Unreal Engine allowed us to experiment and easily make quick creative changes. We also captured rough motion capture performed by members of our animation team; using this data and the unreal topography, we were able to quickly arrive at a rough pre-visualisation of the entire short film. The terrain sculpting tools were a particularly useful and quick way to find the basic shape of our miniature set.

4.6.2 Pre-vis of animation for the on-set shoot

In both case studies, fellow researcher Andrew Bluff experimented with a system for integrating augmented reality for pre-visualising blocked animation on a miniature set during the shoot (see Figure 4.12). In the *Jasper* research and development phase, this system was tested using Unity. A short, three-second animation loop was published using a point cloud scan of the topography of one of our smaller set pieces as terrain registration and reference.

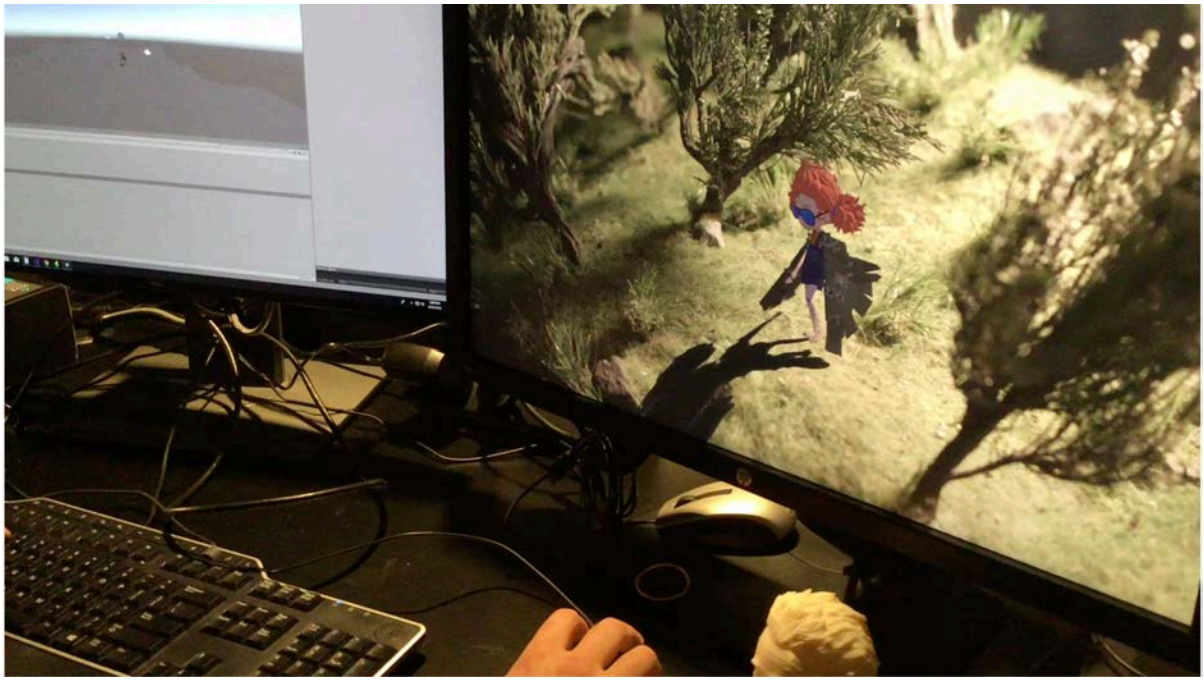


Figure 4.12: Augment reality experiments using one of the Jasper miniature set pieces.

We could not use the character model's existing animation rig and had to attach a temporary rig to the character model to bring the character into Unity. Andrew Bluff had the test working well—this system could help the camera department use a rough blocking pass of the animation to appear in the final shot. While we made experiments at the research and development phase of both case studies on this augmented reality animation blocking tool, the experiments did not translate into a useful on-set method of establishing animation blocking in the two case studies. The techniques were not refined enough to add value to the decision-making process in the time-pressured environment of a film shoot. More recent experiments with augmented reality of animation characters on miniature sets have renewed my interest in developing this technique for possible use in future animation productions.

4.6.3 Set extensions

The skies and the background hills in *Jasper* were created using Unreal Engine and rendered in real-time. This process allowed for a relatively creatively flexible and easy digital cloud design and set extension process. It was probably the most practical use of Unreal Engine in our animation pipeline. Skies and clouds are important story elements in *Jasper* because the short film is about the dream of flight. This aspect was one of the most creatively rewarding and interesting uses of Unreal Engine (see Figure 4.13).

Figure 4.13: Skies for Jasper were generated in Unreal Engine.

In the opening shots of *Jasper*, the audience's point of view is of a camera flying through a field of clouds hanging in a blue sky. The process of designing and executing this shot was particular to a game engine platform workflow. We simulated the cloudscape, and then I 'flew' through it in the same way that a game player navigates a play space. We recorded the flight, approximately 10 minutes of exploration, through the cloudscape in real-time and captured this as an image sequence out of Unreal Engine. Then I picked my favourite moments to use in the opening of the animation edit (shown in Figure 4.14).

Figure 4.14: Skies for Jasper were generated in Unreal Engine.

4.7 Character modelling

The character designer and 3D modelling artist who 3D-modelled Jasper had worked with me on *A Cautionary Tail.* As we started working on *Jasper*, we established creative dialogue about how 3D character models work best composited into miniature story environments (see Figure 4.15). We had established a design aesthetic and a character style that we thought worked well with the hybrid production style. We only had two character models, Jasper as a 10-year-old and Jasper as a 22-year-old adult (see Figure 4.16). We wanted to extend the design aesthetic to improve how the characters composited against the miniature environments, particularly for hair design (which was not very successful on my previous project).

Figure 4.15: Set extensions of miniature sets for Jasper before and after compositing.

Figure 4.16: Jasper as an adult and as a 10-year-old.

A general principle in *A Cautionary Tail* was that all characters were digitally modelled, and most objects or props that a character touched, picked up or interacted with were also modelled in 3D software. We applied the same principal to *Jasper*.

When designing Jasper as a digital character, we wanted to make the 3D model seem like it inhabited the handmade world of the miniature set. We designed Jasper to seem at a smaller, miniature scale—like a real 13-cm-high character running through the miniature set like a stop motion puppet.

Hair was one of the trickiest aspects to improve upon from previous work. Character design artist Mai Pham and I spent considerable time sketching and designing the look of Jasper's hair. I did not want to do a hair simulation for the character because this would break the established design aesthetic of our production style. From a creative point of view, the hair was one of the most successful aspects of the character. I modelled the hairstyle in modelling clay to establish how it might look in miniature, and this was the basis for the computer-generated imagery (CGI) model shown in Figure 4.17.

Figure 4.17: Jasper's hair and skin texture were developed to try and help the model feel like it was a miniature, hand-modelled object.

For the skin texture, a slight exaggeration of an uneven surface, with very shallow bumps and depressions over her body, gave the impression that a pair of thumbs working with modelling clay made Jasper. The effect was that lighting did not bounce and reflect too evenly from the geometry and curves of her cheeks and arms. Therefore, the 3D model would behave under our CG lighting environment similarly to how modelling clay might behave under real light.

4.8 Motion control shot development

As cameras have become smaller and lighter over the history of filmmaking, it has become easier for filmmakers to move them and make shots more dynamic. This attribute has become an integral part of the language of cinema storytelling. The camera has become lighter and more flexible in contemporary visual effects-driven cinema. Moving cameras in a digital, 3D workflow is easy—as simple as editing the values of a keyframe. There are no physical constraints on what a virtual camera can do; however, constraints can be helpful and create a particular style. As *Jasper's* VFX supervisor, Mark Van Den Bergen, said in an interview following production:

> The advantage of CG sets is that any camera move is possible, and the whole scene can be edited and changed right up until the deadline. However, real sets, filmed with real lenses and real lights, give a set of real-world parameters—and from this comes a unique aesthetic.

In Case Study 1, the team wanted to explore new technologies to achieve an enhanced, more creatively flexible motion-controlled camera design system using robotics. In the literature review, I referred to several animation productions that used a hybrid animation production pathway similar to the one I am researching (see Sections 2.13, 2.14 and 2.16). While each of these animation productions was a successful example of this hybrid style, they used relatively simple, single-axis camera movements, excepting the Apple (2018) commercial, *Share You Gifts*, in which more ambitious, multi-axis camera moves were used (see Section 2.14).

Similarly, in my 2013 short animation, *A Cautionary Tail*, the production team, working with cinematographer Callan Green, discovered that motion-controlled camera rigs on miniature sets added a prohibitive amount of time, complexity and expense to the production. The more complex the camera movement, the greater the time and expense. The few shots on which we attempted to use a motion-controlled camera (see Figure 4.18) broke our shoot and post-production schedules.

Figure 4.18: A simple left to right camera move on A Cautionary Tail using frame-by-frame motion control.

Since the production of *A Cautionary Tail*, the availability of technologies such as industrial robots has improved the possibilities of working with multi-axis camera moves on a small scale. *Jasper* provided an opportunity to test a Maya to

KUKA robot arm workflow. To achieve this, we collaborated with the Faculty of Design, Architecture and Building at UTS to attach our Blackmagic URSA Mini camera to a KUKA KR 120 2700HA—a versatile robot arm with an adaptable head, capable of performing a wide range of industrial applications (shown in Figure 4.19). This set-up allowed our camera seven axes of movement and rotation.

Figure 4.19: Early testing on the KUKA KR 120.

We chose this bigger robot after finding limitations with a smaller desktop Universal Robots arm. The camera's weight on the smaller arm caused a problematic judder when the camera transitioned from a stationary position into movement and when the arm brought the camera from a movement into a still position. We also found that the bigger arm provided much more flexibility in shot choice because of its reach. With a reach of 2700 mm on a 7000 mm external axis (rail), the KR 120 can reach a working area of 5400 mm wide × 7000 mm long × 2700 mm high. This robot arm is highly accurate and can repeat camera moves precisely.

4.9 Motion control on *Jasper*

Many unforeseen problems arise when blocking out and filming on miniature sets with a moving camera. The most significant problem was that the Blackmagic camera was enormous relative to our miniature set on *Jasper*. As VFX

supervisor Mark Van Den Bergen said, 'It was like shooting with a camera the size of a washing machine'. Once we had established the scale and shape of our set, the team at the Advanced Fabrication Lab built a top-mounted bracket so that the camera could be underslung below the robot tool head. This arrangement made the blocking process more straightforward. However, we were still limited by the distance from the film back to the camera's underside, making it difficult to obtain shots as low to the ground as we wanted.

Cinematographer Brycen Horne and I established a back and forth conversation between the storyboarded animatic edit, the early Unreal Engine pre-vis, and the two of us physically blocking out each shot with a camera. We used the animatic timings to experiment with a rough, handheld walk-through of our camera movements and start the conversation about lens choices (see Figure 4.20). This process was a good way to establish an approximate camera position, movement and speed of movement from position to position. These walk-throughs were filmed and dropped into a new layer in the animatic.

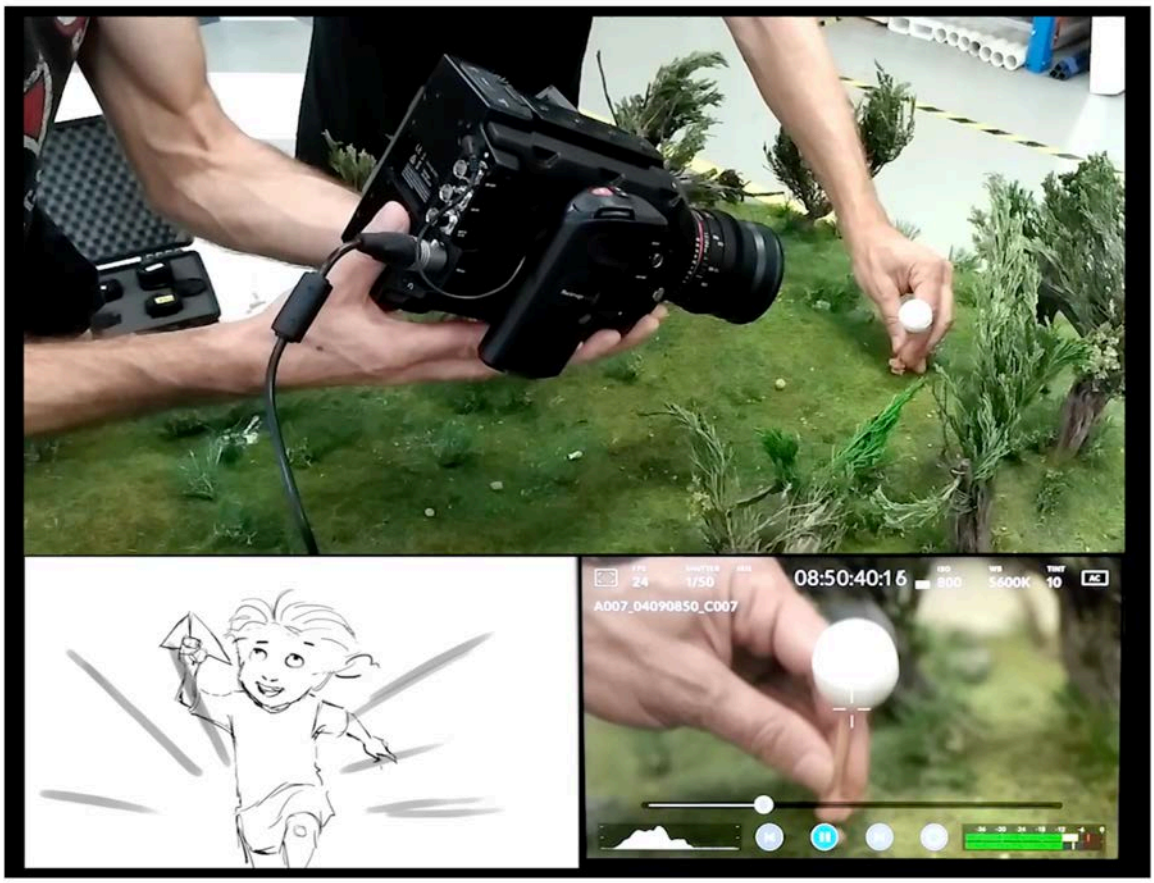


Figure 4.20: A and B animation positions mapped against video timing reference and the animatic.

Walking around the miniature set with our camera and blocking the film from beginning to end was a creatively enjoyable and clear way to experiment with shot ideas and lens choices. We discovered different and interesting shots looking through the lens at the miniature set that were not planned in the storyboards or pre-visualisation process.

Walk-throughs are one of my favourite things about working with miniatures. The process opens up a creative conversation between filmmakers literally on their feet, walking around a set and talking about the story, blocking out the action using cardboard cut-outs and trying different ideas quickly and easily while looking through real camera lenses. This process can be cumbersome. However, I find an all-digital environment where layout artists often interpret storyboards

alone at their workstations, then send them off to review sessions and receive feedback via the chain of command before returning to their computers, creatively inhibiting.

Cinematographer Brycen Horne and I set ourselves the creative challenge of finding an interesting way to move the camera in every shot so that it was motivated by the narrative. We discussed our interpretations of the underlying thematic implications of each image. These conversations became important to our research objective: to determine the degree of ease or difficulty with which our creative choices could be translated from shot design into a Maya to KUKU robot arm workflow on the shooting day. At this stage of the production, the moving cameras took on a layer of significance in terms of the story themes: this animation project was about a little girl who dreams of flight. Keeping the camera fluid and moving on multiple axes seemed to add an effective ingredient and dimension to the character Jasper's dreams.

Despite the KUKA KR 120 2700HA's precision and seven axes of movement, designing a motion control production pipeline initially proved difficult and time-consuming. As VFX supervisor Mark Van Den Bergen described: 'It became clear that working interactively with the robot was not going to be flexible enough for the cinematographer and director to make creative decisions on set on the shoot day'. We improved upon this creative turnaround in Case Study 2: *Jarli*. For Case Study 1, we approached this technical challenge in several ways.

4.10 Using point clouds

Mark Van Den Bergen used a point cloud scanning system to capture and translate the blocking process into working Maya camera moves to be packaged and sent to the KUKA robot. (This was the blocking process Brycen Horne and I had worked on.) Once Brycen Horne and I approved each shot's blocking, we captured a reference video of the shot through the camera lens. We captured video from a second camera of the two of us in the frame blocking through the shot using stand-in cardboard cut-outs of Jasper for scale on the miniature for reference. We captured a series of point cloud scans for each shot. These captured Brycen hand holding the camera in the first and last positions of each shot, and sometimes we scanned one or two midway points (see Figure 4.21).

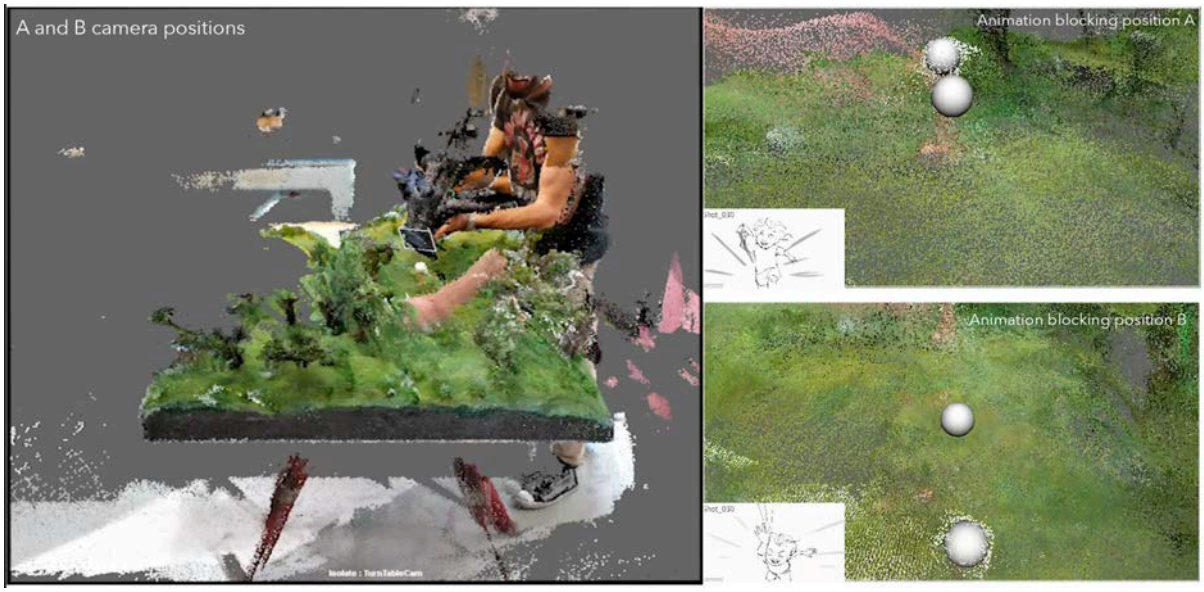


Figure 4.21: A and B camera positions mapped from point cloud scan data.

Point clouds were useful throughout the production's planning stage. As well as mapping shot block passes, we used them for tech vis studio space planning. In some cases, we used point cloud scans of miniature trees to add detail to background elements in the final composites, as shown in Figure 4.22.

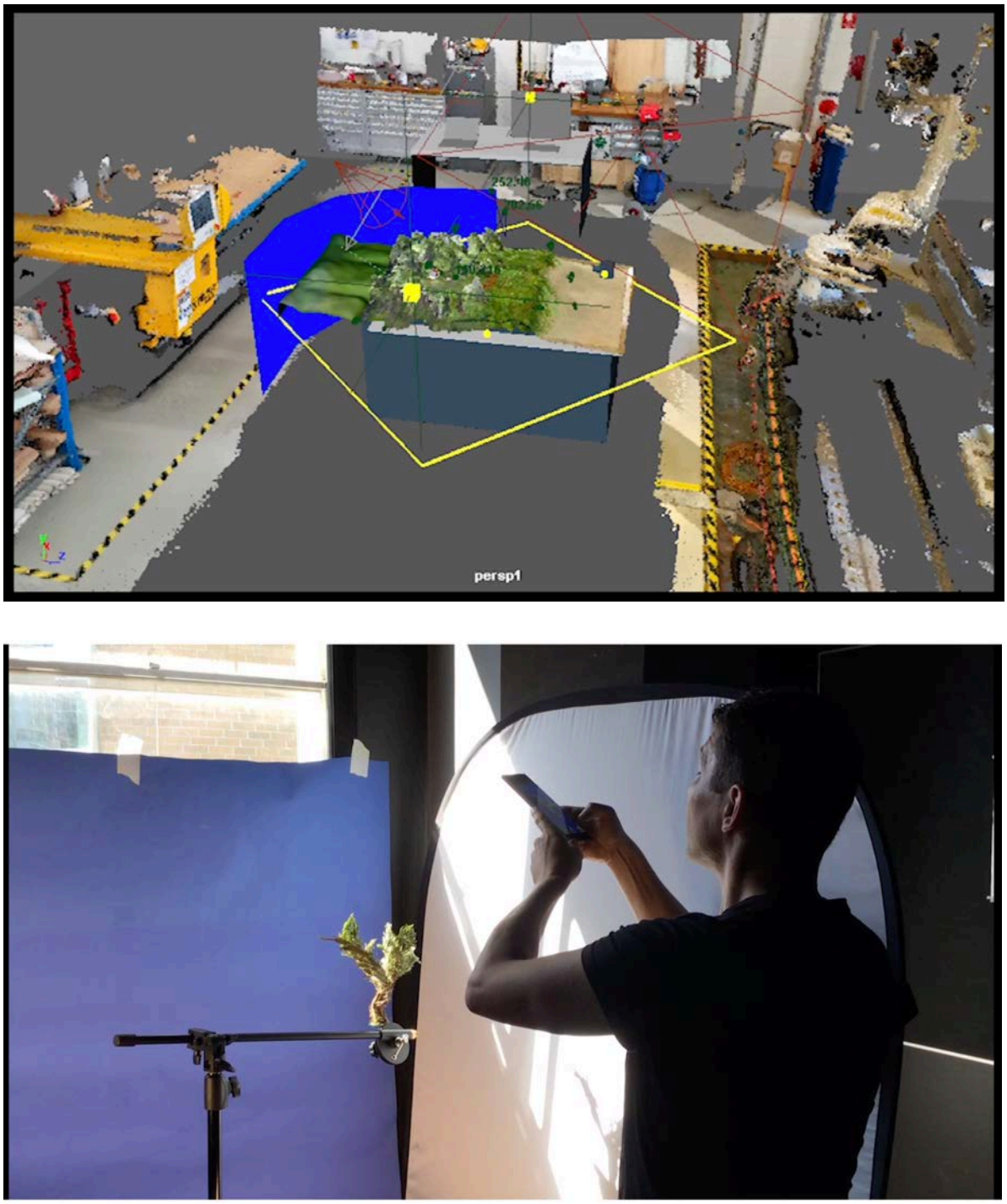


Figure 4.22: Tech vis of shooting space and capturing background elements as point clouds.

The A and B blocking position scans for both cameras used in the animation blocking were combined into a Maya scene (see Figures 4.23 and 4.24). This provided enough scale, position and camera orientation information for each shot to re-create the blocking into Maya cameras, which were animated to match the animatic timings.

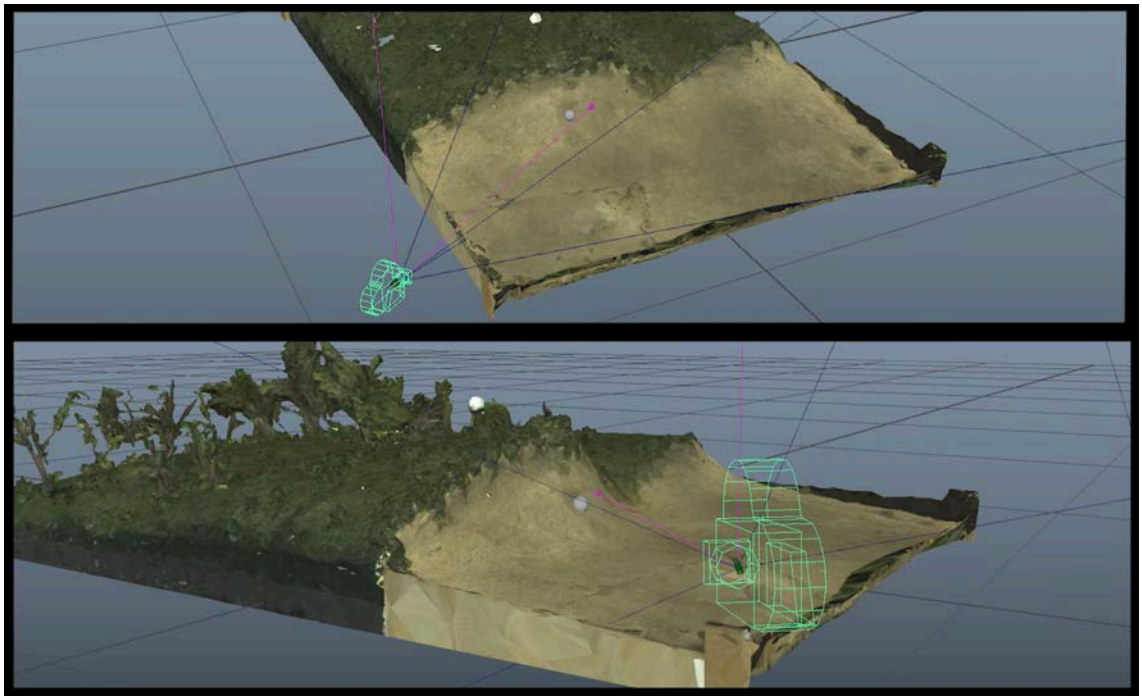


Figure 4.23: Blocking passes are translated into Maya camera moves on a point cloud of the miniature set.

Figure 4.24: Tech vis of cinematographer Brycen Horne blocking each shot on the same set.

Publishing this camera data to the KUKA robot arm did not go smoothly in Case Study 1. The team had limited access to the robot, and the tight scheduling meant that time for testing the translation of this data was only available on the morning of our shoot. We greatly improved upon this limitation in Case Study 2.

One of our biggest technical challenges was designing our cameras at 24 frames per second (fps). Mark Van Den Bergen and KUKA operator Tran Dang had to develop a method to communicate this data to translate the required camera speed

into the KUKA'S movement. Mark exported the x, y and z position data and the x, y, and z rotation data from Maya for each camera shot frame into a spreadsheet (see Figure 4.25).

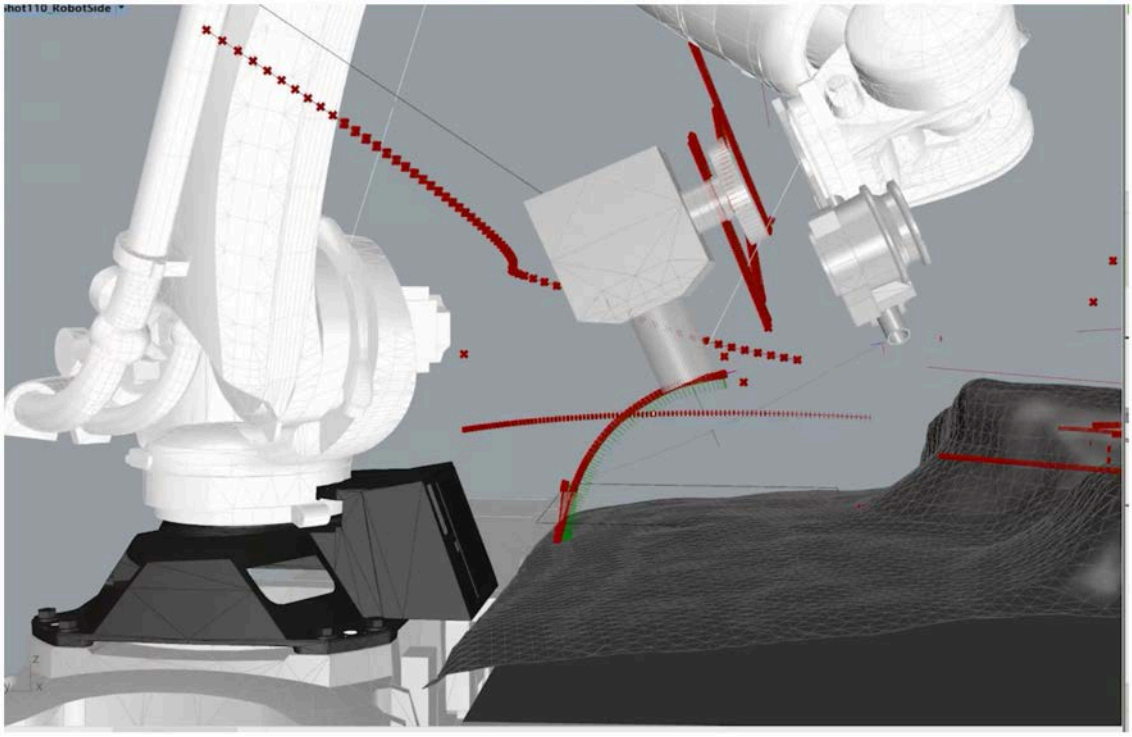


Figure 4.25: Our first attempt at communicating camera moves to the KUKA was through spreadsheets.

Robot technician Tran Dang described the process as:

> A Python Script (computational programming language) was written. [A Python] library was used to update spreadsheet data and extract to position using (x, y, z, Rx, Ry, Rz) values. For each pair of positions, we calculated the distance and divided by the time.

VFX supervisor Mark Van Den Bergen noted:

> First, we roughed out the timing of the story and framing, then mapped out the animation in 3D space, to help refine the edit. The cinematographer and director choose lenses and camera framing and the scale of character was locked down using a paper cut-out. In this stage VFX captured a 3D scan of the camera positions for use in tec-vis. Then camera moves and character animations were locked down based on real-world measurements of the set and 3D scans of the real-world camera positions and lenses. We then calibrated the robot to the miniature set and convert the spreadsheet data into robot instructions. [The] robot moves the camera based on data exported from Maya.

4.11 Motion controlled camera pathway

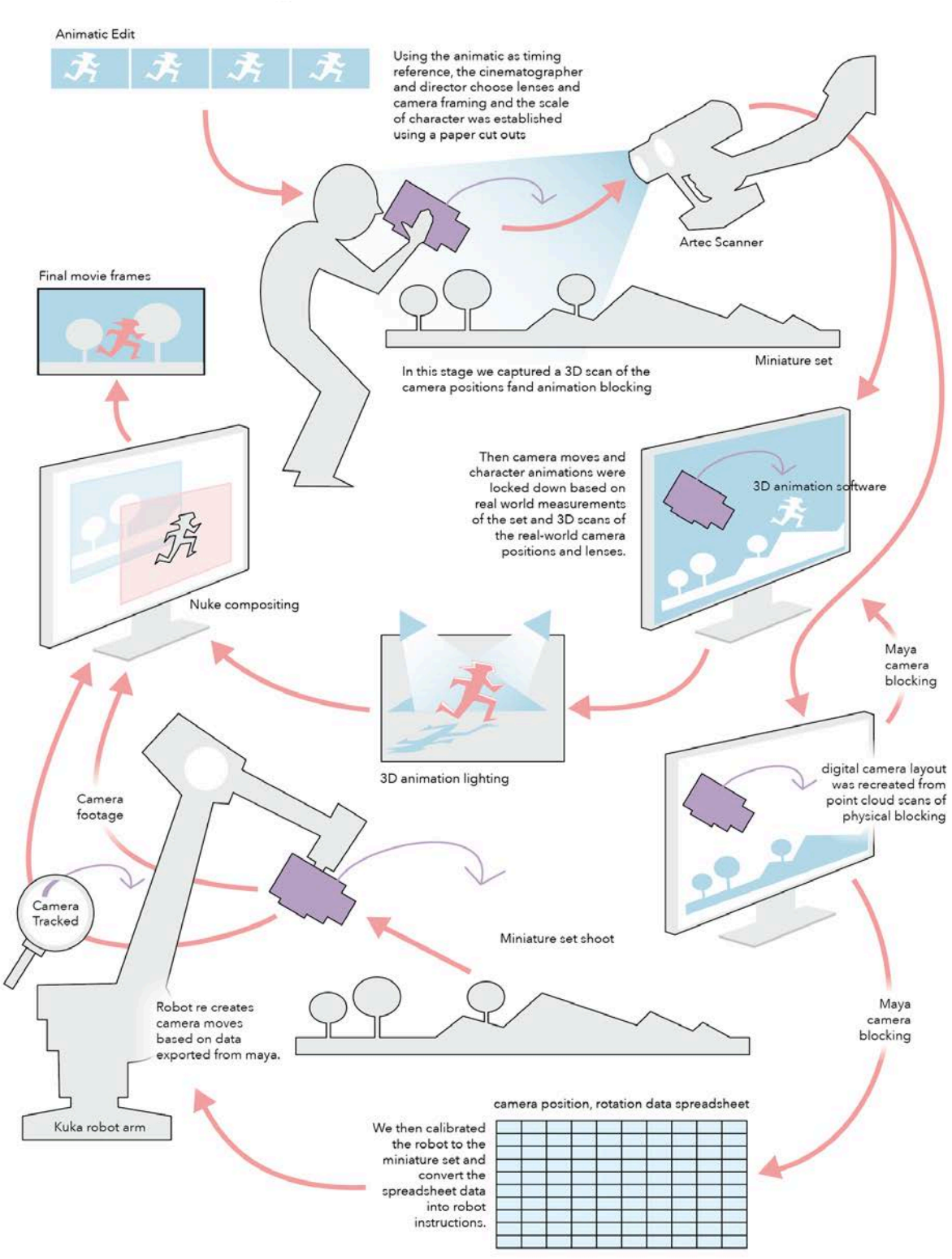


Figure 4.26: Case Study 1: Jasper: Motion control camera pathway.

4.12 The miniature set shoot

One of the most creatively satisfying and challenging aspects of this hybrid style of animation production is getting the miniature set shoot right. It is always more difficult than expected. We filmed *Jasper* in UTS's Advanced Fabrication Lab, where we had two days' access to the KUKA KR 120 (see Figure 4.27).

Figure 4.27: The miniature set shoot crew on the 2-day Jasper shoot.

This hybrid animation style would benefit greatly from the availability of a professional sound stage or filming studio facility to realise the full advantages of this production choice. The cinematographer needs to place the lighting set-up at the optimum distance from the set. Sufficient room is needed so all crew members can move quickly and safely around the space to do their job. The space was not too inhibiting with only one miniature set on the *Jasper* shoot. However, lighting choices were somewhat dictated by the room's dimensions rather than creative choices. Cinematographer Brycen Horne was able to successfully work around this special challenge. To avoid shadows cast by the robot, which towered over our miniature set, we had to place the key light source on the opposite side of the room to the robot (shown in Figure 4.28).

Figure 4.28: The animation team working on the Jasper miniature set shoot.

We captured all shots on the project in just over one and a half days, leaving half a day to experiment with optimising the KUKA arm as a motion control rig. All action in the short film takes place in the midday sun; therefore, it has a similar, single-source lighting set-up. VFX supervisor Mark van den Bergen set up a camera shot that incorporated all shots from the film into the one motion path.

As the continuous camera movement made it impossible to light for each shot, we did not use the combined motion path shots in the final animation. However, these experiments were useful to test approaches we could take to shooting on the KUK. They helped identify the different types of shots we could set up and run on the day and translate into the camera movement. The combined motion path was used to capture almost the entire short film in one camera pass with all the house lights on in the studio. It became a useful tracking reference for the compositing stage of the project.

Mark van den Bergen and I added one of the more ambitious shots to the shot list just before the shoot day. The shot involved the camera moving on a complex, multi-axis crane up and forward while tilting down, then rotating almost 180°, while looking down at Jasper lying on her back on a sandy beach (see Figure 4.29). This shot was a good example of a camera move that would be almost impossible to film using conventional camera grips, prohibitively time-consuming and impossible to repeat accurately. We were interested in trying a camera move that used rotation on multiple axes that would be very difficult to realise using another camera control method.

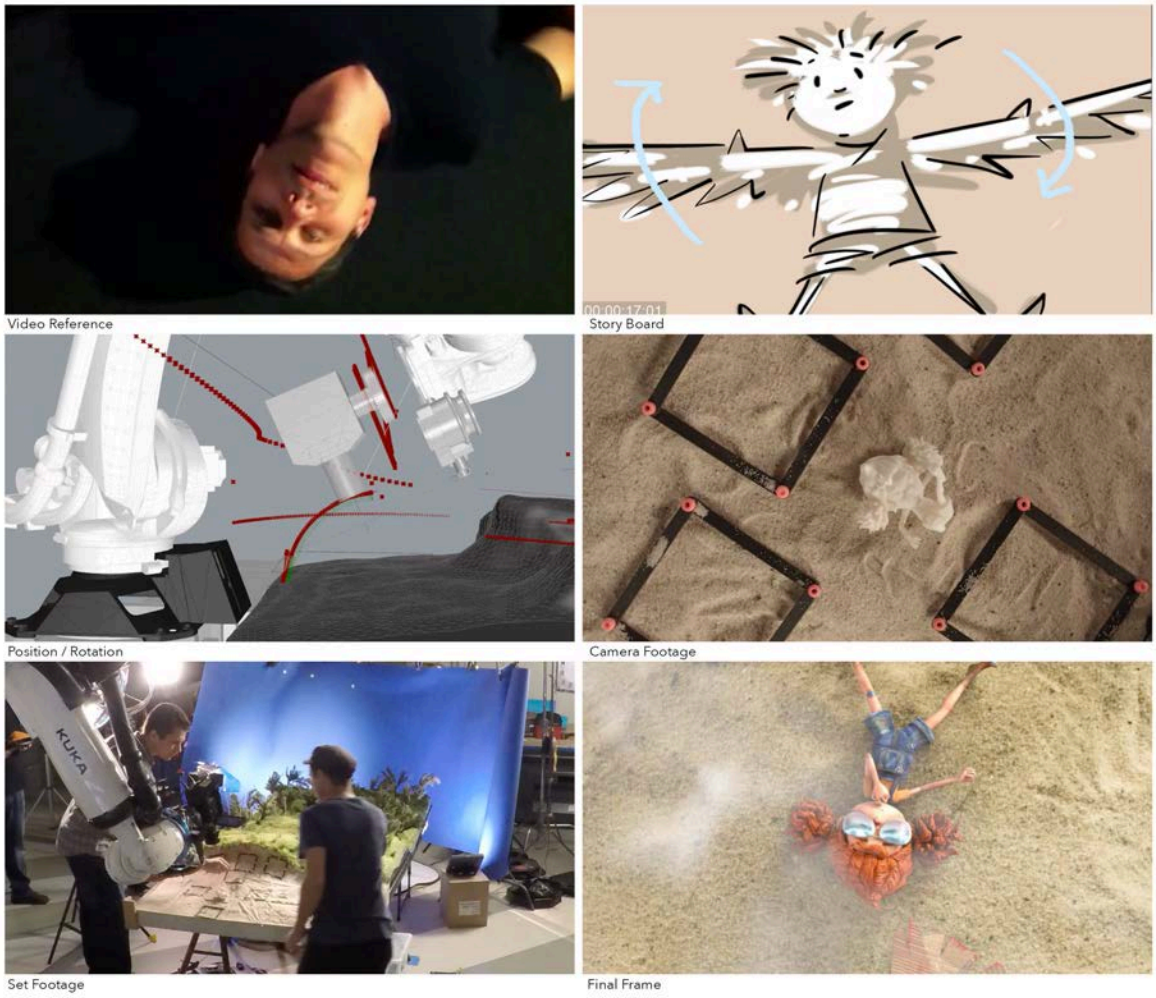


Figure 4.29: An added shot to the production schedule to test a more ambitious, multiple axis camera rotation idea.

Mark and I filmed rough video reference blocking for the shot, storyboarded and blocked it again in Maya. It was exported from Maya to the KUKA the day before the shoot. Once the shot was published and working to the KUKA, we could repeat it accurately. This shot was one of the more interesting and ambitious uses of the robot as a motion control arm as creative medium and translated well into the miniature set style and the final animation film.

Creative turnaround of camera movement was one of the most important aspects for me as the director on the miniature set shoot. I wanted to discuss the shots with cinematographer Brycen Horne and the team, experiment with ideas and refine camera moves with as little turnaround as possible. In our first test, we had a camera update on the KUKA after an overnight turnaround and exchange of position data and python scripts between VFX supervisor Mark and robot technician Tran. On the first morning of the shoot, it took about 45 minutes. By the end of Day 2, this turnaround took about 25 minutes. Although more streamlined, 25 minutes turnaround was still quite prohibitive within the creative working environment of a set shoot. In Case Study 2, *Jarli*, we improved upon this approach and reduced the time of creative turnarounds significantly (detailed in Chapter 5).

Another limitation in Case Study 1 was that the translation of data from Maya to the KUKA meant that I could not directly refine or control the ease in and out of the camera movement speed. Consequently, all moves were quite linear in the

acceleration and deceleration of camera speed. This problem was lessened in Case Study 2 using the Mimic plugin for Maya.

The KUKA robot enabled us to shoot all shots in real-time, rather than frame by frame, like a traditional stop motion control rig. Therefore, once we were set up and the set was lit, we could quickly shoot multiple passes of each shot. Mark and I took advantage of this by shooting various lighting passes with bracketed exposures for shadow and sun. We also shot passes with the set covered in tracking markers and with 3D prints of Jasper for lighting and scale reference (see Figure 4.30). We shot more experimental lighting passes with moving cloud shadows and ocean fog moving through the trees. Mark van den Bergen commented:

> On-set lighting and the integration of the CG character were crucial creative factors. For on-set lighting, the repeatability of the robot arm gave us several versions of lighting for every shot. The DOP could set up the lighting for a specific shot, but we could quickly record the camera moves for all the shots. We had every shot programmed to run one after the other, so it was quick to just record all shots. That gave us a wide range of versions of lighting, offering more creative choices for the final film.

Figure 4.30: Tracking markers and lighting references on the Jasper miniature set.

The *Jasper* shoot was very successful overall. As director, I was pleased with the images we captured and the look of the miniature set when lit in front of the camera. There is significant added creative value to the process of lighting miniatures in front of a camera, and I enjoy this aspect more than working with production design in an all-digital environment. It involves a physical, hands-on, creative process, and the artists can literally walk around the work and make changes. The *Jasper* production was a perfect example of this. The shorter duration also allowed the team to focus on a few visual elements and refine and add detail to them in a way that is often prohibitive under the tight scheduling of a production with many more shots and scenes.

4.13 Animation

One way we kept the *Jasper* animation creatively and technically contained was to set ourselves the challenge of making the film with only one line of dialogue. This approach helped to focus the team on the visual aesthetic of this hybrid production style. Without any text, dialogue or voice over, the audience's attention would be entirely on the flow of images to tell the story (see Figure 4.31). Therefore, our visual style had to be as evocative and engaging as possible to keep the audience's interest in the story. This requirement put extra responsibility on the animation team to carry the narrative entirely through expression and movement, almost like in a classic silent Buster Keaton or Charlie Chaplin film.

Figure 4.31: Storyboard frame and final animation composited with miniature background.

I had worked with a team of five animators on my previous film, *A Cautionary Tail*. I particularly appreciated the creative approach that animator Greg Naud had taken when animating characters for compositing into miniatures set photography. His animation sensibility translated well to the hybrid style. I thought he understood the visual aesthetic approach and could refine and adjust his animation style to suit the medium. I approached Greg to work on this project and was lucky enough to have him onboard for *Jasper*.

Greg also stepped in as the main layout artist. Before beginning animation, he and animator Mai Pham blocked the shots using our point cloud scans from the shot design process to obtain scale and blocking references for layout (see Figure 4.32). Once we completed the shoot, we did some tracking and camera solving, which did not significantly change animation blocking.

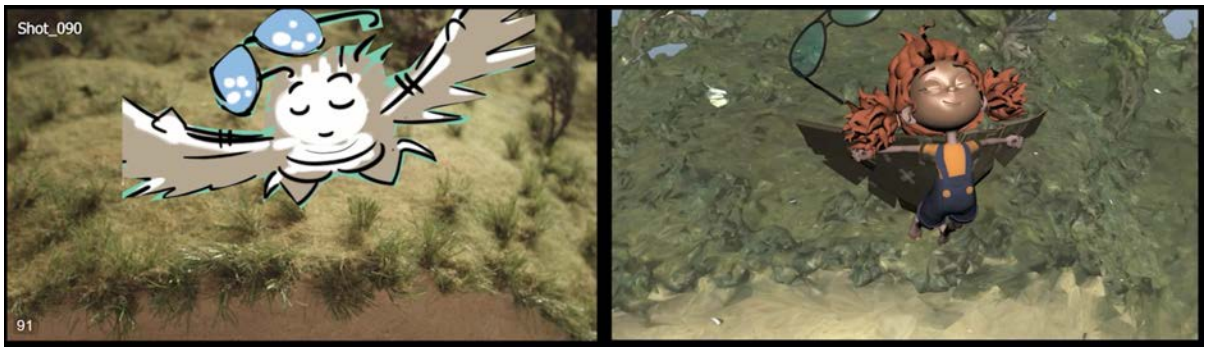


Figure 4.32: A storyboard frame bash comped with miniature footage and an animation shot using the point cloud set scan for reference.

In our point cloud scanning process, Mark van den Bergen and I scanned rough blocking markers with a piece of wood and a polystyrene ball attached as a scale reference for Jasper's action from the animation blocking point to the blocking point on the miniature. Greg also used our roughly blocked out video passes of each shot, with Brycen and I performing the action with the scale reference. This process was a fast and easy way to get the different departments closely aligned regarding timing and blocking.

After discussing references from stop motion and digitally animated movies, Greg used various methods to push the animation style of *Jasper* to match the miniature feel of the production. We pushed the creative objective for the animation to sit between stop motion and non-stop-motion styles. This look kept the weight and physicality of real stop motion puppets but had a subtle amount of bounce and flex in the geometry. We returned to the principles of animation, deciding that we wanted Jasper to move without the excessive squash and stretch aesthetic that has become an important part of more traditional animation of the classic era of Disney animation. As in a stop motion film, we sought a look that gave the impression that Jasper had the real-world physical properties of a puppet with a skeletal armature inside the model, driving the movements.

Greg did some animation run cycle tests, shown in Figure 4.33, in which we pushed the clay sculpted look of the character's hair away from how a stop motion puppet would behave and closer to a digitally animated aesthetic. Greg gave the hair geometry a subtle bounce and flex that added an element of fluidity and flex.

Figure 4.33: Run cycle tests in the early stages of animation on Jasper.

Greg and I discussed using a combination of frame rates. In the wider, more action-oriented shots, we kept the frame rate on twos at 12 fps to achieve a more staccato, less fluid and more stop motion look (shown in Figure 4.34). In closer shots, where the camera was pushed towards Jasper's face, the staccato look felt a little distracting, so we animated on ones at 24 fps, which worked better for the more emotional moments (see Figure 4.35).

Figure 4.34: We used a more staccato, 12 fps approach on the wider shots.

Figure 4.35: We used a smoother, 24fps approach on the closer, more emotive shots.

All these choices were to achieve a look that made Jasper appear like she was at a miniature scale to match the set. She stood approximately 13 cm high in the miniature world, so we tried to match this scale in modelling and animation style. From a directorial perspective, these choices give the overall impression that the character inhabits the miniature environment and belongs in that story world. This helps the compositing artists who have to make this illusion work for the final frames. It also enhances the audience's experience of this hybrid style.

4.14 Surfacing and lighting

VFX supervisor Mark Van Den Bergen led a small lighting and rendering team. They lit Jasper's animation shots using the graphics processing unit (GPU) based renderer Redshift. We dialled in a subtle amount of motion blur in the rendered animation frames to achieve a look somewhere between the animation aesthetic qualities of stop motion and 3D CG animation.

High dynamic range images (HDRIs), panoramic digital images covering the 360-degree spherical field of vision, were captured on-set using a GoPro and a lighting reference video pass, shot with grey and silver lighting spheres. HDRIs were captured for each motion path filmed on the KR 120. Lighting and texturing artist Emma Cooney described her process of designing digital textures for *Jasper* as:

> It was a fun project to be a part of because there was no requirement to be too physically accurate to real-world parameters, but at the same time we had to try and make Jasper look real. In keeping with the stop motion-esque style we were looking at, we tried to match the scale of something like 1/12 scale and simulate the way textures and materials would appear at that scale.

Mark van den Bergen also used the simple low-resolution surfacing data from the miniature set point cloud scans as a reflective lighting source in Nuke (digital compositing tool). In several shots, he bounced light off the set to interact with

Jasper render passes to act as reflective, interactive lighting (see Figure 4.36). This technique added warmth and detail to the lighting passes and helped embed the Jasper renders into the miniature set environment in the compositing process. Mark Van den Bergen explained:

> For lighting integration of the 3D character, we captured the HDRI lighting with a GoPro 360 at a range of exposures. Normally I would use a DSLR [digital single-lens reflex camera] for capturing HDRI, but using the GoPro was an appropriate solution for the miniature set shoot for several reasons. The small dynamic range of the studio (as opposed to exterior shoots) fits within the range of the GoPro camera. The small size of the GoPro (compared to a DSLR) meant it could fit better in among the trees on our miniature set. The capture process was also 10 times faster on-set than using a DSLR.

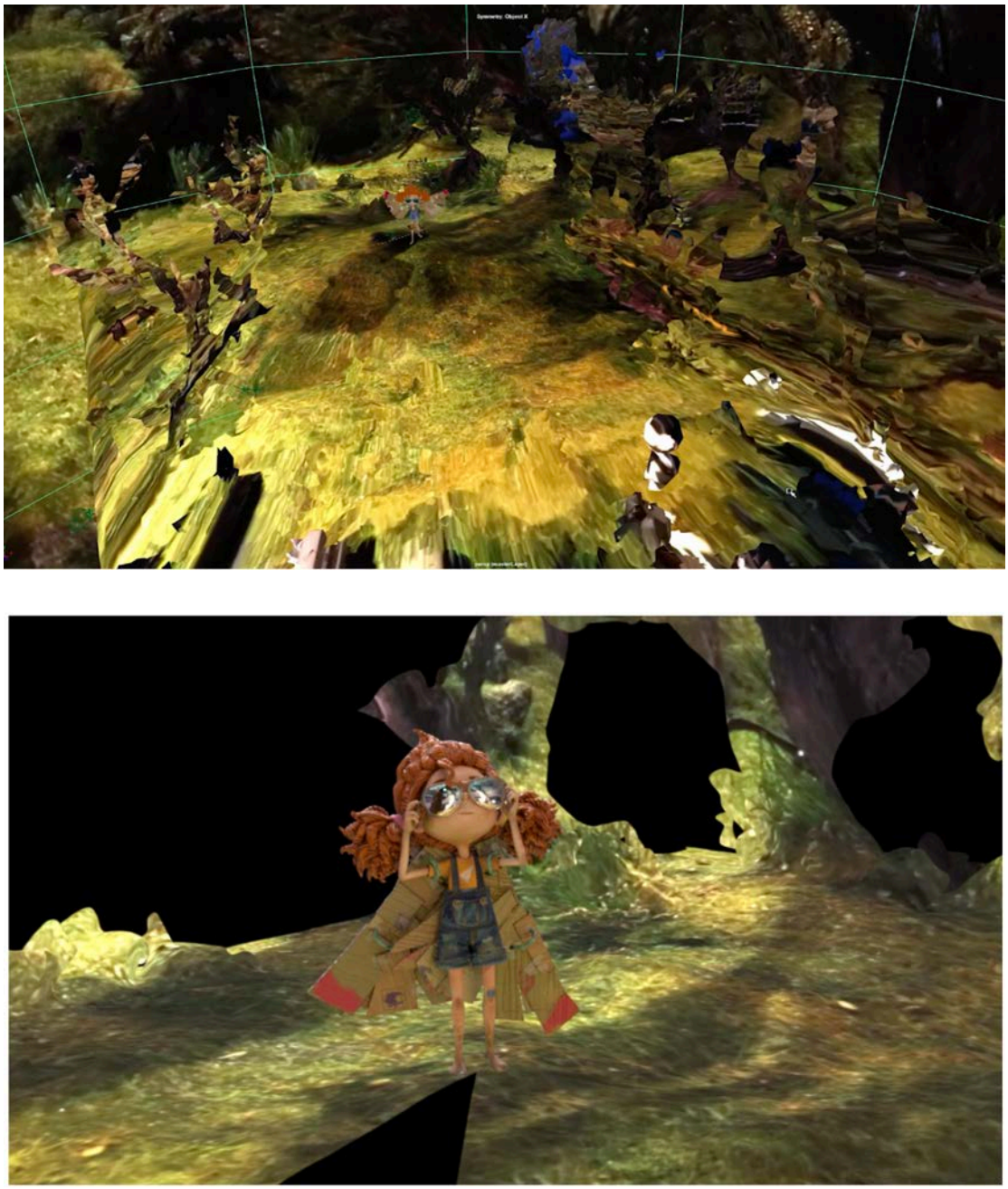


Figure 4.36: Miniature set point cloud scans used as reflective, interactive lighting in the compositing process.

In both case studies, we experimented with on-set lighting references in the form of 3D prints of the character (see Figure 4.37). On *Jasper*, these prints were a useful indication of how the light fell across hair and face geometry in any given shot. This could be a useful video pass to capture in future productions, although it requires time and resources to organise a team dedicated to outputting a correctly scaled 3D print for each shot.

Figure 4.37: Lighting references and tracking markers on the Jasper miniature set.

4.15 Compositing

Jasper was made with a very small team of artists. The same team working on pre-production were on set shooting miniatures and then working on the lighting, tracking and compositing stage of the project. Having the same team was a distinct advantage for the research project as all team members understood the story logic of each shot; they had been involved in its development, had assisted on the miniature set shoot and worked on post-production. For example, having Mark van den Bergen as our on-set VFX supervisor in pre-production, developing shots and leading the compositing team post-shoot was advantageous, especially when we began compositing the shots.

We found an interesting and technically simple solution to capture more parallax depth and focal depth in the landscape when shooting a tracking shot on the miniature set from left to right, following Jasper running through a forest. To generate multiple planes of depth as the camera tracked through the landscape, we captured multiple planes of our miniature by pushing the set away from the robot at four different depth distances from the camera, then filming the set with the same motion path on the KUKA. Each of these passes was filmed with a blue card behind the set so that the individual layers could be chroma keyed and added to the composite in Nuke (see Figure 4.38). This simple, low-tech idea had a fantastic result, and it was one of the most successful examples of a solution to the difficulty of capturing the depth of field in miniature set shoots.

Figure 4.38: The various shoot passes on the Jasper miniature set. Then the first pass composite.

As our tracking and camera solving process got underway, some shots proved harder to track than the team had anticipated. We had initially speculated that, in a best-case outcome, we might be able to use the same motion paths that had been published to the KUK to generate accurate cameras in Nuke. However, this was not a practical solution to camera solving. The tracking team of VFX artists, Ben Streek and Mark Van den Bergen, discovered that the shots from the KUKA robot retained enough shudder and vibration, although small, to warrant a camera tracking process.

The most difficult shot to solve the camera for was when Jasper ran towards the camera and threw a paper plane towards the lens. We swoop up into the sky, and the camera cranes up and back in an extreme wide frame showing the entire miniature set while rotating on multiple axes, following the paper aeroplane up into the clouds. The ambitious nature of this shot was the kind of movement I wanted to test within this hybrid style of production and with our camera on the KUKA robot arm. It was a swooping, rotating camera, moving on multiple axes, which showed the world beyond the miniature set. The shot required an accurate digital set extension and that we handed over from a miniature set world to an all-digital sky environment. The shot proved the more difficult to solve, but the end result was a successful outcome of our research objectives.

4.16 Sound and music

Sound and music play an essential and often underestimated role in any animation or visual effects-driven work to bring disparate visual elements together into the final frame. The sound design enhances the audience's suspension of disbelief and helps create an artificial visual reality. Sound and music work in concert with the visual elements to immerse and embed the audience into the cinematic experience. On *Jasper*, sound design was an especially interesting and creative part of the production process. The absence of dialogue put extra emphasis on the role of sound and music to drive the animation experience and immerse the audience in the illusion of a story world and become swept up in Jasper's dream of flight. Figure 4.39 shows RAAF pilot Squadron Leader Jacqueline Killian recording the voice of Jasper.

Figure 4.39: We worked with RAAF pilot Squadron Leader Jacqueline Killian to give a relatable, authentic voice to the Jasper story.

The sound design and music score also underpinned our attempt to stylistically position the audience into being unsure of exactly what they see on the screen regarding animation format. The music plays a role in this illusion and disarms the more technical analytical part of the audience's brain, at least on first viewing. The score for *Jasper* was developed with composer Jackson Milas from Sonar Music, Sydney. We researched and sketched ideas for music that drew from a feature animation film aesthetic. The musical ideas tapped into the themes of the animation: dreams of flight and the basic human desire to defy gravity. Jackson wove a simple melody that looped and repeated, building subtly in complexity each time through the five mini scenes of the story, gradually ascending and building to a simple emotional peak.

Sound designer Timothy Bridge brought his artistic sensibility to the sound design process for this project. He won an Australian Screen Sound Guild Award for Best Sound for a Television Commercial or Promo 2018 for his work on *Jasper.* I have always enjoyed the sound design process in animation production; it seems to be the stage where the animation and shot work 'come to life' for the first time. Sound design makes the trick of animation work on the screen. Tim responded immediately in our first meetings to the hybrid production choices and the visual aesthetic of our production design and animation style (shown in Figure 4.40). He created a soundscape that enhanced the images and brought them to life.

Figure 4.40: Production still from Jasper.

4.17 Conclusions and findings for Case Study 1: *Jasper*

Jasper was a successful case study of this hybrid production style from a research perspective. The project outcomes were well-received, and the production team was excited about the results of the animation. Creating the *Jasper* animation project led to the following key insights:

- We were able to design moving cameras for each shot of the animation short film and publish these shots to the KUKA robot, using a somewhat slow and rudimentary method, and then execute these camera movements in a miniature set shoot. There was little scope for creative turnaround using this system; however, the moving cameras we designed translated well into the final work.

- The team realised the aesthetic and creative qualities I had set out to achieve. As the director, I was very happy with the look and cinematic quality of the final animation. The small scale and short duration of this short film and the quality of the creative and technical team allowed us to push the image quality to a satisfactory level.

- The use of Unreal Engine throughout the production process produced a range of interesting solutions and outcomes for integrating 3D animation renders with miniature set footage. This process was particularly successful for creating skies and other digital set extensions.

On a technical level, the team managed to shoot all shots on moving cameras using a pipeline from Maya to the KUKA robot with slow but successful outcomes. Although there were areas we could improve on, the team completed our shot list on schedule with a small degree of creative flexibility. Despite the final shots coming together in the lighting and compositing processes, the team had a stressful and technically challenging time getting the KUKA to shoot the shots we wanted each day. We had no margin for error, and any creative changes had approximately a half an hour turnaround. This turnaround time was creatively prohibitive from a directorial perspective in a 2-day shooting schedule. The team decided that a further case study would be beneficial to make further progress in this direction.

The artists involved in the *Jasper* production shared their experiences of working in this hybrid animation production style with the research team. They reflected on the elements of the process that they felt were successful and areas that had been less successful or frustrating.

The post-production camera tracking team of Ben Streek and Mark Van den Bergen expressed some degree of frustration. Despite theoretically having the exact motion paths available in the Maya camera motion paths files that had been sent to the robot arm, we still needed to track every shot to match the miniature set footage and the 3D animation plates in our Nuke compositing process. VFX supervisor Mark van den Bergen and I had optimistically anticipated that there might be more value in these motion paths. However, we realised that this hybrid production style would not be able to circumnavigate camera tracking in the post-production process.

These motion paths can still be integrated into the production pipeline, especially so the layout and animation team have a clear sense of blocking and timing for taking animation close to a polished phase. We had unsuccessfully attempted this in Case Study 2, *Jarli*. We hope to navigate a smoother production pathway in this regard in a future case study (as discussed in Chapter 6). As Mark van den Bergen commented:

> Once we realised we could reliably send data to the robot, it opened up the technical possibilities for some more complex camera moves, including running multiple passes of the camera move to layer up the forest set at different distances. It was a very tight turn around to get the moves finalised in tec-vis before the shoot day.
>
> It was an exhilarating experience, to get it all working in time, and to get the result we were hoping for. The cross-pollination across the two worlds of cinematography and industrial robots, was a fantastic learning experience for everyone involved.

Another notable area for improvement to this hybrid production style that would build upon techniques developed in this case study is an augmented reality animation pre-visualisation tool that is simple and practical to use on a miniature set shoot. We tested an augmented reality animation pre-visualisation tool on a miniature set during Case Study 1's research and development phase but found this process unhelpful when the camera and split monitor were set up and used. Due to the pressures of the creative process in an on-set shoot, this process was not used for either case study. When tested on-set, this process was a distraction from what the team saw on the split monitor.

The lack of an accurate visual reference for animation blocking is a disadvantage of shooting animation shots on miniature sets. Therefore, the team must rely on strong storyboards and shot development. When we roll the camera, we make an educated guess as to the blocking positions of animated characters. Solving this creative and technical problem could inform the camera blocking and lighting choices on the day of the shoot. Despite this guesswork, the team agreed that having a good storyboard or animatic reference on-set was sufficient to inform framing choices.

The most difficult aspect to reconcile was the changing scale of the character from shot to shot. While this was not an issue for *Jasper*, it proved problematic in the more ambitious Case Study 2. We could use 3D prints of the character for each shot, but at miniature scales. However, the slightest amount of camera movement means that these models are less useful for blocking and more useful as lighting references.

There were several more successful elements to the *Jasper* case study, including the ability for ambitious multiple axis camera movements throughout the animation work. We were able to shoot every shot planned on time and within

budget. As the director, I found the results satisfying on a creative level. Cinematographer Brycen Horne and I agreed that the ability to design shots through creative conversations around the miniature set was one of the most rewarding parts of the creative process.

When establishing the best camera blocking for each animation shot, having creative conversations with the team while standing around the set creates a different decision-making dynamic than creative conversations around a screen. When two or more people work around a computer screen or in a review session in a screening room, only one person at a time can control the perspective and point of view of the scene through the computer terminal controls. When working with miniatures in a live shooting environment, we can see the story world right before us. We can walk around the set and discuss the nuances of how light falls on real objects. A light can be moved, tilted, slightly cut or bounced off a reflective surface to make changes.

On *Jasper*, this phenomenon of on-set creative conversations applied to the other artists whose roles focused on the production's digital animation aspect. Having encouraged these team members to become involved in the miniature shoot meant I could observe the digital artists' enthusiasm for interacting and working with the miniature set story world. My impression as an animation artist leading a creative team was that this enthusiasm came from a more tacit and tangible understanding of each shot's creative direction. This understanding informed the team's creative direction working in the digital elements of the production.

From my perspective as an animation director, Case Study 1 was creatively rewarding. *Jasper* is one of the few animation projects I have worked on in which the images I conceptualised at the project's outset were realised on screen. There is always an element of compromise and creative expectation management when working on any animation. So it was rewarding to have the final sequences realised with the visual integrity and production values of the original design concepts (as shown in the production stills in Figures 4.41 and 4.42).

Figure 4.41: Production still from Case Study 1: Jasper.

Figure 4.42: Production still from Case Study 1: Jasper.

This element of success can largely be attributed to the quality of the team that worked on this case study—their creative talent, technical proficiency and how they collaborated as a close unit. There was a considerable crossover of creative roles, and the small group of artists performed multiple tasks in different departments, which helped the project's cohesive nature. Consequently, as a director, I was not always required to brief new artists and bring them 'up to speed' on each department's themes and concepts.

5 CASE STUDY 2: *Jarli*

Figure 5.1: Production still from Jarli.

5.1 Introduction

After wrapping up the short animation project *Jasper*, the Jericho team were satisfied with the creative outcomes and the project's successful distribution and engagement figures. The success of *Jasper* lead Jericho to propose another collaborative animation project to the UTS Animal Logic Academy team. This proposal was for a story to be made in collaboration with and aimed at young people from the First Nations community of Australia, particularly young women (Figure 5.1 shows a production still). The group captain at Jericho at the *Jarli* project's initiation, Group Captain Lyle Holt, saw an opportunity to encourage connections and pathways for employment opportunities in remote areas of Australia, where the Australian Space Agency and the RAAF had been developing new facilities and infrastructure. As with *Jasper*, the broader focus of the project would be on encouraging young women to engage with STEM subjects in their career pathways.

From a research perspective, I was interested in following up on *Jasper* as an animation case study with a more in-depth case study. Case Study 2 would further experiment with and research some of the creative and technical areas of investigation we had begun to explore with *Jasper*.

On *Jasper*, we had developed methods and techniques in a small-scale, controlled environment, with one character, one set, fewer than 20 shots and a short running time. Demonstrating the potential of these production techniques on a feature film scale was a driver of my research. Therefore, I wanted to test our production techniques under conditions closer to an industry-scale production environment, with multiple sets, locations and characters for Case Study 2. This scale would test this hybrid animation production style under more realistic industry conditions like a feature film or television series. I was also interested in adapting the animation style to a different visual palette. A story set in the desert of northern Western Australia was a fantastic opportunity to do this.

5.1.1 Storytelling in collaboration with First Nations filmmakers and artists

I was excited by the opportunity with Case Study 2 to collaborate on a project with Indigenous storytellers, artists and filmmakers. Most significant was the opportunity to co-direct the project with Brisbane-based filmmaker Chantelle Murray, a proud Bardi and Bunial artist from the Kimberley region of Western Australia, and with animation studio Like A Photon Creative, which oversaw the digital animation.

It is difficult to discuss Case Study 2's technical and creative research directions and outcomes without giving the context of its creative direction, especially regarding the story subject matter and story development of the animation. Therefore, throughout Chapter 5, I discuss the story subject matter to provide an important creative context to the technical and creative approach to animation production. Where relevant, I also discuss how these two project elements related, cross-pollinated and informed each other. This discussion provides the context of the project's technical aspects and creative choices. It also explains how the nature of storytelling in collaboration with Chantelle influenced this second animation project's direction on every level.

5.2 Pitching and early development

The initial concept development for the project began with a pitch document in the form of a 20-page treatment. The pitch included initial conceptual narrative ideas and early concept artwork (see Figure 5.2) to give an impression of the area this project might explore. These documents came about in conjunction with early interest from a Sydney-based film and television producer looking to explore this animated story as a longer format (e.g., feature film or television series). This early interest led to a collaboration between UTS Animal Logic Academy and Brisbane-based animation production company Like A Photon Creative, which came on board as production partners.

Figure 5.2: Early concept artwork for Jarli.

5.3 Research aims and objectives

The first project, *Jasper*, was a successful step towards a technical and creative approach to working in this hybrid production style but presented areas that could be improved. In Case Study 2, *Jarli,* the team set out to further develop the production techniques researched and developed for *Jasper*. Case Study 2 provided opportunities to use emerging technologies for a hybrid miniature set and computer-generated 3D animation production techniques.

The aims of this second research project were to:

- produce a second animated short film to further explore the hybrid production style, involving a combination of digital animation and miniature sets
- improve the motion control camera system involving integration and creative control between digital cameras keyframed in Maya animation software and physical cameras filming shots on miniature sets using a KUKA robotic arm. To make this motion control camera system faster and a more creatively flexible system to design and execute complex, multi-axis camera movements on a miniature set, we wished to develop a technical pipeline between cameras pre-visualised in Maya and a red camera attached to the KUKA via Mimic plugin developed by Autodesk engineer Evan Atherton.
- explore other facets of the creative and technical practice of integrating 3D animation and miniature sets into an animation work to facilitate and improve methods for working in this hybrid style of animation production (including game engines, 3D printing, point cloud scanning and other techniques)
- develop the hybrid production style, working between the 3D digital animation and physical miniature sets that the team had used in the short film *Jasper*, under the scheduling pressures of a more ambitious filmmaking environment, with more characters, sets, shot locations and angles to be shot on each set.

5.4 Story development

As we began the story development process in second Case Study 2, the team worked with a series of simple starting concepts:

- We were developing story concepts for a short film story and screenplay and ideas for a longer narrative format (e.g., an animated series).
- We knew that the main character would be a young woman named Jarli, a backyard engineer with a gift for building and inventing new technologies.
- Jarli dreamt of travelling beyond Earth's atmosphere and into space. The narrative would weave visual and oral story elements to explore the dream of flight, Indigenous astronomy and the future of our planet and its people.

As our first step towards developing a script, we assembled a writers' room to develop a story concept in a 3-day workshop. In Case Study 2, I wanted to push beyond the simple, no dialogue style we had explored with *Jasper* to include multiple scenes and dialogue between characters. Due to the project's creative direction, we wanted the writers' room to have input from creative screen writers experienced in story development and screenplay structure and from people with

knowledge of science and Indigenous astronomy. Screenwriter and creative collaborator Erica Harrison helped navigate the process of establishing a writers' room. We reached out to artists from the film and television industry and people from the world of science, astronomy and aviation. Including me, the following people were the core team developing this initial story development:

Jon Bell

A proud Wiradjuri and Bundjalung man, Jon created and wrote the 2013 drama series *The Gods of Wheat Street* with Every Cloud Productions for the Australian Broadcasting Corporation. He is passionate about telling Indigenous stories, which is reflected in his other television credits, including *Redfern Now* (both series), *Ready For This*, *The Warriors* and *Cleverman*, which won the SPA Award for Best Drama Production in 2016.

Andrew Dillon

An Indigenous writer, director and producer with extensive experience in production, Andrew's credits include *Home and Away*, *Heartbreak High* and *Battlestar Galactica*. In 2014, Andrew was recruited by the Federal Government's key screen agency, Screen Australia, as Development & Production Executive, working within the Indigenous Department. Andrew is also the first Indigenous Australian to work within Screen Australia's mainstream Production and Investment management team.

Erica Harrison

Erica worked as writer and script editor on the upcoming narrative comedy series *Fam Time* for Seven Studios. She is the writer and co-creator of the dramedy series *Triple Oh!*, developed with support from Screen Australia's Gender Matters initiative. Erica was a writer on three seasons of the Emmy Award-winning Netflix series, *Beat Bugs*, and two seasons of the Netflix original, *Motown Magic*.

Kirsten Banks

Kirsten Banks is a Wiradjuri woman and astrophysicist with a passion for space and astronomy. Kirsten has been fascinated by the sky from a young age. Kirsten loves to communicate science and has done so on many platforms, including writing for *The Guardian Australia*, speaking across Australia and Europe on numerous radio shows and recently as a panellist on ABC TV's *The Drum*. She is also a regular tour guide at the Sydney Observatory.

The writers' room also benefitted from important input from producers Michael Horrocks and Ryan Greaves, comedian Steph Tisdell and Samuel McKechnie, Flight Officer and Indigenous Liaison Officer from the RAAF.

5.5 The writers' room

The 3-day writers' workshop was to have taken place on the UTS campus in June 2020, just as the initial COVID-19 lockdown came into effect across Australia. So we were forced to change plans and conduct the workshop over video conferencing, with a small number of the team present at a conference at UTS. As this production took place entirely during the COVID-19 lockdowns, conducting creative development work remotely became a recurring feature of the *Jarli* project. Audio and video streaming communication platforms were a significant influencing factor on every creative and technical level.

The initial story team came together with writer Erica Harrison and me at UTS, and the other members, Jon Bell, Andrew Dillon and Ryan Greaves, joined remotely. The writers' workshop team were to spend three days together developing specific outcomes.

Day 1:

The plan for Day 1 was to creatively bounce story ideas for an animation project based on the character Jarli. We began with a talk from Kirsten Banks about her work as an astronomer and scientist and how her work overlaps between a Western science knowledge system and the practice of astronomy in Australian Indigenous cultures.

The group workshopped the types of science fiction references we intended to draw from and the story tone we wanted to establish. We workshopped the question: Where did we want this animation project to sit on the wide spectrum between a realistic science-based sci-fi and a more outlandish, fantasy-based sci-fi? We discussed the general science fiction themes and ideas we wanted to tackle and workshopped ideas around the human exploration of the solar system. This initial brainstorming session led to initial rough story ideas for *Jarli*.

Day 2:

On Day 2, the team focused on more specific script structure and storytelling beats of the film. We developed a scene-by-scene breakdown for the short animation in the form of a beat sheet. This process involved a specific discussion of characters for the story. We workshopped the type of comedy style we wanted, establishing ideas around comedy and character.

We also workshopped how we could structure the arc of a potentially longer-form series and how its main characters would develop over episodes. We kept in mind that we would only be able to explore a small number of these characters in the short animation.

Day 3:

On Day 3, the team worked on a synopsis breakdown for a longer form project, which was the hypothetical part of the writers' room workshop. These ideas were developed as pitch materials for potentially longer productions, such as a feature film or a television series based around the *Jarli* concept. At this stage of development, the project garnered interest from animation producers to develop the story as a bigger project. Therefore, we decided this was a worthwhile outcome to pursue while we had the story creatives together in the workshop.

5.5.1 Indigenous astronomy and cultural specificity

One of the important decisions of the writers' room was, in consultation with writers Andrew Dillon and Jon Bell, to keep the story world of *Jarli* from being too focused on a specific language and or cultural group in the First Nations community. Jon and Andrew advised us to steer our narrative away from being too culturally specific. The team had more creative freedom to tell a story without having to navigate the potentially complex process of gaining cultural permissions from the Elders and Traditional Custodians of knowledge of an individual community. We wanted to ensure we did not tread too heavily on the cultural sensitivities that can come with working within a specific cultural identity. This approach was also confirmed at the next stage of the animation project's creative development when co-director Chantelle Murray joined the project.

Additionally, we wanted to keep our story world and astronomical motifs more general to young people across Australia. We wanted *Jarli* to be a story that was as relatable as possible to everyone and appeal to young Australian children from all cultural backgrounds and all parts of the country. In our writers' room workshop, the emu motif recurred as a story reference. The emu constellation features in the traditional astronomy practices of First Nations communities from different parts of the Australian continent (see Figure 5.3). The emu also appears in the many different storytelling practices of different language groups. Sydney Observatory guide and *Jarli* story consultant Kirsten Banks drew the writers' room team's attention to the fact that most Aboriginal language groups in Australia tell stories about the emu constellation in the western sky (see Figure 5.4). The constellation's position in the sky has been an important method by which people across Australia mark the time of year when they can collect emu eggs.

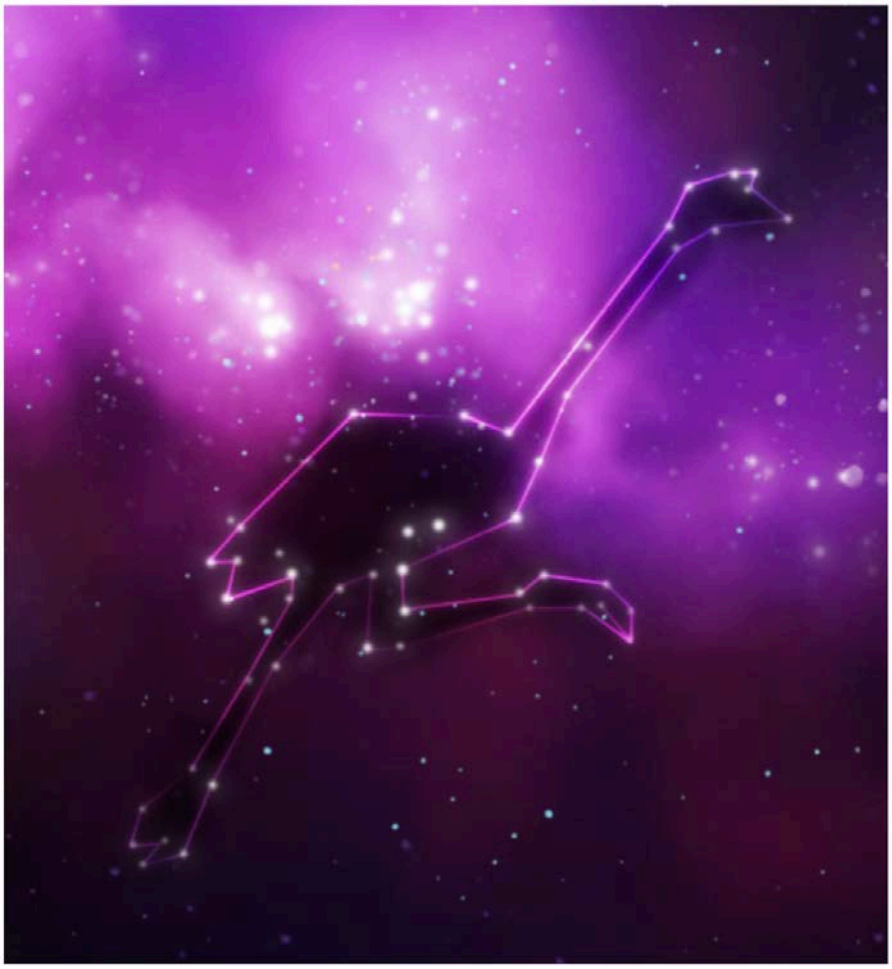


Figure 5.3: Concept artwork from Jarli.

Figure 5.4: The Emu features as a theme in Astronomy storytelling from Indigenous cultures across the Australian continent.

5.6 Beat sheet and screenplay

The writers' room was a rewarding collaborative process, and we finished on a positive note with a strong degree of creative buzz among the story team. We had successful outcomes regarding story ideas, character development and script structure, so the story team set out to produce a screenplay (see Figure 5.5). Everyone felt there was great potential in the *Jarli* project to develop in new and interesting ways. The screenplay was written over a couple of weeks, back and forth between Jon Bell, Andrew Dillon and Erica Harrison, with my creative input. All screenplay development was done via email and Zoom communication. We had the difficult task of reducing the initial draft from more than 10 pages to five or six. Working with Like A Photon Creative producer Ryan Greaves, we established a production limitation of seven pages in terms of budget and other resources.

EXT. CANYON - DAY

On Jarli, freaking out as her craft plummets towards the canyon floor. At the last moment she manages to yank a lever, unleashing a volley of fireworks: BANG BANG BANG. They blast her back up into the air, and she revs like crazy: *flying*.

JARLI
We're doin' it Unaipon!

REVEAL: Unaipon, splayed against the side of his wheel from the blast, cartwheeling through the sky.

They rocket through the canyon towards a narrow fissure... too narrow. Their wings clip the walls and they wobble, careening through the gap--

--and into blue sky! Unaipon squeaks tersely.

JARLI
Okay, maybe you were right -
eleven degrees.

The fireworks splutter out, along with the motor. Jarli looks a bit concerned.

Figure 5.5: A story beat from the Jarli screenplay.

5.7 Collaboration with Chantelle Murray

Early in the creative process, director Chantelle Murray came onboard to co-direct the animation project. Chantelle and I began to develop the animation's visual language and the production design's look and tone and turn the screenplay ideas into a shot-by-shot animation project. We decided to locate *Jarli* in a fictitious region in the north of Western Australia. Our story world's landscape drew on the look and feel of the Pilbara and Kimberley regions. Chantelle's background is from near Broome in the Kimberley region of Western Australia, so her connection with this part of the country was very strong. I also had a personal connection with this part of the country. I grew up in Perth and had my first experience leaving home as a young adult and road tripping through this part of Australia. We discussed the visual elements that make this part of the world visually unique and how we could translate this into the production design of a miniature set.

5.8 Technical research and development phase

The scale of *Jarli* was significantly bigger than the first case study; therefore, the team wanted more time to test and experiment with improved methods and techniques for this type of production. We set aside two weeks for research and development in a small studio space at UTS. Art director and fellow UTS researcher Louis Pratt, research fellow and VFX artist Andrew Bluff and robotics technician Tran Dang came on board for this phase of the project in a second collaboration with the Advanced Fabrication Lab at UTS Faculty of Design, Architecture and Building.

A central objective of Case Study 2 was to improve the motion control camera system involving integration and creative control between digital cameras key-framed in Maya animation software and physical cameras filming shots on miniature sets using a KUKA robotic arm (shown in Figure 5.6). We developed a technical pipeline between cameras pre-visualised in Maya for a faster and more creatively flexible system for designing and executing complex, multi-axis camera movements for filming on a miniature set. We attached a red camera to the KUKA via the Mimic plugin in collaboration with and with technical assistance from Autodesk engineer Evan Atherton (see Figure 5.7). The team also set out to develop an easier, more fluid production pipeline from designing shots on a miniature set, recreating them in Maya, publishing them to the KUKA motion control robot arm, to filming on the miniature set.

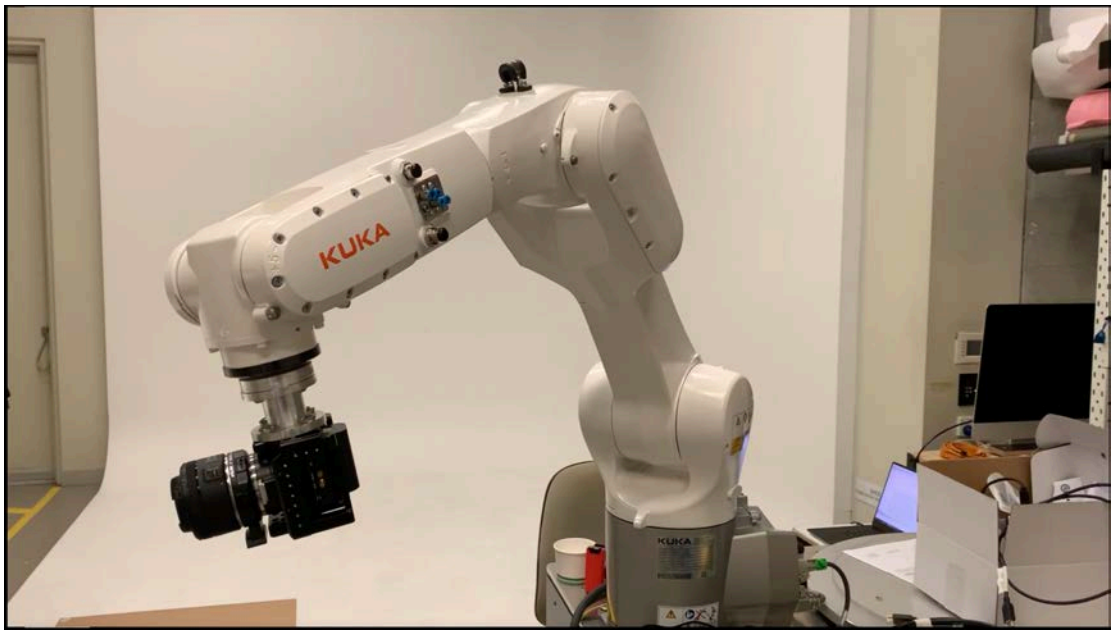


Figure 5.6: Early tests of the Maya–Mimic–KUKA pipeline on a KUKA KR 10.

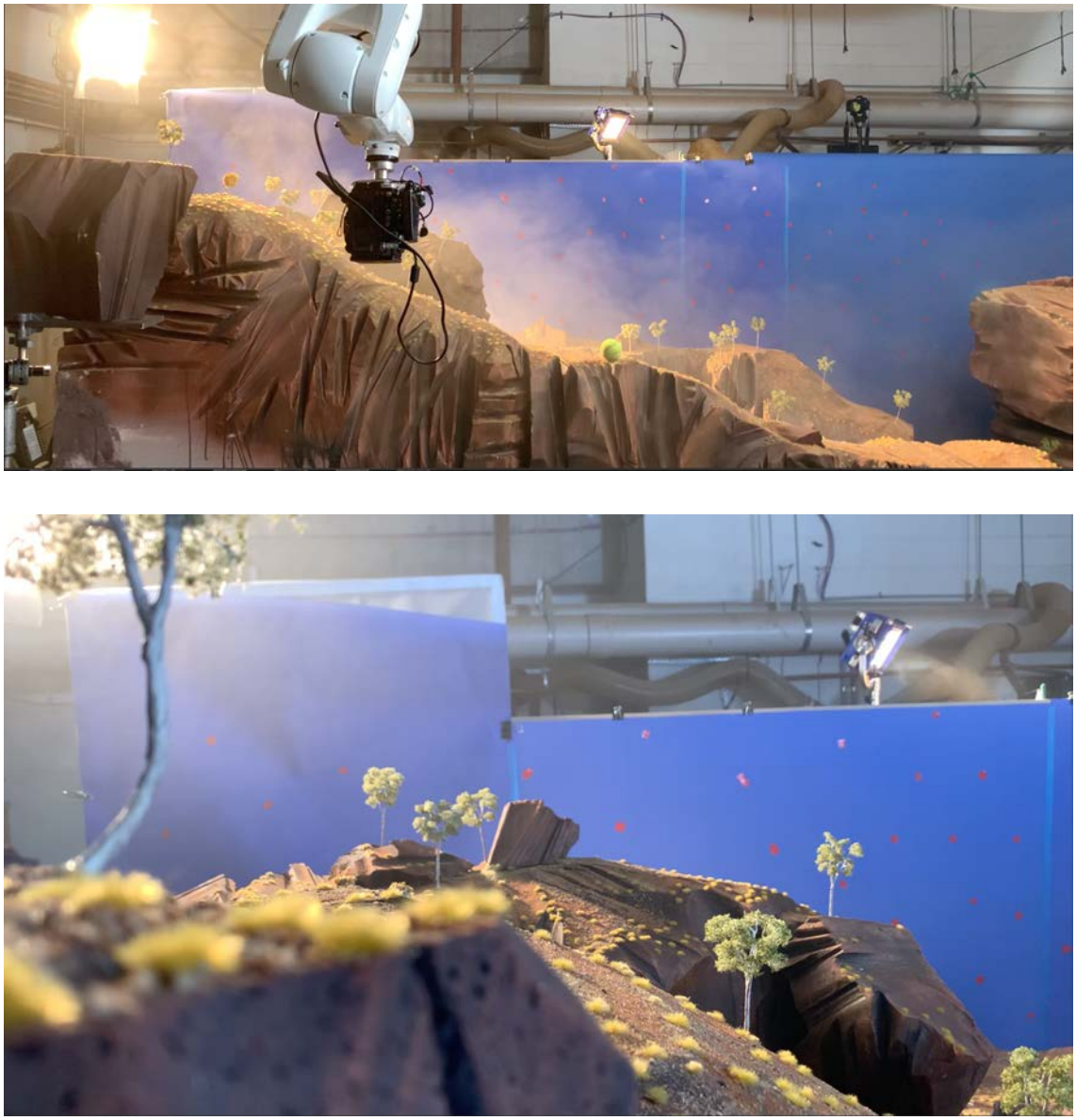


Figure 5.7: The red camera on the KUKA robot moves through the tracking down the hillside shots.

The research and development team on *Jarli* began a collaborative dialogue in the form of regular video stream meetings with Evan Atherton, a senior research engineer for the Autodesk Robotics Lab, who is a developer of the Maya plugin Mimic. Mimic is an open-source plugin for Autodesk Maya that provides an animation-based workflow for programming industrial robots. We experimented with this platform as the interface between Maya and the KUKA in our production pipeline and tested this system on a small miniature set shoot.

5.9 Research questions

In Case Study 2, I was interested in testing our hybrid style animation production techniques under conditions closer to an industry-scale production environment, with multiple sets, locations and characters. Our aim for this research and development phase was to develop an easier and more fluid production pipeline from designing shots on a miniature set, recreating them in Maya, publishing them to the KUKA motion control robot arm to filming on the miniature set, and translating this data through to the compositing process.

The team's objectives in the research and development phase of the *Jarli* project were to:

- design and key frame animate camera motion paths in Maya and publish them to the KUKA motion control arm, while allowing quick and easy creative changes to this camera move using the animation tools native to Maya

- develop a consistent and simple way to locate the position and orientation of miniature sets relative to the tool head (the film back of the camera), thereby allowing precise alignment of the virtual camera and sets with their real-world counterparts

- pre-visualise animation blocking on a miniature on the shoot day

- optimise a robot arm or motion control system that was not limited by the reach of the arm and allowed us to shoot on larger scale miniatures

- develop a camera move system that enabled the use of the generated motion paths and did not simply push the camera solve process further down the production pipeline to a match moving team.

5.10 Equipment and hardware components

For this research phase of Case Study 2, we had access to a KUKA KR 10—a smaller but very stable and accurate robot arm. It was necessary to install KUKA.ready2_animate to publish Maya animation via Mimic to the KUKA robot, 'the KUKA.ready2_animate interface is based on time-based programming of the robot movement, and each individual axis value determines the robot position unambiguously at any moment. Ready2_animate allows the user to generate robot motion profiles with animation software such as Autodesk MAYA, then export this data to a Motion Path Table and transfer it to the robot controller'(kuka.com, 2022), then have the robot perform the desired motion profile.

For this testing phase, we filmed test shots on a Blackmagic URSA Mini, the same camera used to film Case Study 1. Art director Louis Pratt and I also prepared a rough, temporary miniature set as a test bed for this research phase (see Figure 5.8). This test set was an early version of a set we were preparing for the final animation production. We captured a point cloud scan of this set using an Artec Leo 3D handheld structured light scanner (Artec, Luxembourg, https://www.artec3d.com/portable-3d-scanners/). Figure 5.9 shows the test miniature set scan.

Figure 5.8: Artec Leo scanning a temporary test miniature set.

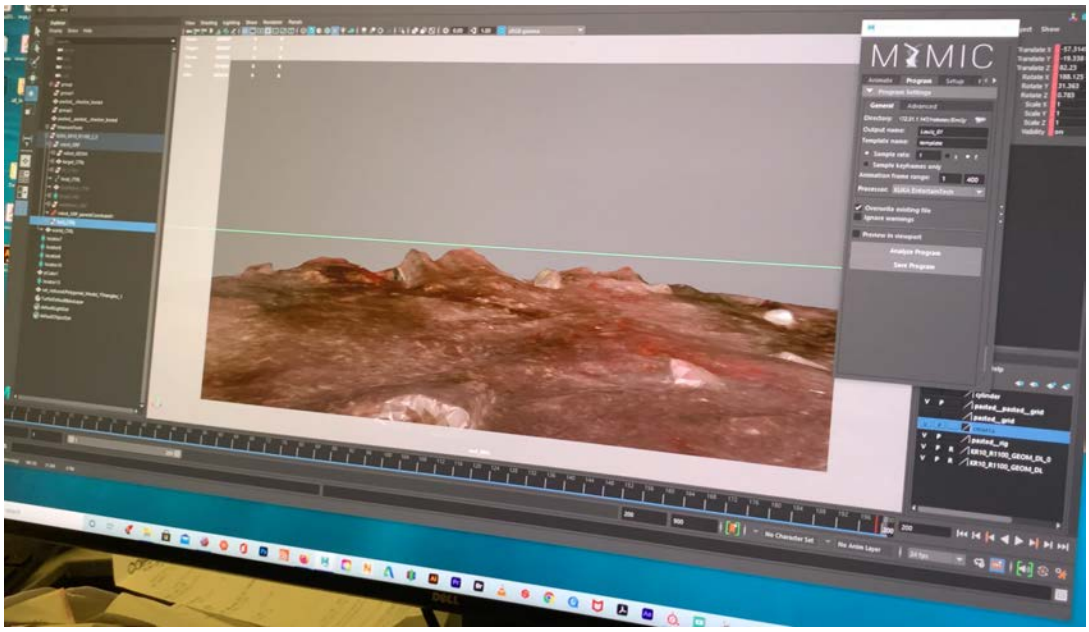


Figure 5.9: Test miniature set scan.

5.10.1 Aligning the virtual workspace

In the early stage of research and development, the team set out to align the scanned version of the set in 3D space as closely as possible to the physical camera attached to the KUKA. This goal initiated conversations about how this might assist the post-shoot tracking and camera match moving process. How close did we need the two workspaces to assist this post-production process? Did the alignment improve the tracking sufficiently to remove the need for shots to be manually tracked post-shoot?

I invited VFX artist Andreas Wanda to visit our research space for two days. He applied his perspective and expertise to setting and aligning our camera as close as was practically possible to an accurate, replicable set of parameters for us to match in our digital space and vice versa.

For this testing phase of the case study, we wanted to improve the method by which we aligned the digital workspace in Maya and our real-world workspace in the studio as closely as possible. We spent the first day measuring and ensuring all parameters, including position, offset and orientation, were the same in both worlds. While this seemed a simple way to start our tests, it proved quite difficult and time-consuming.

The team set out to answer the following questions:

– How close could we align the digital and physical two workspaces before recording a camera move?

– How practical was this alignment from a production perspective, given that there would be a tracking and match moving process post-shoot?

We used an Artec Leo structured light scanner to capture a digital scan of our miniature set and loaded it into a Maya scene. We then used Mimic to load an accurate 3D model of the KUKA KR 10 robot arm into the same scene.

Establishing the correct position and offset of our virtual camera was the most time-consuming. We measured the position of the Blackmagic camera to the tool head of the KUKA robot and applied the same offset to our virtual camera (see Figure 5.10). There was much back and forth getting this data correct and testing it against overlaid footage.

To align the two cameras, we needed:

– the position and offset of the Blackmagic camera relative to the tool head on the robot

– the position and offset of the film back on the Blackmagic camera

– the focal length and distortion of each lens used

– lens grid distortion data, obtained by shooting a VFX lens grid and applying this information to our virtual camera set-up.

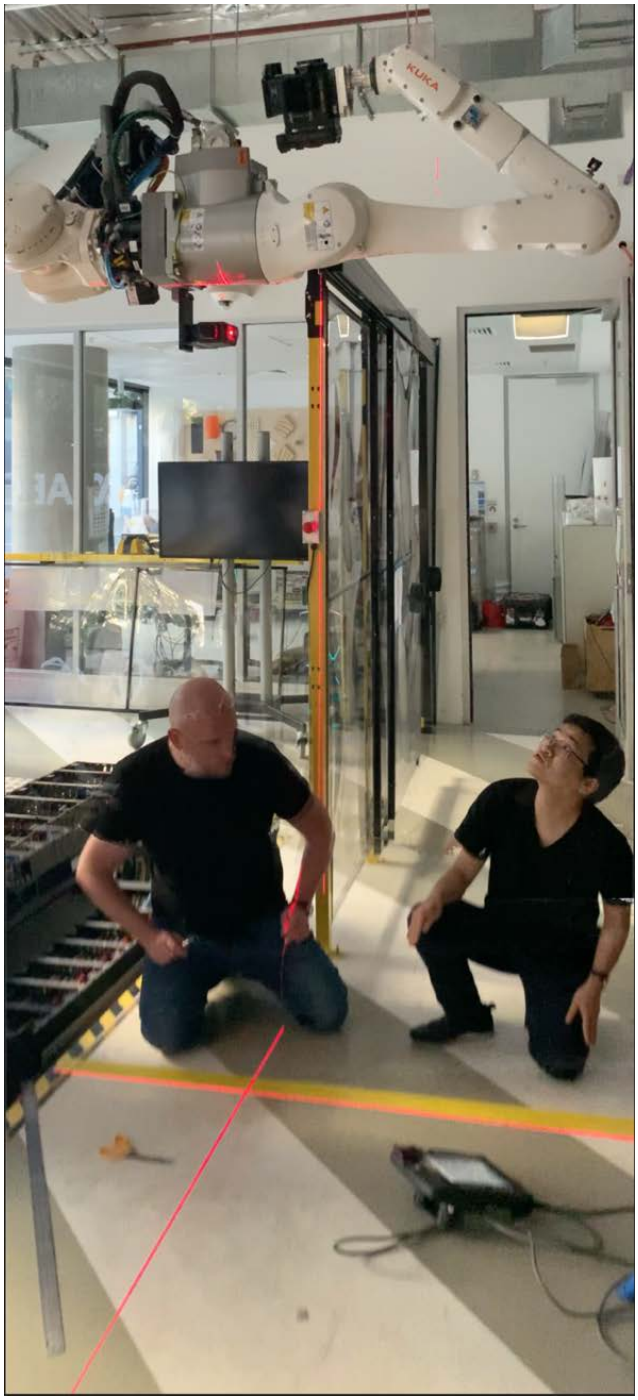


Figure 5.10: Aligning the virtual workspace.

At this research stage, it became apparent that much of this information would not be fully determined until the miniature set shoot was complete. Time pressure meant we needed to transition from testing to miniature set shoot production preparation. The complexity of the process was more than anticipated, and the team thought the real test for the accuracy and efficiency of our experiments would become clear when digital animation plates were composited with miniature set footage. Therefore, we decided to align as close as was practically possible using a series of tests.

5.10.2 Aligning the real-world workspace

It was important to align the real-world robot and camera to each other and our miniature set workspace to align our two workspaces with a practical degree of accuracy from a production point of view. That would let us make accurate and useful measurements that could be translated into our virtual workspace. The team used builders' laser tools to align the camera onto the robot and ensure it was correctly aligned onto its housing. We also ensured that the housing sat level on the studio's concrete floor, considering any irregularities in the studio floor.

To obtain feedback on the accuracy of this alignment, we tested rough camera shots on the temporary test set. These test shots were keyframe animated in Maya, then published from Maya to the robot via Mimic. We filmed the shot, made a play blast of the same shot in Maya and overlaid the two in Adobe Premiere Pro. At this stage, we were concerned with the inaccuracy between the two workspaces.

The results of aligning the two workspaces were mixed. It became apparent that many more parameters and factors could cause inaccuracy than previously considered. The smallest amount of unevenness on the studio floor, an almost imperceptible rotation of the robot arm on its housing or other almost imperceptible orientation factors produced a visible offset between the two images.

Straightening and aligning the two workspaces was time-consuming, and the research team stopped to reflect on the direction the process was heading. Measuring, straightening and calibrating every parameter from the studio floor levelness to the robot housing level, the robot arm to its trolly, the camera fitting on the robot arm tool head, and the Blackmagic camera's film back offset and the lens distortion data were to bring our two workspaces, the physical miniature set to the robot and the virtual set scan, 'close enough' to the Maya camera to practically design camera moves on the miniature set. We agreed that we had aligned the two worlds as close as was practical. Any further refinement was unnecessary, keeping two of our research objectives in mind:

– **We wanted a more creatively flexible camera move system on shoot day.** This creative flexibility is needed to enable the on-set shooting team to change and experiment with the position of sets relative to camera, and for the camera move team to adapt and adjust to these changes without delaying shooting prohibitively. Any creative flexibility gained would be eroded if the shoot team had to align every physical parameter between set and camera every time we moved a miniature set, which would be frequently given the scale and scope of the *Jarli* production.

– **We did not want to push the camera solve problem down the production pipeline to the match moving team**.
Due to this project's experimental nature within the context of production, we experienced successes and failures. The camera solve problem was pushed down the production pipeline to the match moving team (see section 5.26). Although we did not have clear success in this area, we achieved significant insights into how this could be improved in a future case study.

Once we agreed on a pragmatic degree of calibration between our two workspaces, the team conducted simple tests to see how well our system worked.

5.10.3 Test 1: Star foot registration tool

For our first test method to align the two production elements, art director Louis Pratt fabricated a system for a simple, reliable and repeatable method of registering the position and orientation of any miniature set to the robot arm housing.

Louis laser cut a plywood sheet and attached it to the trolly with a negative star shape cut from the centre of its base. A second piece of plywood with a positive star shape extruding from the underside was attached to the test miniature set. The Star Foot miniature set registration tool, shown in Figure 5.11, had eight evenly distributed points, allowing the miniature set to be oriented at 8-degree rotation points and even 45-degree. The same CAD file used to laser cut the Star Foot tool was loaded into Maya to replicate the same positions and orientations in our digital workspace.

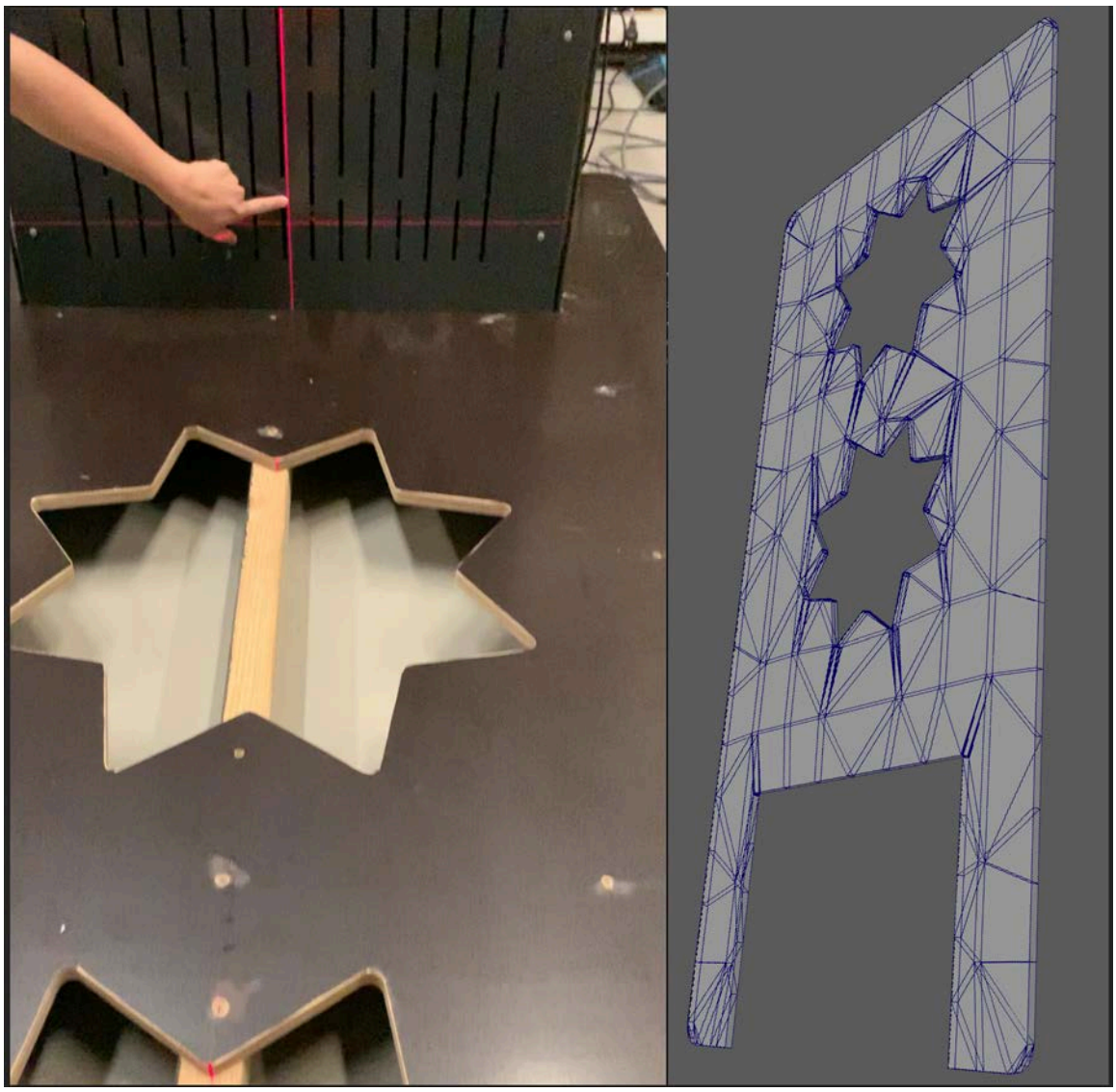


Figure 5.11: The physical and digital models of Star Foot miniature set registration sheet used for CNC cutting the physical piece for testing.

This system was designed as a simple, analogue way of registering a known point at the base of each set to a known position in x, y, and z rotation relative to the robot arm. It was assumed that the animation shot list might be rotated each set for different camera angles and require knowing the incremental degrees of rotation exactly without having to remeasure each time.

We tested this system using test sets on three different scales and quickly discovered the star foot registration bed was somewhat inadequate, although it provided a known rotation value. Due to its size and weight and the necessity to lock it to the robot dolly in a specific position, the star foot system limited the position of the set relative to the robot inhibiting shot composition. We also found that the set's height was too low, and the star foot system did not easily allow for easy

adjustment of the set's height for optimal robot arm reach. The system would create more difficulties than it was worth in an on-set environment.

This test was a great idea for smaller sets at a tabletop scale and height; for example, a production at a scale of miniature sets such as for the commercial *The Invention of Together*, discussed in the literature review (Section 2.13). The *Jarli* production would operate at a bigger scale; therefore, we needed the miniature set to be free-standing and not attached to the robot. Although the Star Foot registration tool worked quite well in the test phase, it was abandoned on the production shoot of *Jarli* due to the scale of the sets and because many of the landscapes were in multiple large pieces. The Star Foot seemed like a good idea when we began to calibrate miniature sets to the robot but it became unwieldly and cumbersome in a shooting environment requiring as much flexibility as possible in arranging sets and lights in the shooting workspace.

5.10.4 Test 2: Etched floor grid system.

In Test 2, we repurposed the base of the Star Foot tool as a visual reference for a simpler approach to alignment. We set up a simple camera move in Maya, published it to the KUKA and filmed it pointing down at the star shape. This established vector shape (the same star shape CNC cut from the CAD file) was positioned in the same place and locked at a known position to the robot housing. Then we cross-referenced this position using laser measurement tools to align the set in the digital workspace (shown in Figure 5.12). We added an etched grid system to this vector shape and replicated this grid in the digital version. Both the grid and the star shape were used as registration images. This system was a quicker and easier way to align the two workspaces and was more flexible when swapping out different miniature sets of different shapes and scales.

Figure 5.12: VFX artist Andres Wanda and the research team using a laser tool to align the camera and robot set-up.

The team captured the two video files, a Maya play blast and video footage from our camera on the robot, and overlaid them in Adobe Premiere Pro. The initial results were quite close; we tweaked the position of the physical star shape in the studio and filmed several other camera moves to detect any obvious discrepancies between the two positions. The results were a little closer and took less time.

5.10.5 Test 3: Lens grid as registration tool

We had input from VFX artist Andreas Wanda for Test 3. We assembled an A2-sized (420 × 594 mm) lens grid printout with the centre of the grid at 90° to the floor and the grid positioned approximately 4 m from the front side of the robot housing. The captured lens distortion data was applied to our Maya scene to determine if it would affect the discrepancies between our two images.

Once the lens distortion values were applied to the Maya camera, we attempted to align the two work spaces by shooting footage of a standard VFX lens grid. This lens grid was applied at the same distance in Maya until our camera play blasts from Maya matched the video footage when one was overlaid on the other in an Adobe Premiere Pro edit timeline.

The two images still did not align as closely as we wanted. The team reflected on the results of these different methods to achieve closer alignment. We realised that we had perhaps approached the problem from the wrong angle. No matter which system we tried, there would always be a small degree of misalignment between the two images. A real-world workspace would always have a degree of imperfection compared to the mathematical accuracy of a 3D digital workspace, particularly considering the many imperfections between two objects in the real world.

Therefore, we decided to move on from the alignment process and test our registration process and the accuracy of alignment in a miniature set shoot production environment. We felt the alignment was as close as possible, so we decided to simulate a miniature shoot on one of our unfinished miniatures and observe how the system worked.

5.10.6 Test 4: Test shoot

For Test 4, we used two of the miniature sets that were being fabricated for the *Jarli* production. We scanned the sets, brought the scans into Maya and designed a simple camera move on the sets. We applied some simple geometric shapes to the Maya scene, positioning them with simple keyframe animation so that one of the shapes traced the topographical contours of one of the sets. We then ran a simple multiple-axis camera move from point A to point B, following the movement of this keyframed shape.

To quickly and efficiently align our two workspaces, we mounted a laser measuring tool on the robot tool head and established the position of the miniature set to the same degree of accuracy. Then we positioned the camera in Maya at point A of the camera move, sent this data to the robot, and then physically nudged the miniature set into the final position until we saw something very similar to the same image crop in both images. Then we moved the Maya camera and the KUKA to point B and repeated the task. This method quickly produced the same result as the earlier tests but took less time on the floor measuring every angle and corner with laser measurement tools.

In this test, the two overlaid images were very closely aligned. In our earlier tests, we discovered where the obvious calibration, position and orientation issues would be and were quickly able to eliminate unnecessarily detailed calibration techniques in Test 4. The tests of different methods of aligning the two workspaces provided a better perspective on which part of the alignment process was and was not worth focusing on.

The accuracy of Test 4 depended on accurate camera lens, film back and lens grid data, all of which are an industry-standard VFX data gathering process (Stump 2021). We ran test shots and camera moves on the set using this system. One of the most important things we learned was the limited reach of the KUKA KR 10 robot. We realised that our robot-mounted camera would need a lot more scope in the reach of the robot arm to shoot the shot sequences that I had begun to develop with the storyboard team.

For the last test shoot of the research and development phase of Case Study 2, the team simulated the first shot of the film in a desert landscape miniature set. The shot was a multi-axis shot following a small desert creature running close across the ground of a rocky landscape. The shot was a good test of the accuracy of miniature set to digital animation because of the camera's proximity to the ground.

I had chosen this shot because the proximity of the camera (attached to the robot) to the ground plane of a miniature set had previously been problematic when using the hybrid approach to animation production. These shots are less of a concern in an all-digital animation pipeline where the camera department can put the camera wherever they want and avoid collisions more easily.

We tried to conduct this final test to match how a shot would be filmed on the shoot day, with a few LED lights to add aesthetic lighting (see Figure 5.13). After using Maya to design a camera move similar to the early storyboard ideas, we used paddle pop sticks as markers and practiced many times running the same shot on the Blackmagic via Mimic to see how well it worked on the set.

Figure 5.13: The first camera moves designed to run on a test set using the Mimic pipeline.

Our simpler visual alignment system from earlier tests brought the same degree of accuracy in both shots with very little time spent aligning the two workspaces. The test was successful; the only obvious limitation was the KR 10's reach. However, we were now limited by the camera moves we designed in Maya, which produced a frustrating number of errors when we tried to publish them to the KUKA. The arm could not perform what we though were quite simple moves while tethered to its housing bench. This was due to limitations in the robot arm's reach and its inability to recreate certain digital moves due to real-world obstruction in how its multiple axis sections obstructed each other in a tight space.

5.10.7 Double robots

To overcome the limitations of the reach of the Blackmagic camera mounted on the KUKA KR 10, robot technician Tran Dang suggested mounting this smaller robot arm as a tool head on the end of the bigger KUKA KR 120 previously used on *Jasper* (see Figure 5.14).

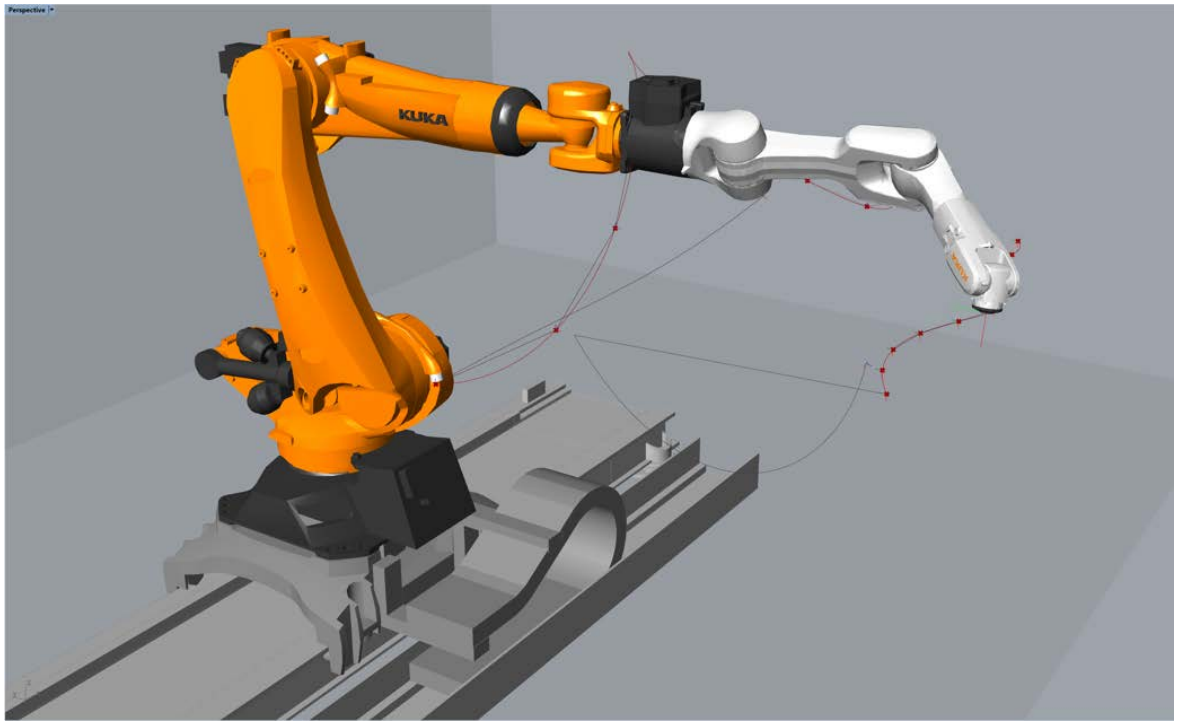


Figure 5.14: The UTS Advanced Fabrication Lab team attached the smaller KUKA as a tool set on the larger KUKA tool head for better reach.

After simulating this system in Mimic first, we realised that it could give the animation production much more scope with camera reach and range. Using the known position and location information of the KR 120 in the Advanced Fabrication Lab, where we intended to shoot, could provide a better approach to the shoot. This information could help us locate the smaller robot and the shooting camera using these known co-ordinates within the Advanced Fabrication Lab. However, we could not test this double robot system in the smaller research and development studio (see Section 5.18 regarding the shot design for *Jarli*).

5.10.8 Summary of test phase

Several valuable research outcomes from the test phase helped us develop our production pipeline and prepare for the more in-depth two-week miniature set shoot a month later. Two outcomes were:

– We established a simple system for aligning our digital and real-world workspaces that did not involve a long measuring, aligning and calibrating process. A and B camera positions were set up, and the miniature sets were aligned visually. This system was faster and achieved the same result—it was the process we adopted on the miniature shoot. This system supported our objective of making the on-set process faster, easier and more creatively adaptable and flexible. This approach had implications for how we conducted the shoot; it allowed for a better flow of crew creativity on-set, which led to better storytelling.

– A new system of coupling two robots was developed that enabled us to shoot with the required range and reach for the scale on the miniature sets being designed. This system would enable the use of a Maya to Mimic pathway on the smaller robot while using the big robot as a location mechanism by taking advantage of the ease by which the robot technical team could locate the robot within the shooting space.

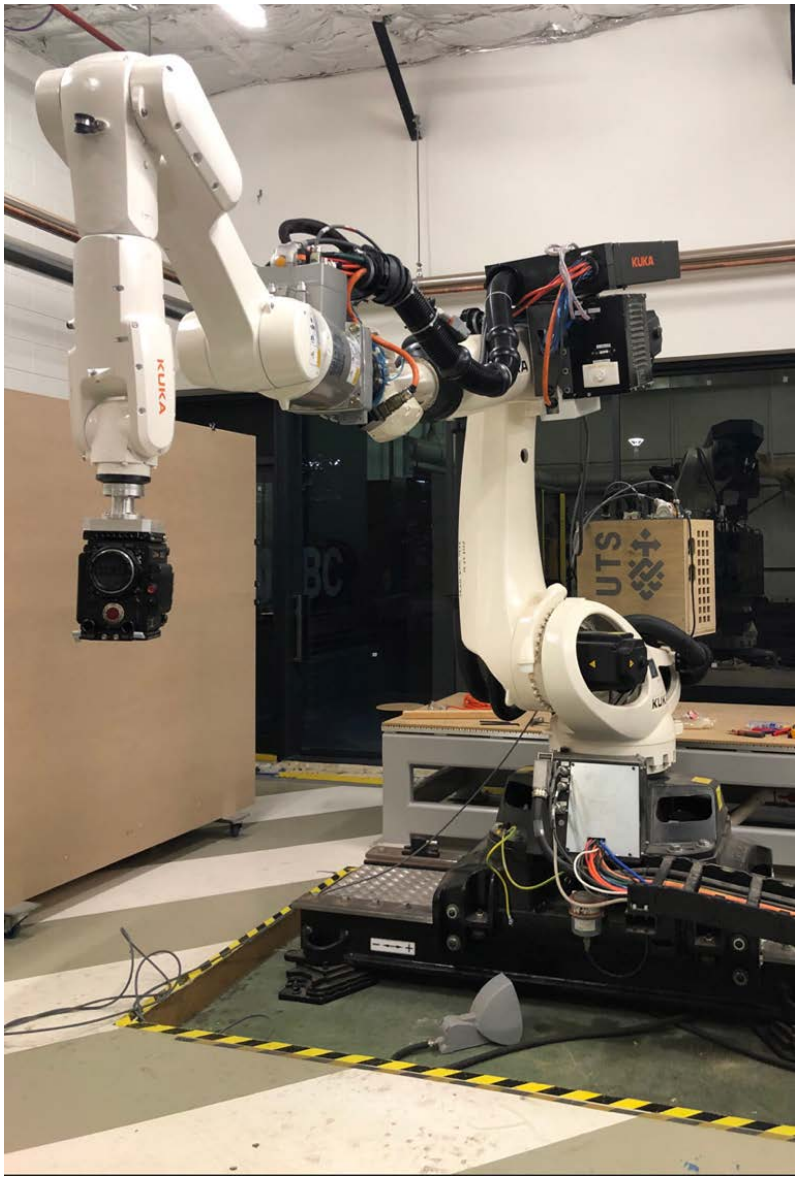


Figure 5.15: The double robot set up.

5.11 Research and development conclusions

The project's research and development phase allowed the team to refine working with our new production pipeline from Maya to Mimic to KUKA robot. This process was nuanced, and we relied on frequent video conferencing conversations with Autodesk engineer Evan Atherton in California for support. We also relied on support from KUKA Australia. This phase allowed us to make all obvious errors and smooth out our pipeline from Maya to the KUKA via the Mimic plugin.

The team reflected on the best way to approach the miniature set shoot for the next stage of production, including a method for using a laser mounted on the robot arm. We discussed using the video data from the robot-mounted camera as photogrammetry data in a process to potentially provide a more accurate position and orientation of the miniature relative to the robot without needing to scan the miniature set before we shot. Using the camera image as a locator, this data could prove more accurate for establishing data showing the film back of the camera. The research team concluded:

– no matter how much time and effort we spent calibrating the robot and camera in the studio space, there would always be a small yet significant degree of difference from a compositing perspective between the digital camera move and the real camera move that warranted a camera solving process

– this hybrid production style would work very well as a moving shot design system—enabling us to design and realise moving camera set-ups quite quickly and refine these shots on set. However, the method for aligning these camera shots with the rest of the animation production team needed improving in future studies.

5.12 Collaborations with Chantelle Murray and Like a Photon Creative

Once the smaller research and development team had wrapped up, the animation production began the next creative development phase. The scope and scale of *Jarli* meant that the available UTS facilities would be limited. We had already begun an industry collaboration with Brisbane-based animation production company Like a Photon Creative. Producer Ryan Greaves, who had helped facilitate the writers' room, came on board to start full-scale production.

Director Chantelle Murray also came on board to co-direct the animation production. She focused on casting, and we began working together on a series of remote sessions to record our actor's vocal performances. Because the *Jarli* story dealt with Indigenous stories and actors from Australia's First Nations community, Chantelle also led the directing of the vocal performance. I attended the sessions and gave some notes but took a back seat to directing.

5.13 Concept development and production design

Concept art and production design began early in the development process of *Jarli*. The film went into production during COVID-19 lockdowns, so I experienced a more isolated process of drawing and designing. This situation was unlike the development process with *Jasper*, during which fellow designer Mai Pham and I printed out concept artwork and stuck it up on three walls of the UTS studio space where we worked. On *Jasper,* we found that this daily interaction helped the design process. We had unstructured conversations with different people daily about the designs and noted how people responded to concept images as they walked past the studio space.

Many creative roles in the film industry will likely rely increasingly on remote artist workspaces. Therefore, *Jarli* was an interesting training ground for this type of production. It is also one of the many ways the *Jarli* creative experience was affected by much of the filmmaking processes taking place via online communication tools.

5.13.1 Concept art

The *Jarli* production was divided into two different approaches to animation production. Using a combination of story logic and production logic, we divided the project between sequences that would be produced using an all-digital animation approach and those that would be produced using the hybrid production style relevant to this research project. All scenes in the desert landscape of Jarli's home were produced using the hybrid production style, whereas all the flying and space scenes were done as a completely digital production process.

Concept artwork was developed by me and Like A Photon Creative designer Nathan Geppert in Brisbane. Figure 5.16 shows early character designs for *Jarli*. Using *Jasper* as a starting point and a proof of concept helped our communication, and we established a design aesthetic that suited the miniature set production process without difficulty.

Figure 5.16: Early character designs for Jarli.

Nathan Geppert designed the three vehicles in the short film, including Jarli's home-engineered bike plane, shown in Figure 5.17. This process worked very smoothly, and I feel it adapts very well to the miniature set and 3D animation hybrid process. The shots of the bike plane riding down the mountain are probably the most successful of the animation project.

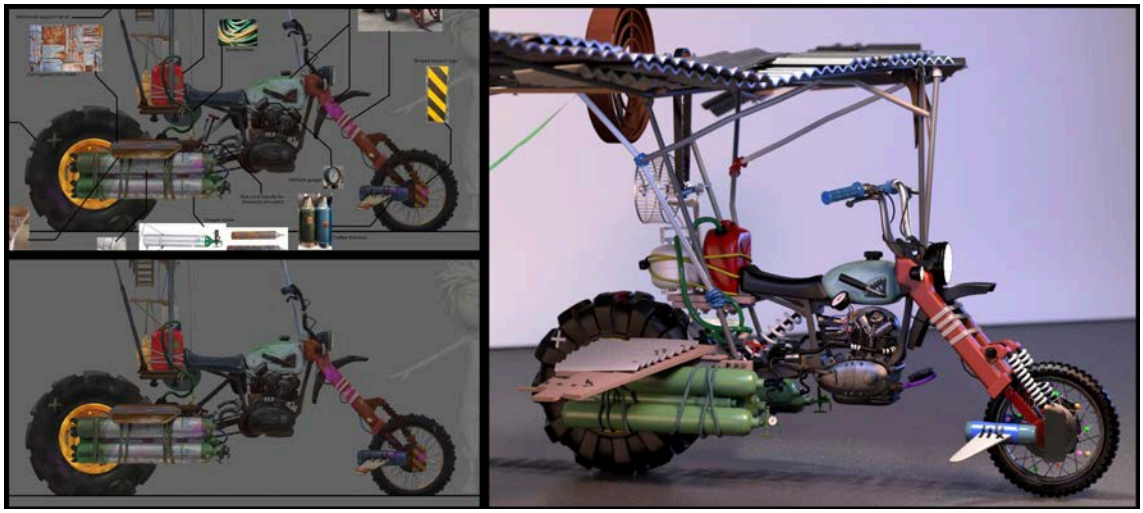


Figure 5.17: Bike plane designs by Nathan Geppert.

5.14 Miniature set production design

The miniature set production design was conducted as a collaborative process between Chantelle Murray and me, working with art director Louis Pratt at art studio facilities in Marrickville, in Sydney's Inner West. We drew from the various passes of storyboards to establish the shape and size of the sets.

With *Jarli*, I was interested in increasing the scope of the exterior desert shots. So we pushed this design process to the edge of what was possible within the studio space available. Co-director Chantelle Murray and I researched images and sent each other many visual references to reflect the look of outback Australia. We discussed the types of landscapes we wanted to reference from northern Western Australia and the specific design elements we could translate into a miniature production design process. We established a colour palette of red earth, yellow grasses, white gum trees and blue skies and the shapes of the hills and the cliffs.

The animation story takes Jarli from above high canyon country (see Figure 5.18), down into a ravine and then out into a wide-open desert country with big skies. To achieve these three landscape story beats in miniature set landscape, art director Louis Pratt and I set up a polystyrene carving process so that, rather than carve the sets to match a drawing, I drew with the hot wire polystyrene cutting tools and designed the sets in a more organic, experimental way. I had done something similar on *A Cautionary Tail.* I had always received positive feedback from audiences on the landscapes in these scenes and wanted to try and push this carving drawing in polystyrene look further.

Figure 5.18: Desert canyon set at the studio in Marrickville, Sydney.

Art director Louis Pratt designed customised polystyrene cutting tools without a fixed frame. The tools used two handles with different lengths of electrically charged wire running between them. This design allowed much deeper cuts into the polystyrene blocks and for two people to cut in multiple angles at once. The emerging carved cliff shapes created interesting negative offcuts. We used these offcuts as positive shapes when designing the moon exterior (see Figure 5.19).

Figure 5.19: Moon surface miniature set.

The interior of Jarli's house was also designed back and forth with Chantelle, who drew references from her childhood home. Chantelle and I worked on a design for the interior that took visual motifs from her references (see Figure 5.20). We designed the art direction of the house using these images.

Figure 5.20: Jarli's house interior set.

I used 3D modelling tools in Maya to quickly establish the scale and shape of each set. This helped jump the creative process forward and allowed art director Louis Pratt to source materials for each set. It was also a useful way to obtain an early version of the dimensions of each miniature on which we could design camera moves using Mimic.

5.15 Miniature sets build

One of the most visually appealing features of this hybrid animation production style is the production design qualities the miniature brings in front of the camera and to the final shot. However, building the sets with a finite time and budget and getting them in front of the camera is one of the more challenging aspects of this production process.

With *Jasper*, I tried to contain the production style, to focus on and refine the visual quality level and the production values. With *Jarli*, I wanted to let the production style expand into something that more closely resembled a film industry scale production, even if just within our 7-minute timeline. Consequently, sets for *Jarli* were on a scale much bigger than anything I had attempted previously. Figures 5.21 and 5.22 show the miniature sets under construction, and Figure 5.23 shows the hanger exterior. Although I used many more sets on *A Cautionary Tail*, in terms of quantity, the sets were mostly much smaller and easier to work with and had virtually no moving cameras.

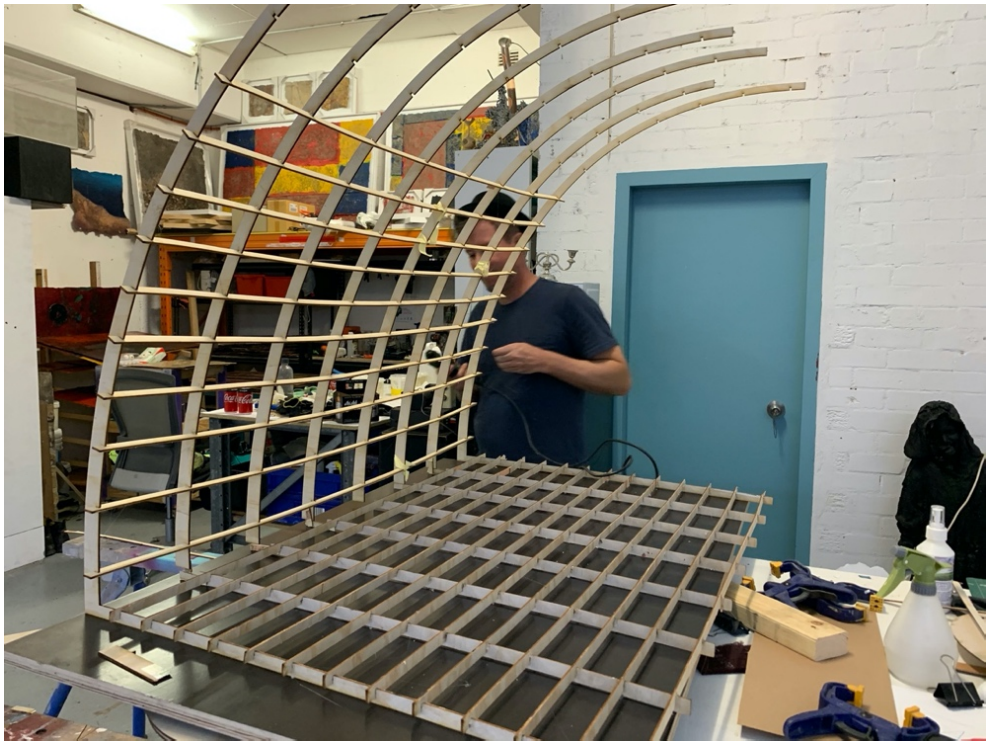


Figure 5.21: The aircraft hangar and desert tree miniature sets under construction.

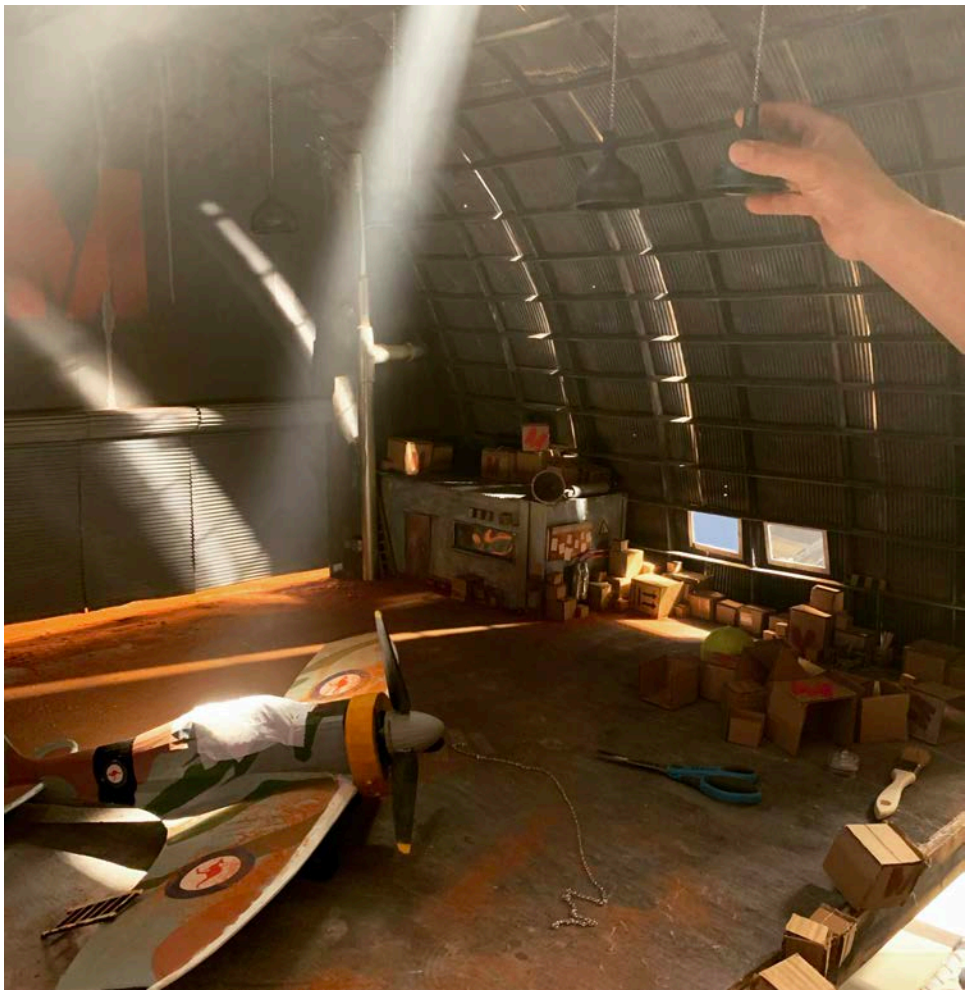


Figure 5.22: The aircraft hangar miniature sets under construction.

Figure 5.23: The hangar exterior set detail.

The art director and I felt it was important not to cross the line where we would push the *Jarli* production too far into an overreach of resources. This decision meant not pushing the research and development aims of the case study. We did not want to play it too safe but did not want to create a disaster. After a series of discussions about where this line was on the *Jarli* production, it was apparent that the scale of miniatures we were aiming for would push us very close to that edge.

We filled the studio space we were working in and had to install shelving systems so we could walk around the studio. The other major challenge of working with miniatures is logistical. Moving the miniatures out of the studio, onto a truck, and in front of the camera within the pressures of a shooting schedule sounds simple but is always difficult. This hybrid production style would benefit greatly from a movie studio facility where sound stages have a production design workshop attached.

5.16 Character design and 3D modelling

The *Jarli* screenplay required the design, modelling and rigging of seven different characters, including a small, native marsupial. Like the set design process, we worked on a bigger scale than for Case Study 1. Case Study 2 allowed the opportunity to learn from past problems with character design and build on the aesthetic style I had developed working with the same character modeller over previous projects.

Several story ideas developed in the writers' room had Jarli and Jasper meet in the same story worlds. If we were to develop these story ideas in future projects, the plan was to make Jasper about seven or eight years older than Jarli. The characters in *Jarli* had to seem as though they could all inhabit the same production style as the first project and the same story world as *Jasper*.

Chantelle was very involved in the designs at this stage of the creative process. She was particularly instrumental in the character design process for Jarli and Cuzzo and made significant changes to Jarli's face. Her clear ideas gave Jarli's design a more heroic aspect and her expression a distinctly Australian feel. Jarli needed to have cross-cultural appeal and feel like a heroic figure from a remote and geographically distinct corner of the world that had not given rise to many similar story characters. She is a technology genius, an adventurer with heroic qualities and a quirky, shy, stubborn kid from the bush.

Jarli's cousin, Cuzzo, was partly based on Jon, Andrew and Chantelle's experience of an archetypal Indigenous family cousin character. It was interesting to see the cultural crossover between this character and the kids I had grown up with in the bush outside Perth. I felt that he had to have a distinctly Western Australian energy about him. For me, he needed to wear the singlet, the stubbies, the lurid green thongs on his feet and the mullet that added up to something the key creatives could all identify with. The team had lots of fun with this character, and he seemed to write himself onto the pages of the script. Consequently, his design came to life very easily.

I worked with the same character modeller from previous projects to model the characters. We have a design style that has developed over several projects in tandem with the development of this hybrid production process. The character design style is a very important way to make this production style work. The characters need to have a tangible quality and that they naturally inhabit the miniature story world—not exactly like stop motion puppets but to a degree in that design direction.

I was particularly happy with how the character design to character modelling process had gone on *Jasper.* Her design had been one of the successful elements of that project, and the 3D model had translated well into a physical 3D print. For Case Study 2, I wanted to take some of the design aesthetics previously developed and push the style further, particularly the hair and clothing styles. However, we decided not to use hair simulations again, principally as a creative choice but also as a production parameter. In future projects using this hybrid style of production, I would be interested in applying clothing simulations to characters with an 'animated on twos' frame rate feel. I think this will add another interesting dimension to the look of the production style.

Overall, the character design process went very well on *Jarli*. The only drawback, from my perspective, was the remote nature of working on some of the secondary characters, where creative communication was difficult. Character design is a part of the creative process where it is much more difficult to develop a constructive, productive conversation when working remotely from the modeller. The character modeller and I have developed a dialogue and communication system that involves me sketching and drawing on a tablet while she writes. As a character designer, I find that many subtleties of design are difficult to communicate remotely, and the advantage of face-to-face, back and forth communication is significant.

5.16.1 Storyboarding, animatic and pre-vis

There were three approaches to storyboarding, each bringing a different perspective to the shot design and storytelling processes. Most of the first pass of the short film storyboards was done as an isolated creative process in lockdown. During this time, I ran through the different shot ideas for the film and created rough sketches so we could begin planning the film and how sequences could play out shooting on miniatures.

The first pass involved a series of rough vector-based sketches that I converted into shot ideas in Adobe After Effects. This process took the form of an early animatic. Using After Effects as an animatic development tool was a quick and easy way

to explore ideas for how I wanted the camera to move in the shot and to see camera movement from the beginning. I want to develop this process in the future.

Having an early version of a camera gave a strong sense of timings and frame duration for each shot and approximate timing for the overall animation work. This first rough animatic became a useful way to communicate to other departments without unnecessary extra work or explanation about the intention of the shot. It allowed the remote teams to visually identify which areas of the image would be miniature and which would be a digital set extension.

The second round of storyboarding I put together used very simply modelled geometry in Maya as a pre-visualisation of the opening sequence where Jarli rides the bike plane off a desert hillside and into a canyon (see Figure 5.24). In this version, I colour-coded the miniature sets, the 3D animated characters and the digital set extensions to make it clear what the plan was for each. It was useful to see the whole opening sequence pre-visualised in a 3D work space at this point of the animation production. This version was useful for the research team as we could install a working model of the KUKA robot arm and run early versions of the camera moves in shots in the animatic timeline using Mimic.

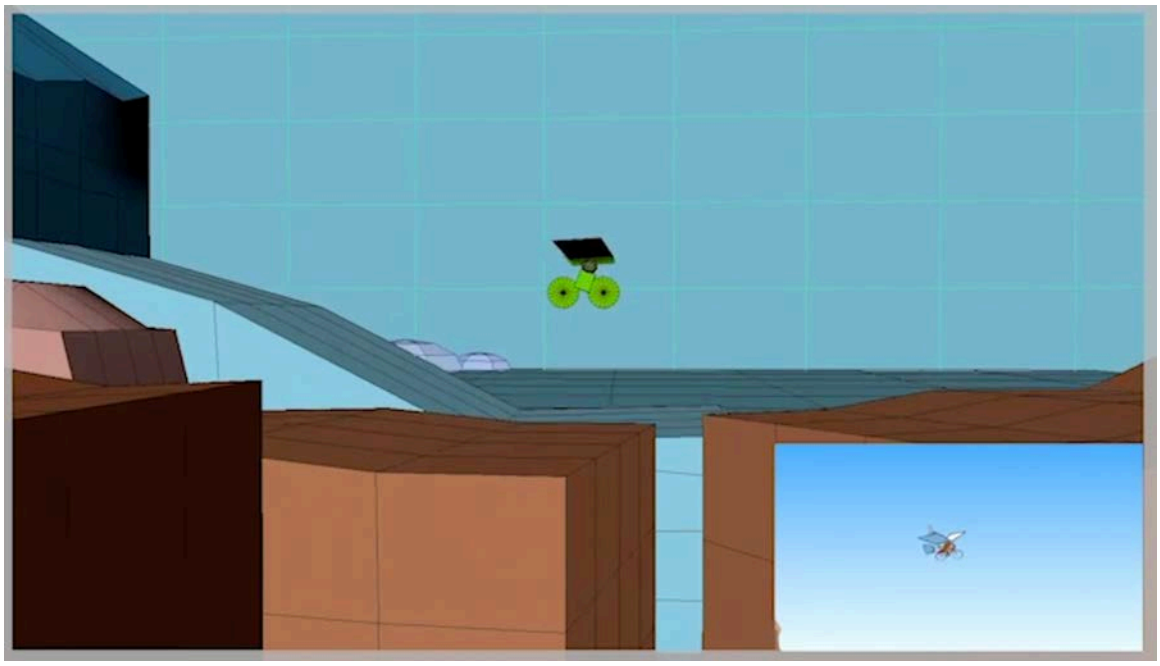


Figure 5.24: Maya shot blocking and storyboarding.

This Maya version became like an early layout pass. It helped art director Louis Pratt and me determine the scale of the sets we needed to build, so the scale and scope were right for the sequence. This was particularly so for the canyon fly-through sequence in which Louis and I needed to build the set at the same time as storyboarding. The set needed to be much bigger than any miniature set I had made before. I used this pre-visualisation for the early design shape of the individual mountain pieces. This process was more effective than a concept art design process. I used the Maya camera to sense the geography and topography of the scene before carving the pieces at the art studio.

Pre-visualising the canyon sequence in a Maya workspace was the only way to test how we could use the double robot set-up. No one knew how the camera would reach over the set and into the canyon until we tried it first using Mimic in Maya. Even with two robots, we were stretching the possibilities of the KUKA's reach (see Figure 5.25).

Figure 5.25: The canyon set was a narrow fit and would not have been achieved without the two robot system.

Consequently, I had already worked through a couple of versions of various animation sequences before Like A Photon Creative storyboard artist Paul Kassab came on board. This was an interesting process for me, as Paul brought a new perspective to the story. I already had much of the film blocked out in my head, and Paul brought a more 'Hollywood feature animation' aesthetic to the storyboards (see Figure 5.26). He developed a new and much-improved approach to many of the later sequences in the film, particularly the flying and space sequences. Working with Paul was very rewarding because we had to figure out how to tell the story incorporating the best of our ideas, and that was possible to execute shooting with the KUKA on a miniature set.

Figure 5.26: Storyboards by Paul Kassab.

5.17 Storyboard edit

Paul's final storyboards were cut into an animatic at Like A Photon Creative in Brisbane. The animatic was more than 10 minutes long; however, our production budget limited the animation timeline to seven minutes. Therefore, we had to make some difficult editing decisions, cut scenes and reduce the duration of the animation timeline.

Chantelle and I worked on a new version of the film, based on the first draft Like A Photon Creative animatic, which incorporated her story sensibilities, comedy timings and sense of timing and nuance. Stylistically, Chantelle and I wanted fewer quick cuts and more longer shots. We felt that this was vital to the story world and narrative style. We did not want a Hollywood cinema aesthetic style. We wanted to make a film where you could take a breath between moments of action and see the world. The intention was for the audience to have a more immersive experience from more frames on each image, giving them a moment to visually digest what they are viewing. I feel this editing style works better for this hybrid style of animation production. The audience needs a few more frames, beats, sometimes seconds, to visually digest and connect with the images they are watching, which is also true of stop motion movie making.

The next pass of the animatic edit had to feel connected to the same story world as the previous project. Therefore, we needed to keep the story worlds the same tonally and in a way that would work well in the miniature set hybrid production style.

5.18 Shot design

At this point in the production process, we had most of the miniature sets in various stages of construction at the studio in Marrickville, Sydney. Cinematographer Evan Papageorgiou came on board the shot design process to help design shots from a specific cinematographic perspective. Evan and I walked around the studio and blocked out shots similarly to how I had worked with Brycen Horne on *Jasper*. This time, we used the cinematography tool Artemis, a screen-based application or interface that allows the user to frame an image through a phone or tablet, make lens choices, frame compositions and record photographic data (see Figure 5.27). These blocking and framing sessions were vital to the miniature set detailing process. There was considerable canyon terrain to detail, so knowing where the camera would frame shots and what would appear within the frame helped reduce our art direction time and resource use.

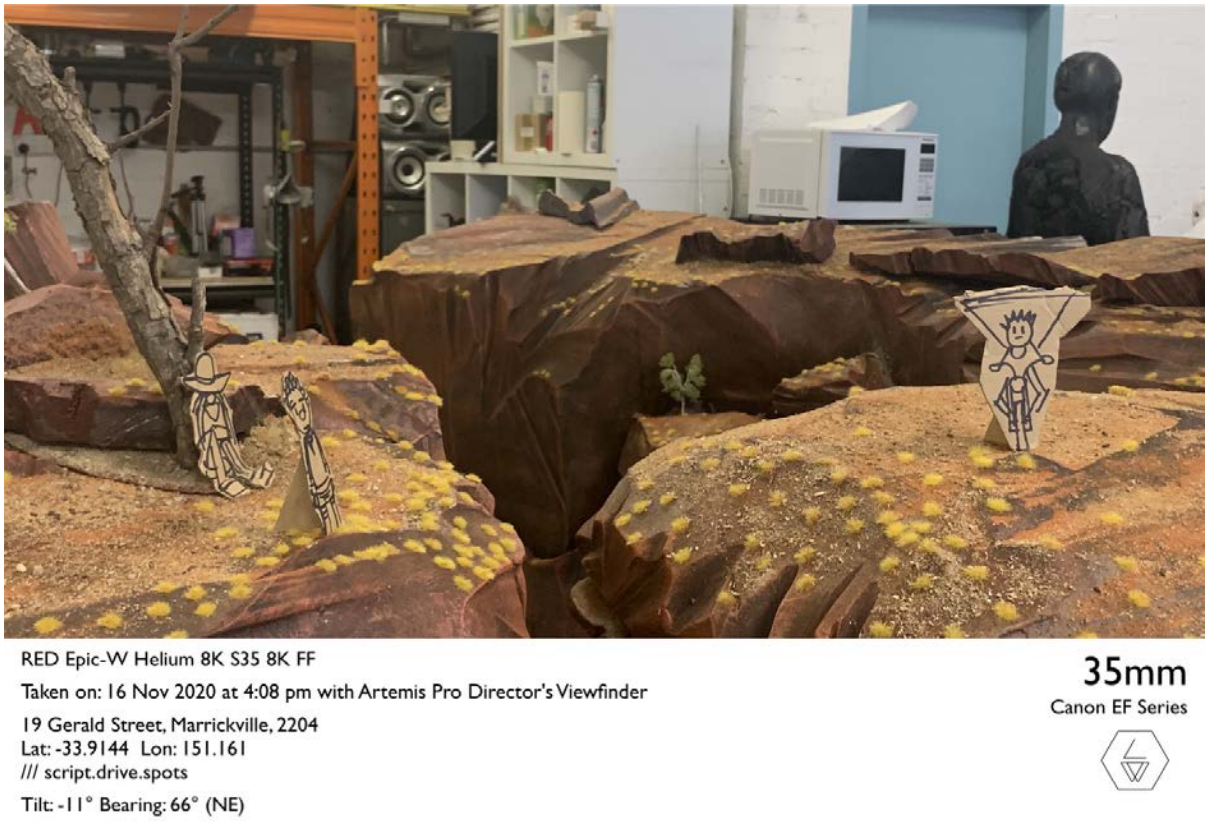
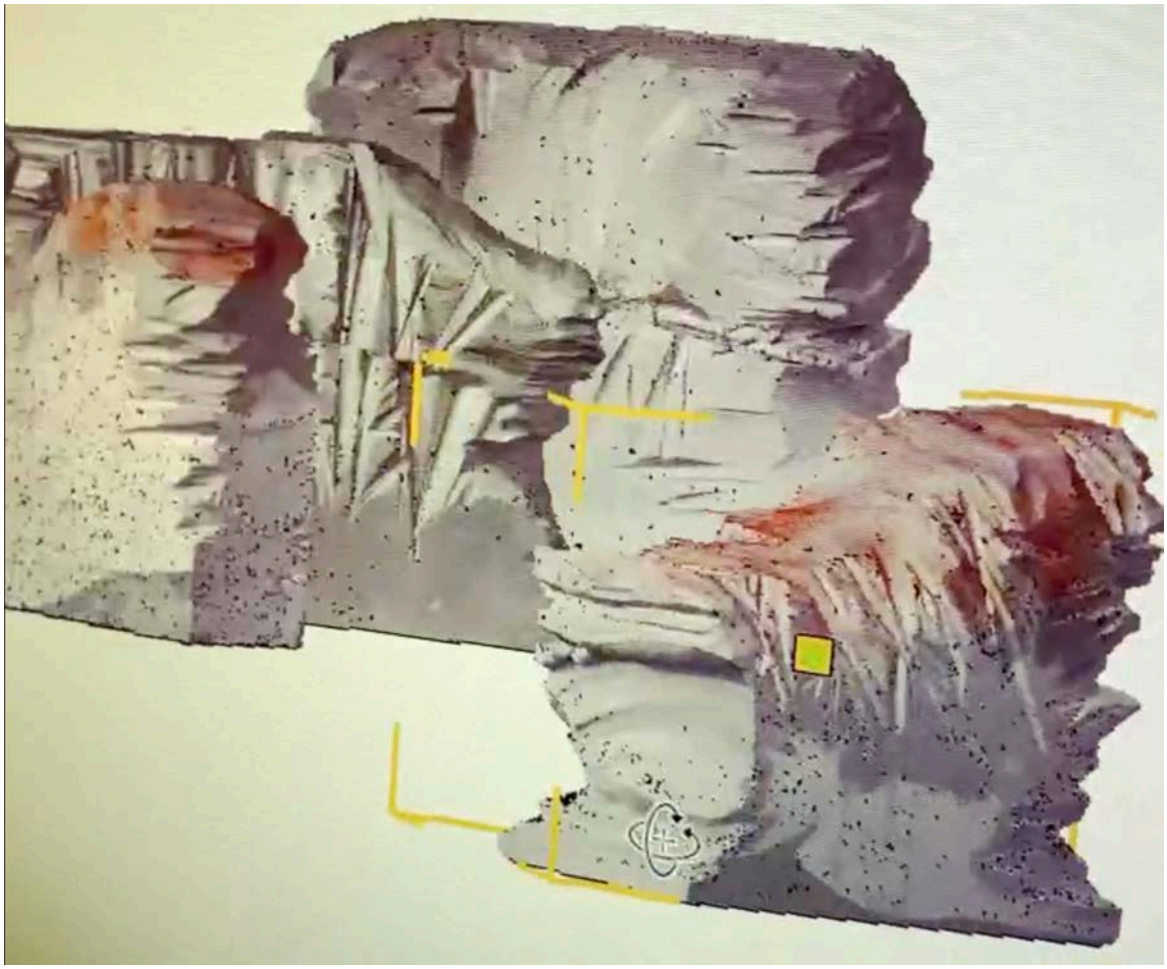


Figure 5.27: A frame from cinematography tool Artemis showing camera and lens data.

Evan and I began filming video references with Artemis. Art director Louis Pratt scanned the latest versions of the miniature sets, compressed the scan data and added our Mimic robot set-up. We sent these packages to the team at Like A Photon Creative.

The Brisbane team received point cloud scans (see Figure 5.28), video files of miniature sets and live walk-throughs from me over Zoom as a reference point for how each shot would be blocked on the miniature set. Understandably, sometimes it was unclear to them how these references translated into the storyboard. This stage was an interesting turning point in the pipeline of this hybrid style of animation production.

From a directorial perspective, I was wary of being locked into creative choices at a very early stage of the story development. The Brisbane team at Like A Photon Creative needed clarity because they wanted to assemble a layout pass of the entire animation so their animation team could continue working. At this stage, I needed more creative development. Consequently, some shot designs and timings were pushed further down the production process and into the miniature set shooting days.



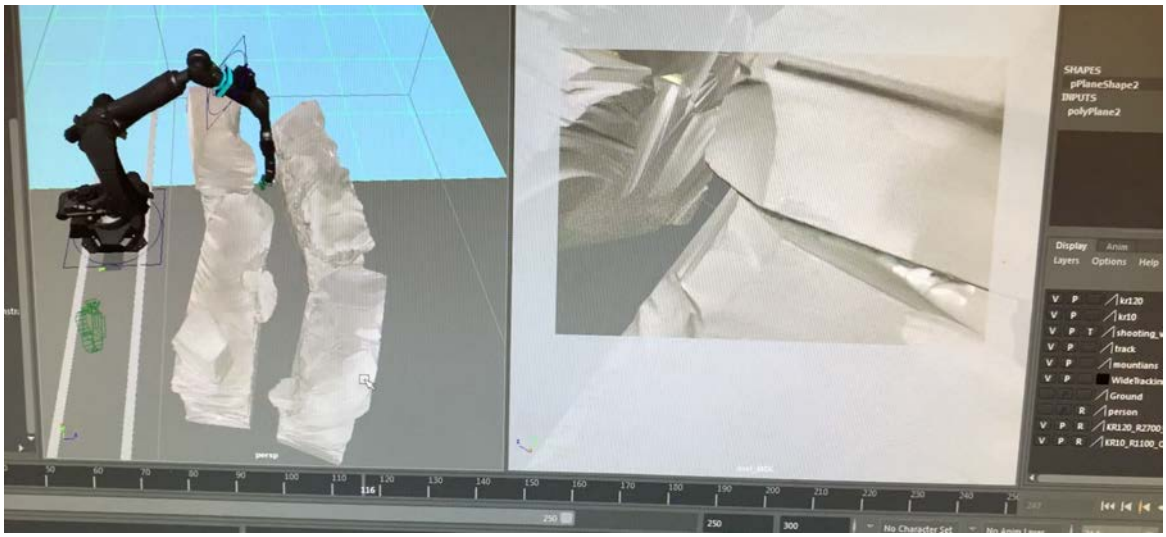


Figure 5.28: Point cloud scans of the desert landscape miniature set pieces with shots blocked in Maya on the digital versions of the KUKA robot set up.

At this point in production, working with remote teams in different cities became problematic. It became apparent that this production style needs further technical research and development to function more smoothly. Due to the technical research element of this production, it would have been challenging had we had the digital team and the miniature set team in the same location. Therefore, having the two teams work remotely from different cities meant that the process

broke down somewhat. It was not a disastrous breakdown, and we managed to bring the production back on track, but not without introducing time and budget stresses and compromising the creative outputs to some degree. There was a definite tension between the need for clear, concise digital camera layout outcomes, so the Like A Photon Creative digital team could keep their schedule on track and the need for creative flexibility to achieve the best photographic image outcomes and explore the blocking shots on the miniature sets from a research perspective in Sydney.

The team at Like A Photon Creative in Brisbane assembled a group of four animators for *Jarli* and began putting together the project's layout. Their team used our Mimic set up in Maya, but because they could run test versions of the shots, they developed shots without any direct visual data from the actual robot. Consequently, it was difficult to know whether or not the shots would work until we were on set and publishing these shots to the KUKA.

Figure 5.29: Moon surface miniature set being scanned.

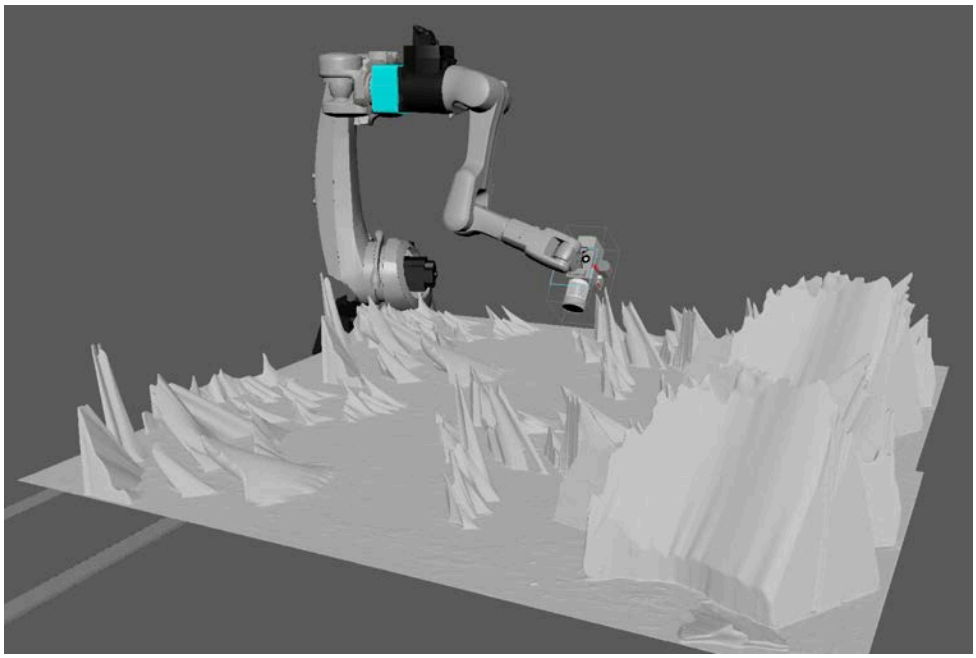


Figure 5.30: Moon surface scan camera blocking.

5.19 The miniature set shoot

Continuing from the outcomes of the research and development phase of Case Study 2, Tran Dang and Gwyn Jones at the Advanced Fabrication Lab set up the piggy-backed, two KUKA robot shooting system, in which we reconfigured the KUKA KR 10 and installed it as a tool on the end of the larger KUKA KR 120. While this new, doubled-up robot system provided significant advantages to the shoot, it required the team to schedule more than the seven days originally scheduled to work through the miniature shooting schedule. The scale of our miniature sets became a factor in scheduling. The canyon set was six large pieces that filled approximately 3 × 8 m of studio floor space—almost the available work area. The scale of our sets, the number of shots in the animation and the double robot system required 10 days of shooting.

Week 1: Testing the double robot

After running out of time in our research and development phase to test the double robot system, the team used the first day of shooting to test the system ready to shoot (shown in Figure 5.31). An advantage of using the KR 120 as the base robot for this system was that Tran Dang, operating the two robots, could communicate directly with Louis, who was on set setting up and publishing the Maya cameras, exactly where the tool head of the KR 120 was in our shooting workspace. This enabled Louis to locate our miniature sets accurately in the Maya workspace space.

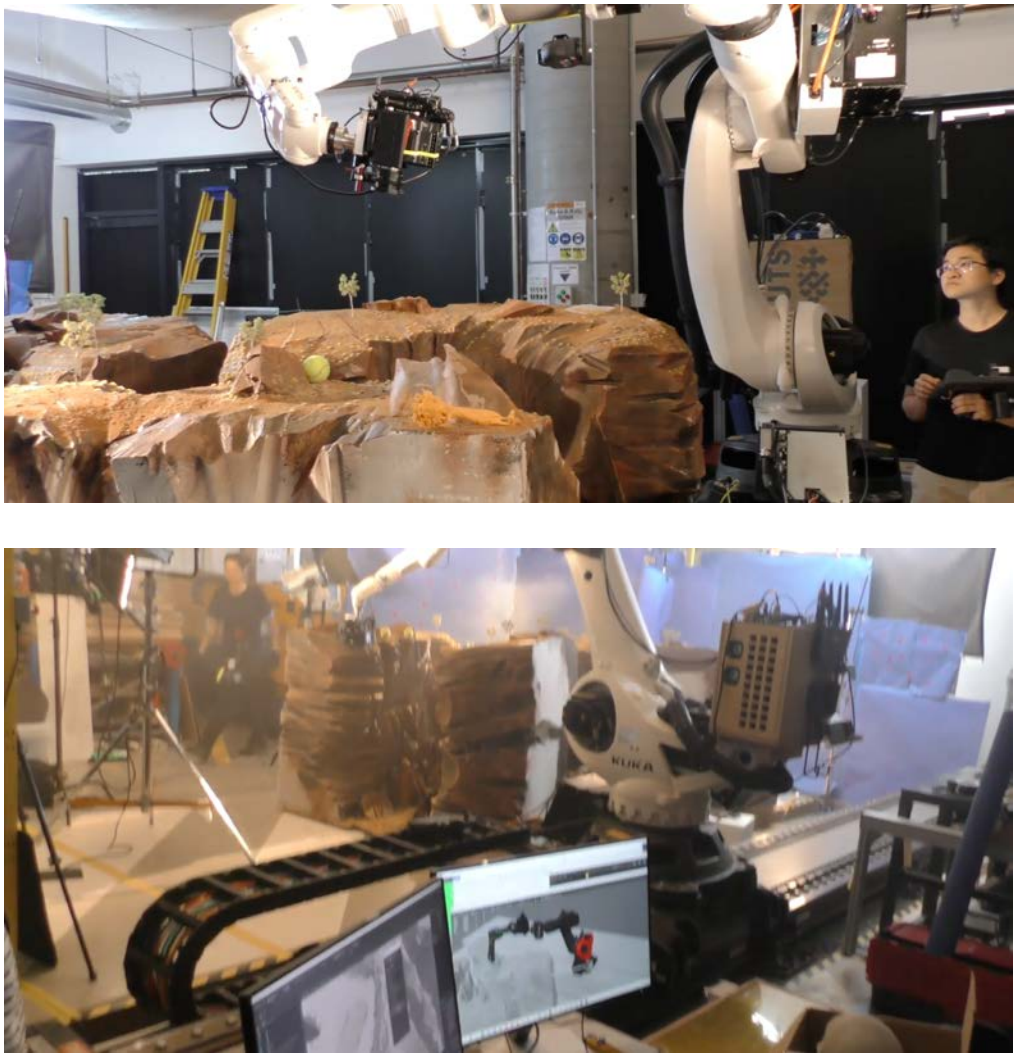


Figure 5.31: Tran Dang tests the double robot set up with motion paths published from Mimic.

As we had yet to test the new shooting system, we began the shoot with the smallest and simplest of our miniature sets, the interior living room set where Jarli and her family watch television (see Figure 5.32). There were frustrating stops and starts getting the system to work, including a day when we needed an update from KUKA on ready2_animate. The ready2_animate hard drive did not function smoothly throughout the shoot, and the system required rebooting many times.

Figure 5.32: Jarli house interior on Day 1 of the miniature set shoot.

Working in the Advanced Fabrication Lab space at UTS gave the team access to the KUKA robot arms (see Figure 5.33). However, it also meant we did not have the depth of space needed for the scale of sets I had designed. The first few sets were fine, on a scale I had done *with A Cautionary Tail* and *Jasper*. The bigger canyon sets in the shooting space made it difficult to walk around the studio.

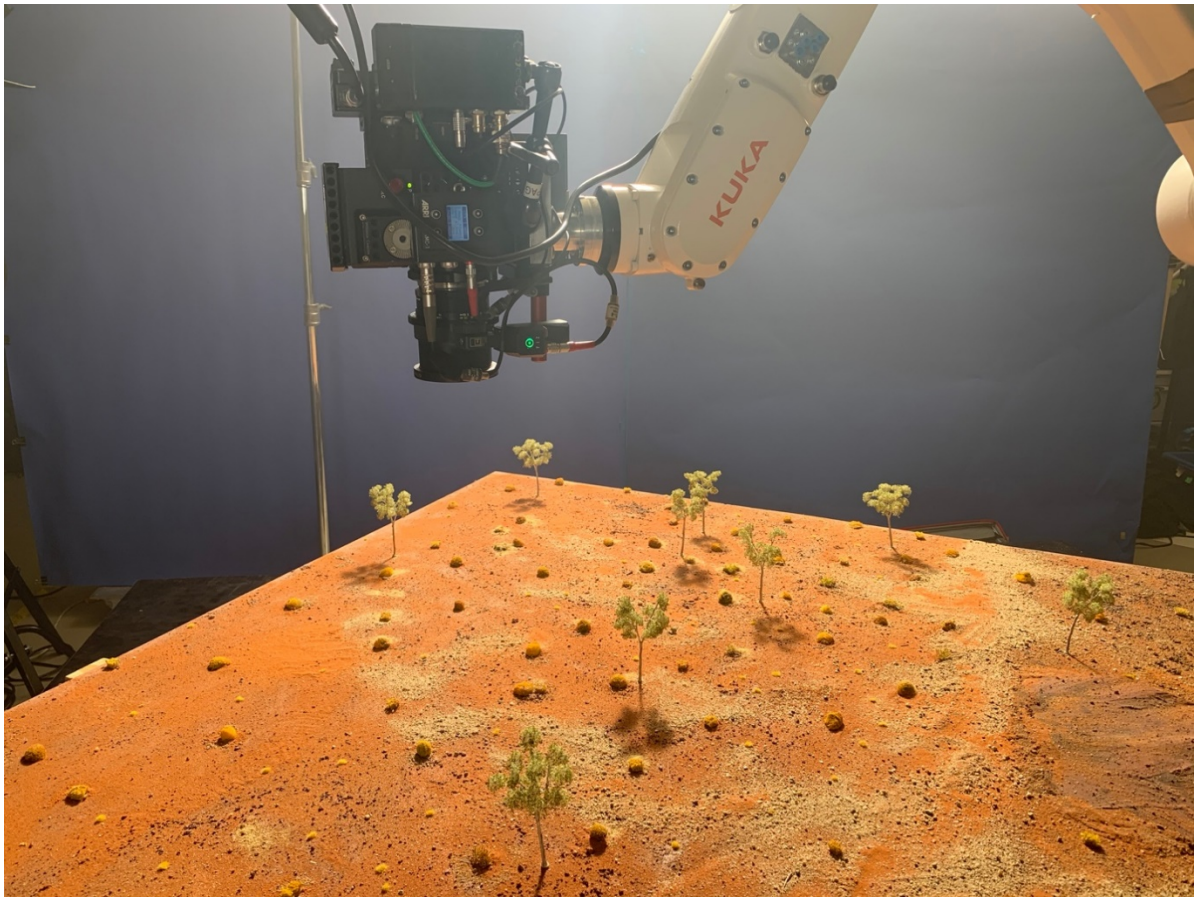


Figure 5.33: An aerial view looking down on the desert.

Cinematographer Evan Papageorgiou's lighting team was very professional and adapted well to the working environment. The scale of the sets and the difficulty of shooting multiple angles on these landscapes were physical limitations of the project that forced me into creative corners. We always intended not to play it safe with the creative ambition of the project and just do what we had already done on previous projects. While difficult to manage, the larger scale sets led to interesting technical and creative challenges to work around, shoot and light, and brought scale and complexity to the production.

5.20 Working with Like A Photon Creative layout shots

Like A Photon Creative sent us the layout shots their animation artists had assembled based on the packaged shot description information we had exchanged during the shot design process. After many clarifications and adjustments, Like A Photon Creatives team had completed a layout process, and their production team were ready to sign-off so their animators could start working in earnest.

When we loaded up the Like A Photon Creative layout shots, we could not execute the shots on the KUKA. Most of these shots were laid out in a 3D scene, which described a different shaped space to our workspace. The required robot moves did not fit into our studio space. We had shifted the entire filming production to the Advanced Fabrication Lab studio space at UTS. However, when we tried to relocate the miniature set in the shooting space to match where it was located in the digital layout, there either was no room, or the set's orientation did not work with the KR 120's 10-metre track layout.

Additionally, many the layout camera moves, even some of the simpler ones, triggered a program error and could not be run through ready2_animate, even with multiple systems reboots. Robot technician Tran Dang had to obtain support from KUKA for rebooting to the ready2_animate hard drive, technical support and reissuing of the firmware.

We discovered that a specific starting set-up was required for the double robot system. This set-up was impossible to configure until we had done a day of testing with our first set on Day 1. Therefore, we had to redesign the shots on the shoot day using our Maya to KUKA system. This situation created production difficulties as we did not shoot the shots that the team in Brisbane expected us to shoot. Their animation team had begun work on early versions of shots using animation shots with these camera blocking passes and were potentially wasting significant time.

Conversely, these challenges brought some advantages from my perspective as a researcher looking for more flexible outcomes in designing camera moves in this style of animation production. From this perspective, the team was forced to adapt to a very fast and creatively flexible shot set-up. All these factors added up to the loss of time from the Brisbane team, which caused some frustration as they were trying to navigate a tightly organised budget and production schedule.

I had assembled a full shooting crew on set at UTS and had a finite window in which to shoot the animation, so we needed to film shots on the KUKA. Mimic operator Louis Pratt and robot technician Tran Dang effectively became our on-set layout artists (see Figure 5.34). We sped up our process of bringing in a miniature set and orientating it correctly to the camera (see Figure 5.35). We then opened the Like A Photon Creative cameras and used their timings and animation curves as a reference for reconfiguring every shot in Maya in the studio environment. We also had the animatic on set; cinematographer Evan Papageorgiou and I used this as a second reference for frames and timings.

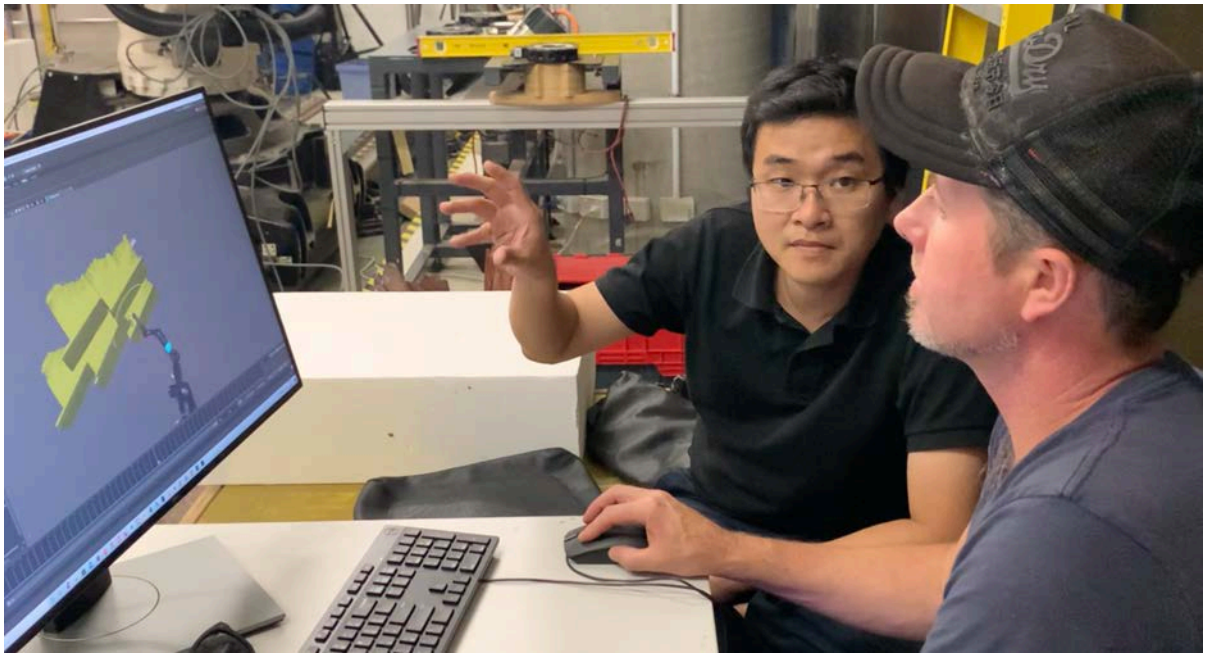


Figure 5.34: Mimic operator Louis Pratt and robot technician Tran Dang adapted to become our on-set layout team.

Figure 5.35: The hilltop set on shoot day.

5.21 Creative camera changes

It became apparent at this point of production that I wanted to make creative changes to the timing and blocking of shots. Before this point, shot design and layout were more hypothetical. With lights and a camera on the miniature set and watching test passes of shots on a split monitor, I felt I could contribute important creative direction to the shots with a greater visual perspective. This realisation on the *Jarli* shoot was one of the more important learning outcomes of this case study.

Planning shots in an animatic and a layout pass of the animation timeline is essential in any animation process, including this hybrid style of production. However, the completed layout shots could not be executed accurately on shoot day with the assumption that they would work for the story. It was only when the lights were up in the studio, the correct lens was on the camera and the captured image was initially shown on a monitor for the team to view and discuss, that the job of creatively directing the final refinements to miniature set shots could be properly done (see Figure 5.36). A simple method for maintaining flexibility beyond the shoot and into an edit is to shoot multiple takes of each shot (e.g., a live-action film shoot with varied camera speed, focal depth, composition and other parameters).

Figure 5.36: Turning the desert shots on their side to film looking up at the sky between the canyon walls as Jarli flies overhead.

Until the miniature set shoot, all camera moves developed as part of the layout were a technical first pass. It was difficult to assess the final timing, smoothness, composition, depth of field and production design from a final image point of view and make adjustments to fit the overarching project's story qualities. It was not until I saw the shots through the camera lens and discussed them with the cinematographer. With our newly adapted camera design process operating more effectively, the cinematographer and I creatively discussed and redesigned the durations and configurations of almost every shot. This became a dilemma from creative and production perspectives. I was torn between the concerns of two different teams, the on-set shooting team and the post-production camera solving team.

This situation was frustrating for the Brisbane crew and caused confusion between the two production processes. It had the advantage of testing our shot design to execution system in what had become a stressful shooting environment. Being adaptable and creatively flexible on set was a central objective of my research and an improvement I wanted to make from Case Study 1, so the miniature shoot team forged ahead.

5.22 Motion control camera pathway

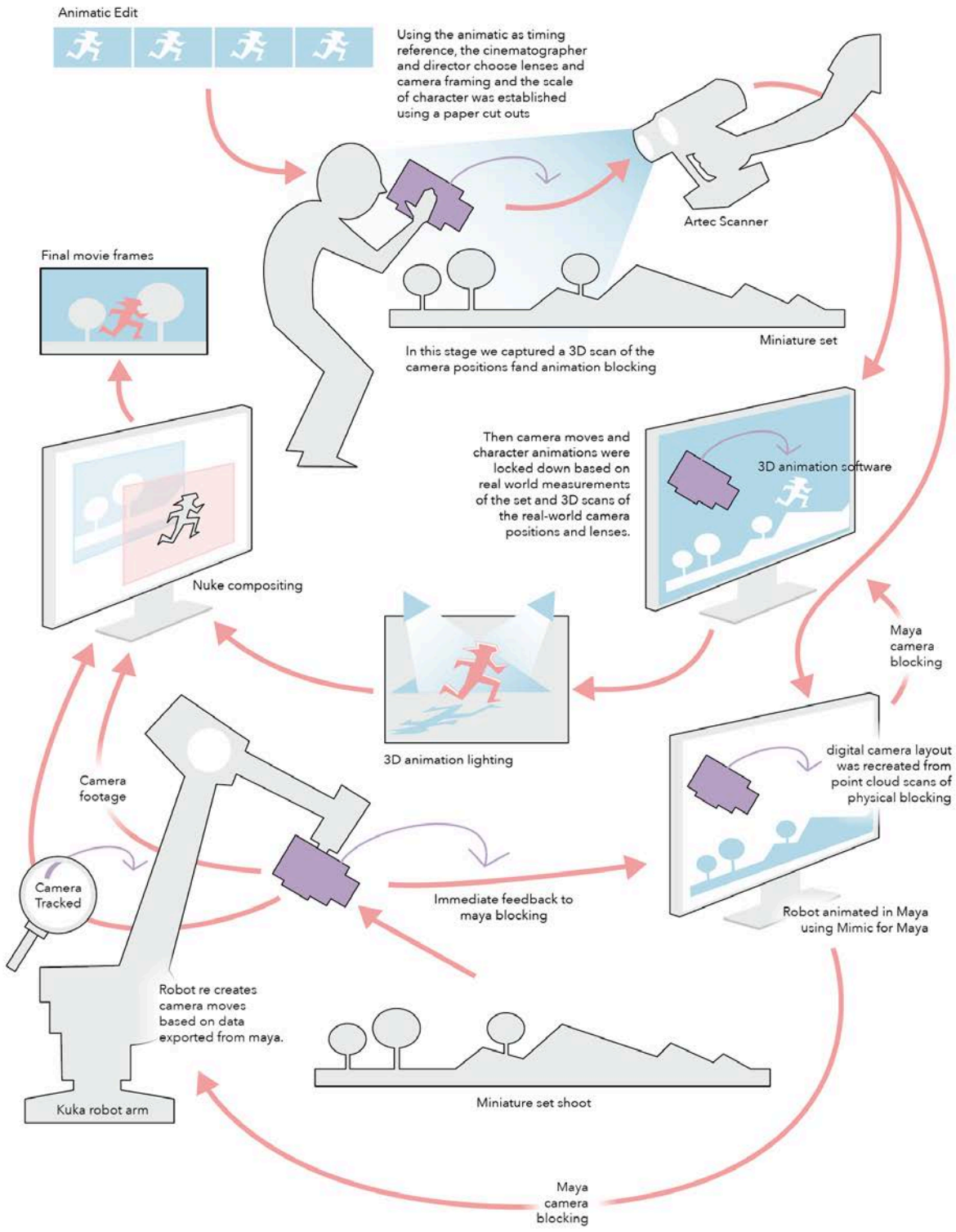


Figure 5.37: Case Study 2: Jarli: Motion control camera pathway

Part of the process of keeping the miniature set shoot as a creative space was improvising new locations for two scenes in the film. We completely redesigned at least two locations by using pieces of other sets, rotating and repurposing them as

new environments. The sets were modular, so we could rotate them and develop backgrounds. The scale of the sets in the studio also meant that we could not see a version of these two locations until shoot day.

We also developed a system by which we added a subtle 'nod' before each camera movement, giving the tracking and post-production team a clear idea of where each motion path began in the video frames. The nod was a simple rotation shift away from the camera's first position and back again over approximately 24 frames. It gave the post-production team a visual representation of where the camera keyframes began in time. Without this process, artists working on the shot after the event would find themselves searching footage to guess the beginning of a camera movement. In future versions of this production style, we intend to use a simple red laser light for the same purpose.

5.23 Camera specs

Cinematographer Evan Papageorgiou shot *Jarli* on a RED Epic camera with a spherical lens capturing 4K and 8K images.

5.24 Deep focus v. shallow focus

A creative challenge of shooting on miniature sets compared to shooting at a 1:1 scale is the relative difficulty of creatively dialling in the depth of focus for each frame. I have found this difficult to navigate on every miniature set shoot. When researching the miniature set work of Wes Anderson's cinematographer, Tristan Oliver, the same challenge was mentioned, as discussed in the literature review (Section 2.11).

On *Jarli*, I observed that cinematographer Evan Papageorgiou favoured a shallow focus. I agreed it looked great on the monitor. However, I foresaw a problem in the composition process if the blue screen edges, where the horizon of the miniature set met the blue screen, were out of focus (see Figures 5.38 and 5.39 showing exteriors against blue screens). With this in mind, we shot multiple passes of each shot with multiple planes of focus, always ensuring that we shot a pass of each camera move with the horizon or line where the miniature set meets the blue screen in focus. These passes were discarded in the compositing process.

Figure 5.38: The hangar exterior miniature on set with blue screen and a frame from the final film.

Figure 5.39: The hilltop section of the desert canyon set against blue screens.

5.25 The various passes

As on *Jasper*, for each shot, we captured other passes of the motion-controlled movie, including tracking marker passes, lighting reference passes, various focal depth passes and HDRI's captured on a 360-degree camera.

On *Jasper*, VFX supervisor Mark van den Bergen was on set and led the compositing department. However, we did not have a VFX supervisor on set for *Jarli*; this was a shortcoming on my part in organising and coordinating the miniature set shoot. COVID-19 travel restrictions in December 2020 meant our VFX lead, Egan Wesener, could not attend the shoot.

5.26 Match move fixes

Once our on-set miniature set shooting team had rebuilt the layout cameras from Like A Photon Creative and had new motion paths for each shot, we repackaged these shots as updated layout cameras to keep the animation team in Brisbane moving forward. However, the new layout scenes were not orientated and positioned in the digital world space in a way that allowed animators to simply open the shot and start working. The layout scenes needed to be realigned, positioned and orientated relative to the zero transformation point before the animators could work on the shots.

While this pipeline problem was a production hurdle on *Jarli*, we will be able to navigate it more smoothly in future animation projects. To correct the camera orientation disparity between our teams in Sydney and Brisbane, we assembled a new team to work on each shot and stay ahead of the Brisbane animation team.

The new layout realignment team aligned the new animation workspaces close enough that we could send them to Brisbane and keep their animation team on track. This process involved taking the video files from the shoot and bringing them into the latest Maya shot that had been used to drive the KUKA on shoot day (developed on set by Louis, Evan and me). We rotated and translated the set scan, so the digital set and the real set in the video file matched closely enough to allow an animator to continue working. It was not a technically difficult job, but it required familiarity with how the shoot

had been conducted and each shot had been executed. It would have confused the artist in Brisbane, opening the shot and beginning work.

In a post case study interview, fellow researcher Andrew Bluff described this process from his perspective:

> The process to line these things up, was done by trying to find something in the video footage that would be easily identifiable in the scanned set and then lining them up visually, which you could do, but it wasn't achievable so that it was 100% aligned on every axis. Like, you know, if you just were off by a couple of degrees on one angle it would still look fine in the footage. But then when the camera panned, like five seconds later, it was like, 'oh, no, actually, we've gone way off that way when we should have gone off [the other] way'. So, it was like, we had the quality of scans we had and the quality of footage, which was fine, but it wasn't enough to get you amazingly accurate placement spatially and to multiple angles of rotation. This was the problem really. And then, you know, once you've figured out that you had gone on the wrong angle one way, you basically had to go back to the start and then realign it again and then go back again—like, you couldn't just find two points and say, 'okay, that's lined up, and that's lined up now, computer go and sought it out,' … There probably is a mathematical way to do that but wasn't built into our software and we didn't plan for it.

Producer Ryan Greaves in Brisbane rescheduled the animation team. We also had small teams of artists in Brisbane and Sydney working on the next step and tracking shots. Between both production teams, we managed to bring the camera solving process back on track and keep the animation team working; however, it was at a cost to the schedule and the budget. At this point in Case Study 2, we faced the challenge of doing research within a production environment. The research needs forced the team in Sydney to stretch our budget and schedule in an unanticipated direction.

From a research perspective, the learning outcomes from these technical challenges and hurdles were among the most valuable of the case study. The technical challenges clarified the best technical and creative strategies for conducting animation practice using this hybrid production style, as detailed in Chapter 6.

5.27 Animation

Brisbane-based co-director Chantelle Murray had not directed an animation project before. Although she had been very involved in story development and character design, she had taken a back seat during the camera layout and miniature set shoot. We both gave notes remotely. This was a challenge for the animation team, although Chantelle and I quickly aligned our creative intentions and ideas for the project and gave the team unified creative notes. Chantelle learnt fast and brought all her talents and skills as a director working with live action and directing actors on set to the animation process. Her sensibility for directing actors translated smoothly into the voice over recording and the subsequent animation process.

All our scenes in the desert landscape of Jarli's home used the hybrid production style, whereas all the flying and space scenes were a completely digital production process (see Figure 5.40). Animation lead Tanya Vincent discussed an animation style to help merge these two production approaches. It needed not to be jarring for the audience when we moved from one visual production style to the other. I felt that I would be able to discern a significant difference between the two styles in the final product. However, I was interested to see how significant this shift would be and if there would be noticeable or significant effects on an audience's experience of the story.

Figure 5.40: The Jarli flying shots moved fast over an all-digital background, in contrast to the hybrid production process.

The story logic behind the shift from one production style to the other emerged from discussions in the writers' room. We decided that we would follow the same logic if the *Jarli* project were to go forward into a longer-form animation. Scenes in Jarli's home country needed to feel more real and grounded and were produced using the hybrid digital animation composited with miniature sets production style. Her space adventures would be more other worldly and suit an all-digital production style.

Jasper also had some all-digital shots at the end of the short, when we see her in the fighter plane cockpit. I felt the style shift in Jasper was made easy to watch by the huge time shift and circular editing dissolve at that point in the story. In *Jarli*, a significant portion of the film's shots, almost one-quarter, were completely 3D animated sequences. Therefore, it was challenging for the animation department to match the look of these two styles so they appeared to be in the same story world.

Because the camera layout process had been pushed back, the four-person animation team could start the all-digital flying sequences. Tanya and I discussed a similar approach to animation we had taken with Greg Naud on *Jasper*. In general, wider shots with action had a more steppy, 12 fps feel, while closer frames with a more emotional beat were animated on ones. We followed this principle closely, although there was also a process by which we adapted this principal shot by shot.

The team narrowed the animation look with a series of animation tests of Jarli running and jumping. Chantelle and I decided to pull back from a more exaggerated animation style and pushed for a more subtle, understated animation style better suited to the realness of the miniature. In particular, Chantelle had strong ideas about Jarli and Cuzzo's mannerisms and physicality. It was an interesting experience co-directing an animation team and an instance where remote working worked well.

5.28 Compositing and digital set extensions

Egan Wesener led the VFX match moving and compositing team at Like A Photon Creative. The tracking and match moving of miniature set shots were done using 3D Equaliser. The detail on the miniature sets made for good tracking data, so this

was a relatively straightforward camera solving process. VFX Nuke artist and compositor Jamal Knight tracked shots in Sydney using Nuke. In both cases, the camera solves generated new geometry data, which was updated from the miniature set scans. This data became the more accurate contact point between digital animation elements and the miniature set world photographic elements.

The first shots through the pipeline looked very close to my creative intention for the project. The shots were an interesting hybrid of miniature, stop motion look and a more fluid 3D animation look. I was happy with these outcomes. The hardest shot to track and composite between the two worlds was the first shot of the film. This long tracking shot moves closely across the desert ground and then cranes up slightly to find Jarli on her bike plane. The shot moves on multiple axes, leaves the miniature set and hands the image over to an all-digital visual workspace.

This tracking shot was the same shot we used as the test shot in our research and development phase of the case study. The shot that presented the tracking and compositing team on *Jasper* with the most difficulty was similarly structured. It also tracked across the ground and then lifted in the sky, with the camera rotating on multiple axes off the miniature set and into an all-digital environment. On *Jarli*, this shot was the most difficult in terms of match moving the real camera and the 3D animation camera. There was a very small, slightly perceptible degree of slip when the shot handed over from miniature set footage set to the digital image. Egan and his team fixed this slippage with more detailed hands-on camera solving work.

We initially tried to use an Unreal Engine set extension system with the flying scenes. We found the time required to develop a satisfactory look process was limited within our budget and schedule. I am interested in pursuing this production avenue again, as we did on *Jasper,* in future hybrid production style animation projects (see Chapter 6). On *Jarli*, this Unreal Engine approach was abandoned for a more traditional geometry based on the miniature set scans and placed into a desert environment. Some time was spent on this production element; we eventually arrived at a look that blended sufficiently well with the look of the miniature sets.

As a creative point of difference from the *Jasper* project, Egan and I decided to use a different look for some of the set extensions and skies in several of the wide shots of the film. We worked with concept artist Nathan Geppert to design a series of matte paintings that were layered. We staggered the paintings in depth (z) space and perceived a degree of parallax to the moving camera in the final image. This approach created a unique visual style; miniature sets, stylised matte paintings, 3D animation and dust effect passes work together to create a look that feels unique and visually ambiguous as to its production method.

5.29 Sound and music

The soundtrack for *Jarli* was composed by George Papanicolaou and Leon Ross. George was brought on board the animation through his previous collaborations with co-director Chantelle Murray; he brought a wealth of experience to the project. They had previously worked on various projects that dealt with Indigenous themes and First Nations storytelling. As with the *Jasper* case study, sound and music played an essential role in bringing the disparate visual elements into the final moving image frame. The sound design enhances this visual experience and helps immerse and embed the audience into the story.

Unlike *Jasper,* we had dialogue throughout the animation, which made for a different audio experience. George and Leon wove their musical score in close collaboration with Chantelle and me. The score included vocal elements by a singer in the final credits, adding an interesting new dimension to the project.

5.30 Conclusions: *Jarli*

Case Study 2, *Jarli,* produced several learning outcomes about the hybrid animation production process. At times, producing the animation in a remote way was much more difficult for this style of production than for Case Study 1, *Jasper*. However, these difficulties also served as valuable conditions for testing a creatively and technically ambitious project.

The *Jarli* animation project tested the hybrid production process to its limits providing valuable insights. As with the *Jasper* project, in Case Study 2, we discovered many facets of our technical process and pipeline that could be improved. Other areas of the production built on the learnings of Case Study 1, and the outcomes exceeded expectations.

In Case Study 2, working on a narrative sequence in which the animation timeline jumped between two different animation production techniques was interesting and revealing. Some scenes of *Jarli* were produced in an all-digital production process, while others were created using a hybrid miniature set and digital characters production process. Seeing these two sequences next to each other in the story timeline provides an opportunity directly compare the outcomes and processes of each production pathway.

5.30.1 Development of animation style on *Jarli*

An important aim of this research project was to further develop an animation visual style working between 3D digital animation and miniature set builds. In hindsight and from a directorial perspective, the shots produced using this hybrid style of production have a visual quality that stands out when assessed in the context of the contemporary aesthetics of animation production. This look is comparable to the visual style I developed in Case Study 1, *Jasper*, and my previous animation short film, *A Cautionary Tail*. It is a visual animation style distinct from most mainstream animation production in its aesthetic qualities.

While significant artistic and technical skill was employed to make the all-CGI shots seem part of the same timeline, they still do not have the same tangible visual quality as the hybrid shots. The shots in *Jarli* that I most like are those in which the miniature sets provide a real and tactile design sensibility.

For my aesthetic visual taste as a director, I found the sequences using the hybrid style of production and collaged miniature sets with digitally animated characters the most visually interesting with the more evocative design qualities. As VFX supervisor Egan Wesener stated when discussing the hybrid production process in the lighting and compositing stage of production:

> It was obviously this sort of cobbled together mishmash of different materials, and for me, that was super interesting to texture and shade and, and get looking sort of real, you know, because we were obviously going through this mixture of like photo real with, with, you know, this whimsical sort of miniature look. So, it was definitely something that I found creatively appealing.

One of the important learnings of this case study was the need for a more integrated approach to shot development with better communication between the layout team and the miniature set shooting team. The ideal approach would require

layout to stay at a temporary stage until the shoot, at which stage the layout camera would be based on the shooting cameras. This was effectively the pipeline we were forced into on *Jarli*, and it would be beneficial to schedule and production plan a future hybrid animation project accordingly.

We improved aligning the digital and real-world miniature set workspaces quickly and efficiently from Case Study 1 to Case Study 2. We used the Artech Leo scanner to scan miniatures, brought the scans into a 3D workspace, and then used Mimic to design a camera move and publish it to the KUKA robot. These techniques meant we could quickly design and produce working shots to the correct scale lined up with the miniature workspace. However, a significant amount of research and development is required to make this process more efficient and enhance the creative process of this hybrid production style. This is especially the case in the post miniature set shoot when bringing the images together into the compositing process.

As we could not use pre-designed camera moves on the *Jarli* shoot, the motion control camera design process was pressured to perform quickly, and we relied on producing all camera moves on set, more or less from scratch. These stressful production conditions produced successful results. We were able to block, design and execute shots with a practical and creatively flexible turnaround from beginning to end while keeping the shoot on schedule.

In the next stage of the process, achieving alignment of the set to camera in the digital compositing process caused the most problems on *Jarli*. Most of the problems at this stage and in post-production largely indicated the project's logistical and budgetary limitations rather than limitations of the technical production process. However, this case study showed that technical improvements could be made to this production style.

Robot technician Tran Dang, art director Louis Pratt and I identified potential techniques to improve this process for future productions that need testing. The focus should be on an updated and different approach to a location system to accurately orientate the miniature set relative to the camera mounted on a KUKA robot in the physical shooting set environment.

The plan is to test two ideas in a future project. One test would involve mounting a scanner (e.g., Lidar) on the camera's tool head to locate the set. The second test would use the camera as a location tool. Ideally, this would negate the need to calculate the offset from the locator (scanner) to the film back of the camera because the camera would be the locator. I expect the second test would achieve better results as it involves fewer steps in the pipeline and fewer offsets to calibrate and calculate in the alignment process.

In an interview, fellow researcher Andrew Bluff described an idea for on-set alignment:

> I think a better way to do it perhaps is if we had some kind of three-dimensional widget, like a QR code or something, a three-dimensional QR code that was physically attached to the sets, somehow, obviously in a placement that we didn't need to see in the actual footage, but that we could scan, you know, it wouldn't move, it would be scanned with the set.

Art director Louis Pratt suggested another idea for on-set alignment:

> I think what's really interesting about this process is that it was crossing the line between animation and live action filming, in that you had a set, and because we could update in Maya, you could then have that feed into the animation.

I mean, obviously, where it sort of fell down a bit was that we weren't knowing exactly what the camera was filming and what you had in Maya. There was still a disconnect. And probably, we've talked about this a bit, if there was some sort of photogrammetry, or 3D scanning situation that could bridge that little gap. I think you'd have this really seamless workflow and one that you can compose shots on the spot. I think that's really important.

Using a modular set design system was a successful research output from Case Study 2. The ability to create multiple locations and environments from the set pieces benefited this production. This ability increased creative flexibility and created an interesting design element to the shoot process, which let the team create set extensions in front of the camera and design them on the split monitor.

Having greater creative flexibility and control of depth of field is another area that could be improved upon in my practice of working with miniature sets for cinematic storytelling. The aesthetic qualities of miniature sets on-screen require that focal depth and detail are not forced to the narrow end of the depth of field spectrum. It is important to find the desired depth of field within an image rather than be forced into a narrow depth of field, as is often the case. In my practice as an animation director, I have often felt limited by depth of field constraints.

When discussing depth of field with cinematographer Evan Papageorgiou in a post-production interview for this research, he commented on a bigger yet simpler lighting set-up:

Interviewer:

If we like, had a lot of, you know, all the resources and space in the world for another shoot like *Jarli*, how would you approach lighting landscape sets like that? Would you go for more like a big overhead lighting set up? I mean, we were pretty cramped, right?

Evan Papageorgiou:

I would use less lights, but bigger lights and have a little bit more of a natural sort of sun, you know, in the ideal place. That's if I had the space and if I had the distance. We, you know, we had a small space and low ceilings, really. So, we had to bounce light a lot. I think we've made it work for the scale of the model, though. Anyway. Yeah, I mean, I would go for a bigger space where we can really cast some light but that's more a style that I'm looking at now anyways, maybe using less lights, so we're really using one like a sun in a really good spot, right?

Evan also commented on the realistic nature of miniature sets captured through a more traditional photographic process:

I think with the lighting, that was something that worked really well, because it meant that I could sort of bring all my experience of lighting and craft dramatic lighting, and, and add some reality to it. And then then they, you know, with the lighting references and stuff they can really, you know, control whether that digital lighting was coming from the sky and where it was hitting the characters, you know, which is satisfying to me. I thought it was a really good team. A really good collaborative process. I felt like, you know, like, I got to bring my knowledge of cinematography to a different type of process. You know, and to help bring some realistic lighting ingredients where possible.

The ability of digital cameras to capture exposures at higher ISO ratings in lower light levels has improved greatly in recent decades. However, there are still physical realities relating to the optical capabilities of lenses and the scale of cameras relative to miniature scales. While these factors are limitations to achieving more control in this area, there is scope for

improvement in this area in future studies. There are interesting possibilities for using lenses specifically designed for miniature photography. For example, snorkel lenses could provide a different range of photographic options and opportunities in this area. Other simple improvements could be made regarding prioritising more base-level light in the studio and allowing for smaller apertures and greater depth of field options.

Our approach to this problem in both case studies, *Jasper* and *Jarli*, was to stack the focal depth in multiple depth focus passes of each shot, using the repeated action of the robot arm. In *Jasper*, which had a smaller crew, VFX supervisor Mark van den Bergen supervised these shot passes on set. He also composited those shots, so there was a direct connection between both tasks that did not require a line of communication. On a bigger project, with multiple teams working in remote locations, these lines of communication easily become lost in translation or commonly fall down the priority list of things to be addressed when the production schedule comes under the stress of deadlines and schedule deliveries.

I want to experiment further with the technique of shooting multiple passes of the same camera move to see if we can stack the focus passes in the compositing process without tracking every pass. This technique was done very successfully on one shot in *Jasper*. Getting this to work on a single shot is not necessarily practical from a production point of view. This process needs to be tested over multiple shots to establish a clearer system and inform the shooting process.

There was tension between the need for clear, concise digital camera layout outcomes so that the Like A Photon Creative digital team could keep their schedule on track and the need for creative flexibility when blocking shots on the miniature sets in Sydney.

The team developed and refined our shot design process to a much higher degree for *Jarli* due to our experiences with *Jasper*. The camera team was more creatively flexible and adaptable on the second miniature set shoot. We were able to design a shot in Maya and publish it to the KUKA robot system using the Mimic platform, then make multiple refinements to that shot design. As the director, I discussed the look of the shot with the cinematographer and gave notes; then, we were able to shoot multiple passes of the shot quickly and easily. This development was a big step forward from Case Study 1, in which the shots were locked in on the day of the shoot.

As is common in-set filmmaking environments, the miniature set shoot team had a slow first couple of days. They fell behind schedule before establishing a faster collaborative rhythm and working well as a team. During the first week of shooting, I experienced the most challenging days and the most fun and creatively interesting days of directing an animation project. By the end of the week, the crew worked well together, and there was a great energy on set. Cinematographer Evan Papageorgiou, art director Louis Pratt and robot operator Tran Dang and I blocked, lighted and shot many shots in a day, each with a different creative brief and a very different camera move. The process felt creatively flexible and as though our filmmaking system worked well.

Figure 5.41: Production stills from the Jarli short.

Figure 5.42: Production stills from the Jarli short.

There were also improvements in how art director Louis Pratt and I designed and constructed miniatures for Case Study 2. We increased the scale of the miniature set design and production, making more sets that were bigger and more ambitious in scope. We also built more modular sets; these could be rearranged in different ways to achieve multiple landscape locations, perspectives and shots (e.g., pieces rotated, different combinations).

As we learned on the *Jarli* production, sending this type of work to a post-production team can create significant challenges. Ideally, in future productions, we would be better prepared to hand over the outputs from this adaptable, improvised set shooting process so that the shots are more easily accommodated in the match moving and camera solving process.

Louis Pratt discussed the set design and build for *Jarli* in an interview:

> I think the scale, like, in certain scenes, what sort of scale you could do was really important. [As] opposed to live action, where everyone's fairly clear about what scale everything is, because we're all in the real world. But once you get into miniatures, if you can go bigger, you will want to go bigger, for a better look on camera. And also, we're always sort of thinking about how far you could sweep the camera lens. but that introduces a new set of problems, so there is this push and pull.
>
> And then for this sort of set build, because we were working to a tight budget, we really also wanted to work with ready-made scales of building material, so that there was sort of a speed at which we could put things together and compose things. So, we were always looking at standard sheet sizes. And sticking to those standards and making them work within the camera. And the camera lenses was also really important. I think that's where when you were coming in to look at the set, it was really critical that you were using that lens software Artemis, because if we weren't building it to the lens, we were going to end up in trouble somewhere down the line.

Figure 5.43: Production stills from the Jarli short.

Figure 5.44: Production stills from the Jarli short.

This research had interesting and valuable outcomes for my practice as an animation director looking to adapt these techniques and in the development of a personal animation style when planning future productions (see Chapter 6). An important outcome of Case Study 1 was the development of the hybrid style of animation production from a creative perspective. A principal aim of this research project was to develop this approach to animation and explore and develop the aesthetic qualities of this production style. Due to its more contained scale of shots, characters, sets and locations, Case Study 1 was more successful than Case Study 2 in some ways. For example, the shot in the middle of the short of Jasper running through the forest, flapping her cardboard wings, shows my stylistic approach in full effect. The forest does not appear designed and lit by digital artists; it has an organic, tangible quality that feels distinctly physical. This quality is

much more accessible when working with handmade objects and lighting them in a studio under real lights with dust and haze.

The more successful research outcomes of the final animation, *Jarli*, translated into a positive movie experience from an audience perspective. I attended screenings at the Palais Theatre launch in Melbourne, Flickerfest in the Bondi Pavilion, Sydney, and the Avalon Airshow in Victoria, where younger audiences gave positive feedback (see Appendix F). Audiences were engaged in the story and its themes and were interested in the animation production process. At the Avalon Airshow exhibition, school children could experience the story with the miniature set in front while seeing the camera move on the set with a live footage feed to a screen beside the final animation work. They displayed a strong sense of curiosity and interest in how animation films can be made.

6 CONCLUSION

Through this research project, I made valuable progress in the practice of creating animation films using a hybrid of 3D animation with miniature set builds. The case studies successfully explored methods to give the filmmaking team more creative options in implementing this animation production style. The project successfully developed a motion-controlled camera system using animating cameras in Maya and publishing these to control the real-world cameras mounted on a common industrial robot arm with the capability of fast iterations to these camera moves. The aims of this research project are discussed in turn.

- To produce two animated short films as case studies of a hybrid production style combining digital animation and miniature sets.

This aim was achieved, as outlined in the case study Chapters 4 and 5. Both *Jasper* and *Jarli* films have been released for festival screenings and online. *Jasper* was nominated for an AACTA Award and an AEAF Award. *Jarli* was screened at the Sydney Film Festival and the Chicago International Children's Film Festival; it won best short at the Brisbane International Film Festival.

- To develop a motion control camera system involving integration and creative control between cameras keyframe animated in 3D animation software and physical cameras filming on miniature sets using a KUKA robotic arm (for a faster, creatively flexible system for designing and executing complex, multi-axis camera movements filming on miniature sets).

This second aim was achieved with significant improvement in results from the first to the second case study (see Sections 4.16 and 5.42). While the team had limited ability to refine and iterate versions of moving camera shots in Case Study 1, once in production, the shots were completed on schedule without compromising the initial plan of moving, multiple axis camera movement on every shot. In Case Study 2, the significant disruptions to camera layout in the miniature set shooting production pipeline had a positive outcome from a research perspective. The miniature set shoot team reacted to the situation with agile flexibility, using the Maya to Mimic to KUKA workflow to produce new camera layout shots on set and publish to the KUKA robot with creative refinement from the director and cinematographer.

Therefore, we realised all shots on schedule in Case Study 2. While this was not a perfect execution of this style of motion camera design, it was a significant step towards a more creatively flexible motion-controlled camera design workflow for this hybrid style of production. I hope that future productions by myself and others will build on these foundations. From a research perspective, the findings from these technical challenges and hurdles were among the most valuable of the case studies.

- To explore other facets of the creative and technical practice of integrating 3D animation and miniature sets into an animation work to improve methods for working in this hybrid style of animation production (including game engines, 3D printing, point cloud scanning and other techniques).

This third aim is more general with many smaller research outcomes. These outcomes were realised by improved techniques using various emerging tool platforms for achieving results within this animation style. Techniques included extensive use of point clouds scans, 3D printing, game engines to realise digital set extensions and smaller side experiments to explore how this technique of compositing 3D animation with miniature set shoots might be improved.

- To further develop an animation visual style working between 3D digital animation and miniature sets builds that I have begun to develop as a director in this medium of animation filmmaking.

While probably the most important research aim, the last aim was the most difficult to document. Central to this research project was an attempt to creatively push the boundaries and visual quality of my animation practice and develop an animation visual style working between 3D digital animation and miniature sets builds that I had previously begun to develop as a director working in this medium of animation filmmaking.

These aims were framed with the following research questions:

- **Camera movement**: Could the research team produce animation using the hybrid animation production style, filming shots on a miniature on-set while not compromising the design and realisation of multi-axis camera movement and rotation? Could we design and improve on a technical pipeline to realise these moving camera shots that allowed improved creative flexibility and iteration of camera movements while shooting on set?

- **Emerging tech (e.g., 3D printing, point cloud scanning)**: What are the benefits or drawbacks of using a range of emerging technologies and technological platforms to enhance the creative and technical processes of this hybrid production style? Which platform added value to the production process regarding creative flexibility and technical facility?

- **Animation style**: Could we use this hybrid production style to demonstrate an animation outcome that stood out and was stylistically distinct and recognisable within the genre of contemporary animation?

Writing and designing an animation film or sequence and bringing the idea through production to the final images on screen usually involves managing creative expectations and navigating a process of creative or technical advantage and compromise. Ideally, initial designs and production strategies can open creative possibilities and create final images on screen that exceed and surprise a project's writers, designers and directors.

There were shots in *Jasper* and *Jarli* that realised on screen what we had set out to achieve, particularly in *Jasper*, which was a much shorter and more contained animation project. In *Jasper*, we created final shots through this hybrid production approach better than I had expected, especially when projected onto a cinema screen.

In *Jasper*, the character of Jasper had more successfully realised stop motion quality while retaining some features of a digitally animated character. The quality of work produced by the collaboration between my directing style and the work of VFX supervisor Mark van den Bergen is at its most successful here. Mark meticulously created light flickering through the tree branches to create a mottled dappled lighting effect. He also filmed real lens flares and used these to add a subtle lens flaring from the sun—all of which helped to integrate the shot's visual elements. Our approach of shooting multiple planes of depth using the same miniature set was successfully in this shot, providing parallax to the camera's left to right tracking. This shot sits in an interestingly different place from either all digital computer-generated 3D animation or an all stop motion production. It is one of perhaps 10 shots from the over 80 shots produced by this research project that exceeded my design expectations.

The two animation projects successfully realised this research project's creative aims and were an inspiration for future projects. In particular, the integration between the visual elements in the shots of Jasper running through the forest (timecode: 00:55) and on the beach looking up at the sky (timecode: 01:27) knit together successfully. As with my previous animation projects using this style, I had industry feedback at the project screenings that expressed interest and enthusiasm for the look and production design approach.

Case Study 1 was a more controlled and contained project that successfully demonstrated the visual aesthetic appeal of this production style. Case Study 2 was more ambitious in scale and generated interesting and valuable learnings regarding the advantages and disadvantages of working with this style of animation production under a more pressured, industry-standard working environment. Case Study 2 contained several shots and sequences that successfully demonstrated this style of moving image.

I consider the most successful outcome in both case studies was that the film's final look is visually distinct from an entirely CGI-rendered 3D animation production. This visual distinction results from a combination of distortions, blurs and other artefacts created from light travelling through real glass lenses. The shapes and forms of the story world created from real objects have a tactile quality that suggests a stop motion animation, yet the feel of the 3D animation pulls the image into an interesting middle ground. The moving cameras in both projects allowed the audience to follow the flow of the shot rather than experience the story as a series of static images, as in *A Cautionary Tail.* This characteristic helps knit the two image production modes together as though they are of the same story world.

These two case studies produced a sliding scale of successes and frustrations in achieving the aims of this research project. However, some shots and sequences came very close to the level of cinematic design quality that the creative team and I aimed for during the project's concept development, and some instances surpassed our initial design expectations.

From this research project's findings and the creative and technical experience of directing the two case studies, I am confident that emerging technological platforms are opening new avenues for producing a feature film scale animation using a hybrid miniature set composited with a digital character production style. I intend to refine and develop this hybrid production process in future animation projects.

This practice-based research project was a successful exploration of animation production methods. The team improved on techniques for developing the use of this hybrid animation production style. We generated useful research outcomes and knowledge to be built on in future projects by myself and, hopefully, others.

6.1 Interview findings

A key method for reflecting on the outcomes of this research project was through a series of interviews (see Chapter 3). Interviews enabled me, the researcher, to debrief with artists and technicians who worked hard on the project and invested their creative energy and technical knowledge into the animation work. Interviews were undertaken in a semi-structured, conversational style by which the artists could express their enthusiasms and frustrations about how the work unfolded and the outcomes from the perspective of hindsight. The interviews were a chance to draw from the collective knowledge of the artists working on the project and discuss how creative ideas, research methods and case study outcomes might be improved in future works. Interviews were also an interesting method to cross-reference my reflections and findings with those of the rest of the creative team.

As a practice-based research project into a creative process, it was challenging to draw concise, concrete conclusions. I think that the most valuable outcomes for practitioners in the field of animation can be observed in the work itself and the behind the scenes videos documenting the filmmaking process.

The nature of this and other creative practices means that the research outcomes are somewhat amorphous, imprecise, and difficult to define neatly. Despite this, I found the interviews conducted with artists, researchers and technicians working on the case studies a useful resource for reflecting on the outcomes of this thesis and arriving at conclusions. Most of the direct referencing of these interviews is in the conclusion sections of the case study chapters (see Sections 4.17 and 5.30). Each participant interviewed drew conclusions and reflections that overlapped and sometimes differed from mine. It has been interesting and insightful to note that each artist was less interested in the technical problems we dealt with during the case studies and more interested in the creative approach to this style of animation production. Most considered the technical complications we encountered could probably be solved more effectively with more time and money, but these technical problems should not be over-emphasised when reflecting on the results of the case studies.

A common theme in my interviews was that the production pipeline set up in Case Study 2 was in some ways an overly complex, wrong-footed approach to the animation and this research project and was further hampered by the COVID-19 lockdowns of 2020. Multiple interviewees reflected that the 3D camera department needed to be more integral to the on-set production team in this style of production. Pre-visualisations established by the digital camera department needed to be treated not as data to be matched by the on-set shooting team but as a sketch from which to build a shot. The interviewees agreed that the on-set creative process of developing a shot lay at the heart of this approach to animation. To compromise this process was to lose the inherently beautiful and unique aspects and attributes of this approach to filmmaking. As Andrew Bluff said in his interview: 'I think it's quite … it's just a very different environment than a digital working environment. And I think there was a lot of fun and buzz around it'.

A particularly interesting set of insights drawn from interviews regarded the use of camera tracking as a part of this hybrid production process. Andrew Bluff and Egan Wesener observed that I seemed to avoid the tracking of camera shots, but perhaps this was not the best approach. It is true that after my experience on my first hybrid animation production, *A Cautionary Tail*, and on Case Study 1, *Jasper*, I concluded that camera tracking shots were something that I could overcome or improve upon with my approach to this hybrid style of animation. I had decided that tracking was a slow, expensive and unnecessarily tedious part of the animation process that I could leapfrog through more effective use of motion control animated cameras and of this data straight into the pre-vis or animation process. Andrew and Egan suggested that it was more beneficial not to avoid tracking but to rely on the improved quality and efficacy of camera tracking tools in post-production. I will consider tracking in future productions if the team is not averse to this process and an experienced VFX supervisor is integrated into the shoot (like in Case Study 1).

Another suggestion common to three interview participants was implementing a hand-blocking system for the on-set camera. In this system, the camera and robot are set into a loose, manipulatable operation mode and physically placed by the cinematographer into positions A and B (and any other in-between waypoints), then these positions are recorded and sent back into Maya. This system would improve camera blocking and make it easier. The ability to set waypoints by hand is easily achieved on smaller robot arms but was not an option for us on the larger KUKAS used for our case studies. Therefore, there is no technical barrier to implementing this suggestion for future projects, only the requirement that this is a feature in motion control hardware and software choices.

All artists and technicians interviewed described a positive, creative experience working in this hybrid style of production. Many expressed frustrations at the technical difficulties we faced, particularly how the team experienced friction between the requirements and priorities of practice-based research and production deadlines, and that the project took place during global COVID-19 lockdowns.

Interviewees described the use of our mimic to Maya camera design process as a success. Nearly all expressed appreciation for the creative benefits of working with miniatures in collaboration with a CGI animation process. As Andrew Bluff responded about miniature set shoots:

And that to me, if you're not doing that (prioritising the miniature set shoot), you're missing out on the beauty of physical shooting, like of, you know, a miniature set. Like that's, to me, I know, you've talked about before, you know, the lighting quality and just the physical and the optical aesthetic of the miniatures. And the beauty of that, I totally get that. But I just I think also just the, the physical shooting around the miniatures that is, is a big, creative thing as well, which shouldn't be overlooked.

6.2 Future works

I currently have several film projects in the screenplay and concept development stages, which I would like to produce using this hybrid production style. This research project has been an opportunity to gain insight, proficiency and perspective on the advantages and pitfalls of embarking on a bigger, more ambitious project using these production techniques.

As discussed in the literature review, over recent decades, animation projects using a process similar to the hybrid animation style explored in this thesis have been produced for television commercial format or short film format, but not for a longer feature film format. One or two productions have stalled at a production dead end after setting out to explore this process and switched to a more industry established all digital 3D animation workflow.

Previously, I experienced resistance from some industry professionals towards the idea of an animation project using this hybrid production style, particularly from producers who consider it too risky and susceptible to scheduling and budget overreach. This concern is not unfounded. A motivation for this research project was to demonstrate techniques to gain perspective, assuage some of these concerns and find creative and technical opportunities to overcome technical limitations. Having had some success with the two case studies, I feel that additional research and development case studies are required to resolve some important production issues. These works could take place as a series of short research and development studies, not as part of an outcome-based animation project (i.e., as standalone tests to clarify areas that remain technically challenging).

Tentative explorations were made of several technical and creative ideas as a part of this research project. Further research should be undertaken before these techniques can be effectively integrated into production. I am interested in further exploring the use of the following in a future case study or animation production:

– augmented reality (or other methods) as an on-set pre-visualisation tool to provide more accurate animation blocking on set to inform cinematography choices. Several interviewees speculated about future studies involving a camera locating

QR code or another visual widget to help locate the robot arm, camera and digital camera in the same x, y, z position and rotation data.

The team made early investigations at each case study's research and development phases into the use of augmented reality for pre-visualising either completed animation or blocked out animation on the miniature sets. However, these investigations were not adopted in the production phase of the case studies. Experiments were conducted in this area by fellow researcher Andrew Bluff (see Sections 4.6 sections). Time and resource constraints and the consequent need to stay focused on more immediate production concerns drove this choice. I consider that there is potential for in-depth use of this technology within this field of research and would like to explore this in future productions.

– clothing simulations for CGI characters that are integrated into the miniature set environment and differentiate the production style apart from stop motion animation.

Creatively, and given a bigger budget, I would like to integrate the use of various other FX simulations, such as water, smoke, fire and dust. Cloth simulations for characters would be an interesting creative angle to explore further within this process (with a dedicated team of artists creating these elements, responding to the creative brief of matching our hybrid, almost stop motion style). This unexplored creative angle on this production style could greatly enhance final outcomes.

– photogrammetry as a creative tool at several different stages of the animation process. Photogrammetry could be used as a fast and more easily integrated camera to set alignment and location strategies that could benefit future hybrid style productions.

– a range of other interesting technical developments in contemporary filmmaking that the team considered exploring for this research project but could not within our time and budget constraints. For example, virtual production techniques to achieve 'in camera' digital set extensions and virtual cameras for shot development could be applicable for works using this hybrid production style.

Integrating photogrammetry as a production technique and a creative medium was intended as an area of research in Case Study 1. However, the team could not explore this area because of the schedule and budget. In future productions, I would like to investigate the use of photogrammetry as a method for transferring miniature props and sets from the physical workspace into the digital workspace. When engaging in reflective conversations with the camera alignment team on *Jasper* and *Jarli,* we agreed that the next step for aligning and orientating our camera to the miniature set to facilitate a direct correlation to the digital workspace without having to re-calibrate or realign could be with a photogrammetry system, using the video footage captured by the camera as the source of data.

An important reflection on both case studies and this research project was that future animation projects using this hybrid production style would benefit from the logistical advantages of both digital and real-world practical miniature set teams housed in the same production facility. There were notable disadvantages to how the case studies were conducted over multiple facilities in different locations. The disadvantages include the logistically difficult and damaging transfer of miniatures from fabrication to shooting facilities. On the *Jarli* project, this was compounded by the digital team's isolation in another city throughout the global COVID-19 pandemic 2020–2021. While this separation and the communication breakdown between digital and miniature crews impacted the outcomes of these animation projects, it also emphasised some of the central creative values of working with miniatures in this production style. There are benefits of having a

digital and miniature set production team collaborating in-person with easier back and forth conversations and collaborations, working with real-world lighting and camera production values of a physical object.

Using a movie studio style shooting facility for this hybrid production style would allow for a miniature shooting space with more than one unit operating during the shoot schedule, easy loading access with a workshop attached and a digital facility in the same location. All teams working in the same studio complex would greatly facilitate future productions. It would enable daily shot development passes as a more collaborative creative process between the digital post-production and shoot teams. This arrangement could allow for more flexibility in the development of shot design at the layout stage of the animation process. An ideal production rollout would see digital layout and miniature set Mimic to KUKA layout happening earlier and more collaboratively. It would be advantageous to have a VFX team visit the workshop and make scans as the miniatures are being built and developed and a storyboard layout team working together from earlier in the process.

The methods and technologies discussed in this thesis have the potential to enable the application of the hybrid animation production style to create larger, feature film animation productions with a striking, unique cinematic style. A more ambitious animation production would be a visually compelling contribution to contemporary animation practice.

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APPENDIX A: SCREENING AND AWARDS

– *Jasper* was screened at the Australian Effects and Animation Festival (AEAF) festival in 2019. It is an industry event that takes place in Paddington, Sydney, and celebrates VFX, Animation, Games and Immersive media. The event includes a speaker program, an awards evening and a technology showcase. Following a day of talks from leading practitioners in the VFX industry, the AEAF Awards Night is a celebration of the best work by digital artists from around the world. AEAF's speakers include VFX Supervisors, Animation and Creative Directors who present to those attending from the industry new, creative approaches to their work and insights into the projects they have contributed to. A short, Q&A session follows each presentation. The team from *Jasper* gave a well-received slideshow presentation and talk outlining the animation production. Jasper also won a Gold award in the awards part of the evening.

– *Jasper* was nominated in the short animation category at the Australian Cinema and Television Arts Awards in 2019. These awards are the most prestigious awards ceremony for the Australian film and television industry.

– *Jasper* was screened for over a year on Qanats inflight entertainment program. I had the interesting experience of sitting next to a young boy and his Father, who were watching the short together and discussing the story. The young boy told me that he really liked the animation but seemed very sceptical when I told him I was the person who had made it.

– In 2018, Jasper won the faculty of Engineering and Information Technology Higher Degree Research (HDR) Excellence Award in recognition of outstanding academic performance and the best individual HDR project of the year.

– *Jarli* screened at the 2021 Sydney Film Festival and the 2021 Chicago International Children's Film Festival and the Brisbane International Film Festival, where it won a Best short film award.

– *Jasper* will be screened from November to December 2021 at the Magic Arts: Australian Animation from 1970s to Now, which draws attention to the past 50 years of animation in Australia, showcasing a cross-section of studio and independent productions from the 1970s to today. This screening program will be presented by the Australian Cinémathèque in the Gallery's cinemas as part of the tenth Asia Pacific Triennial (APT10) at Queensland Art Gallery | Gallery of Modern Art (QAGOMA).

APPENDIX B: SLIDE SHOWS FOR INDUSTRY PRESENTATION

Another important means of reflection, collation and examination of the outcomes of this research project was through industry talks and slide show presentations that I had the opportunity to give on the making of the *Jasper* animation case study. Preparing slide shows for presentation is a valuable and useful opportunity for reflection. These presentations were an interesting process of collating findings in the form on images and video files from the production process. The act of curating these artefacts into a coherent narrative not only initiated interesting conversations with industry peers but helped process and contemplate the successes, failures, creative opportunities, surprises and frustrations of the production process in a way that is valuable for the conceptual development of future projects.

Industry presentations were made at various events and academic institutions in Australia and several larger scale animation and VFX industry expos:

– Women in Aviation, 2019 in both Melbourne and Brisbane

– SIGGRAPH Asia, Brisbane 2019. A copy of a paper outlining the process of creating animation case study *Jasper*, presented at SIGGRAPH Asia in 2019 is included: https://drive.google.com/file/d/1Ez5XpSdpIFIYiJKKBk8pujoy68YIvcpc/view?usp=sharing

– International Animation Comic and Game Industry Expo 2019 at the Shijiazhuang International Convention and Exhibition Centre in Shijiazhuang, Hebei Province in China

– Australian Film and Radio School Masterclass presentation, December 2021.

APPENDIX C: ARTEFACTS AND BEHIND THE SCENES VIDEOS

As outlined in the methodology chapter, the two case studies conducted as part of this practice-based research project produced a number of artefacts integral to the outcomes of the research project. These outcomes include video files for screening purposes.

The outcomes of the short animation productions were video files in three formats: a Digital Cinema Package (DCP), and ProRes and DNxHR Quicktime Video files. DCP is a digital package exported at the lowest compression practical and designed for screening in a cinema digital projection system. The DCP includes 5.1 sound.

The QuickTime Video files were encoded with ProRes and DNxHR codecs. These video files are for screenings through a good quality projector in any environment. Both were encoded at 1920 × 1080. DNxHR and ProRes are widely used as a final format delivery method for HD broadcast files in commercials, features, Blu-ray and streaming. Both these video packages included stereo audio outputs. The Quicktime Pro Res packages were the most screened video outputs in a public setting. Video files are encoded as H.264 or mp4, which is a commonly used format with a higher form of video compression for the recording, compression and distribution of video content.

Behind the Scenes videos

I produced short, less than 10-minute, 'Behind the Scenes' videos for each case study. These videos give another perspective into the team's production processes. These videos are hosted online and are useful to view in conjunction with the animation works as a quicker to digest, more accessible artefact of the practice-based research process.

The video files can be accessed at:

Jasper, Vimeo link: https://vimeo.com/293461406

Jasper Behind the Scenes, https://vimeo.com/294056966

Jarli, Vimeo link: https://vimeo.com/695909564 (password Unaipon)

Jarli Behind the Scenes, Vimeo link: https://vimeo.com/647191611

APPENDIX D: INTERVIEW EXCERPT

The following is an excerpt from an interview with fellow UTS researcher Dr Andrew Bluff discussing the process of working on the *Jasper* and *Jarli* case studies.

Andrew Bluff:

My name is Andrew Bluff and I have a background in software engineering for the entertainment industry. I've worked on audio and video post-production suites as well as lighting, theatrical lighting, desks. And I've also been a sound and music designer and artist, and also dabbled in animation and modelling on a personal basis, which I'm pursuing now to make a computer game. And I've also got a PhD in interactive art, which is, it's more doing live motion capture, and creating graphics and sound based on movements of artists and performers in real time.

Interviewer:

I want to talk a little bit about the case study two research phase, where we worked on calibrating the two workspaces. Can describe from your perspective, how our miniature sets KUKA production developed from that research phase to the actual shoots?

Andrew Bluff:

I might go right back and probably interrupt on the other questions, but so comparing it to *Jasper* where we didn't have the Mimic and ready to animate package, so I guess, going into this test phase for *Jarli*, it was like, 'Okay, so now we've got the ready to animate package, which means we can integrate Maya into the pipeline a lot more readily and correctly, in the hope of giving us more control over the, over that whole process and tighter integration between the digital and physical'. So yeah, the test phase was really the first time we'd ever connected, ready to animate to a robot. And I think it was also Louis, it only just sort of downloaded, you know, maybe at a quick play with ready to animate, but as it was early days for the whole thing. And that reflects in the fact that the first day or two days was basically plugging it into the robot and making that work. Like I think Tran had a few problems with that. We started off with not even being able to quit and control the robot, to actually being able to, you know, use the robot in a real shooting environment. So that's a huge progression, right there. So then, then during that first testing week, we two weeks.

Interviewer:

Basically, we were kind of coming up with systems where we could quickly move sets in and out and align them, scan them into the digital world and align them so that the physical and the digital will line up. And I think we very quickly got close.

Andrew Bluff:

Yeah, and I think also think we maybe got a little bit slower, we kind of realised that getting very close was not close enough if we wanted to actually line up the two work spaces up, because, you know, if you're out by, like half a degree rotation or something at that small scale of shooting, well, you're a long way off actually shooting what you want to shoot. So, you know, we went through a whole lot of trials, Louis great system of making that structure that we could attach the sets to was a great idea. But, again, that was just a little bit out too right? The robot was a little bit out, at one stage we had

a slightly wrong robot file. The amount of the camera was a little bit out, everything you could possibly think of was just a little bit out, which is what happens, because, like that's the real world. Right. So, I think it was great for the first few days. But then I was really longing for the real set to be there, and a real shot to work on. We just need to shoot something and just see if we can work with it and how we're going to work with it. But it worked out fine in the end.

Andrew Bluff:

To take it one step further, we really needed to give our scan data to the animators to do a rough animation on, do a camera pass, and to create a test camera move on that. And then get them working on it for a bit and then get those animation files and test a shoot that way. And just basically just lock it in and be like, okay, now we've got a good starting point for the camera moves.

Interviewer:

And how was your experience working as the kind of point of contact between the digital team and the camera team during the shoot?

Andrew Bluff:

Well, it kinda worked, but, also it didn't really work out like we wanted. For a couple of reasons, I think. I think like, one of the reasons was that it didn't quite ... like, we never quite got the system to work perfectly. But I think the other reason is, once the set was there, I don't think you actually wanted them to line up exactly the way that the digital team had set it out. I actually think that seeing the real sets there and seeing the real thing in camera. I think most of the sets had actually changed enough. Most of the shots changed enough that it was unnecessary to even line them up with what the animated previous shots were.

Interviewer:

I've been writing a little bit of reflection on the shoot and coming to a similar conclusion—that any layout, sort of any design leading up to that moment has to be very, pretty much just the blocking pass, we can't be trying to line up our shots exactly to that. It was just a bit of a waste of time. You really just have to be making your master kind of shots there and then.

Andrew Bluff:

Yeah, absolutely. And that to me, if you're not doing that, you're missing out on the beauty of physical shooting, like of, you know, a miniature set. Like that's, to me, I know, you've talked about before, you know, the lighting quality and just the physical and the optical aesthetic of the miniatures. And the beauty of that, I totally get that. But I just I think also just the, the physical shooting around the miniatures that is, is a big, creative thing as well, which shouldn't be overlooked.

Interviewer:

And for me, it's also the way that you work with a crew, just the way that the creative process happens in that environment which makes a big difference.

Andrew Bluff:

I think it's quite … it's just a very different environment than a digital working environment. And I think there was a lot of fun and buzz around it. And you know, you could do things really quickly and effectively. Yeah, I think it is a really different environment for the shoot than a digital environment.

Interviewer:

So, from that, you know, knowing that what you just said, then if you were say, you know, hypothetically, a producer on an upcoming project using this production method, what would you say to a VFX layout department? You know, in retrospect, how would you plan a shoot like this with a team? You know, that's a pretty broad question, but how would you structure that kind of shot design process leading up to a miniature shoot?

Andrew Bluff:

I think, actually pretty similar to what you did, to be honest, I wouldn't change much. But what I would change was the expectations. So, I guess I would change. You know, when you're giving people digital scans of the of the set, but I think it's very much pre-vis, just to get your head around what we're doing kind of thing, to get everyone on board. Have it just as a as a really good talking tool. So, everyone's on the same page and can get their ideas across.

Interviewer:

Yeah. So, like, you think of it more like a storyboard a digital storyboard? And so it's more just kind of a guideline right?

Andrew Bluff:

Exactly. Yep. Yeah. I think very, probably very useful as that kind of tool.

Interviewer:

Yeah. That makes a lot of sense. All right. I guess my next question was this from a maybe more technical point of view, was sort of, that period of the shoot where our two teams kind of fractured. Where we, we got back on the rails again after a couple of weeks with a kind of work around, and it all went back together again, but you know, you were there at that point, when those two teams kind of fractured and there was that disconnect. Everyone was like, 'oh, hang on none of these cameras work. We'll have to redo all them'. If you could describe that, specifically that breakpoint in the production because you were on the front line of it. How was dealing with all that from your perspective?

Andrew Bluff:

Yeah. Okay. So, from my perspective, like what I was saying before, maybe there was an expectation, which in retrospect, was unrealistic, but maybe at the time, we didn't think it was a big expectation that this, this workflow was going to be very precise. That we could just pick up their layout files, and basically shoot them as they were, and give them back footage that would match up with their digital previous files instantly that they could just slot into their workflow and have everything work like, overnight kind of thing. And I, I kind of it's something that I've noticed, while being at the Animal Logic Academy and stuff is that film, you know, whether it be animation or live action films, everything just seems like such a well-established production. I mean, they, everyone calls it a pipeline, right? Because everyone knows their little place,

and it just goes from one chunk to the other. And you can kind of estimate how much time everything is going to go happen in. But, I mean, still, every movie seems to go overboard, and everyone freaks out at the end anyway.

Interviewer:

Yeah. Totally. Ha ha, that's funny.

Andrew Bluff:

But yeah, but it's very much, okay, you give it to this person. And then you give it to this person, and, and you've got to slot them into where they've got a slot to go in. It's very, like, a military grade kind of production, right? Everyone knows their purpose. Everyone knows what they're doing when they're doing it. Well, that's the goal anyway. And I think, with the problem was that we're doing something that was a bit more research based, and trying out a system that we've never really tried out before. But I feel like those guys, as us, we were all over our head had basically everything was scheduled like, a well-established pipeline, to the fact where they're just like they have animators booked and other people booked to work on this, assuming that they're just going to get finalised products from us straightaway, that they can plug into a workflow. And then, when that wasn't happening, because we were so busy. Or basically, we were just busy wrangling the set-up together on our end to make sure that we could get good quality footage.

Interviewer:

Any footage!

Andrew Bluff:

Yeah. In the first couple of days. It was it was a bit of wrangling to even make sure that you were getting footage, right. And then after that, sort of, got established, it was like okay, now we're trying to wrangle getting decent quality footage that could fit into the whole 3D pipeline. Yeah, I, I feel like the biggest problem was a scheduling problem. If they had have just said, 'okay, you're doing this weird experimental shooting, do what you can do, and then give us the best files that you possibly can after that'. That would have been ok. And then we will start the process from there.

Also, I think, another thing, which really hurt us was COVID. And I think one of the, I think, maybe their lead effects supervisor guy was going to come down to the shoot. And then they would have had more insight of what was going on that they could have trusted, both helping us with everything and also maybe, getting more what they wanted. And also being able to talk to them in a way that they've just like, 'yes, we trust that you know what you're doing' and 'Okay, so it seems like this procedures a bit different than what we thought'. You know, so because we didn't have that, because it was all done a distance and the head the scheduling thing, it got a little bit, a little bit anxious there for a bit. Yeah, it all got a bit sketchy. Yeah. Yeah.

Interviewer:

Interesting, I thought your description of a pipe, you know, the, the use of the word pipeline in the film industry is interesting, isn't it? That is, like, because it is so true. You know, the sort of the business side of filmmaking requires that this kind of creative process, you work like, it's made like a machine like you know, or like water flowing down a pipe, it's gonna go from here to there, and then the pipes going to bend and the water is gonna go that way, you know, it's

sometimes just backwards, and water doesn't always do that. And anyway, and as I you know, I watch a lot of making of stuff, behind the scenes, I always enjoy that stuff. And all the really interesting films, ha ha, they go off the road. You know, like *Star Wars*, the classic example and that was an absolute clusterfuck in a post-production, you know, reaching out and it took them a year just to get it from freak-out back to a place where they could even put it in a screenings in the cinema, and everyone watched it and went this is? 'what the hell is this?' There's always there's always these blank shots on screen with text going, where you know, this will be where the VFX shots are gonna go. Yeah, everyone was like, 'What are you gonna do?' George Lucas describes it as a really horrible and stressful time. Like how the hell are they going to do this? And the VFX team pulled it off in the end, but it was always very close to being a disaster. Yeah, right. Like all the interesting films I can think of pretty much don't go, you know, they really just don't go in that the way that a producer would like him to go.

Andrew Bluff:

No. Because, yeah, a producer is about being efficient, I guess. Yeah.

Interviewer:

And productive! They have to actually produce the thing! In some ways, I think for producers, it's like, how the art goes. It can totally be kind of, sort of a creative thing. So then, so creatively, it's like, I can match up this person over here with this person over there. And then by this date, we're going to hit this mark, and it's like a creative process. It is it's like conducting an orchestra or something. I think I get it from their perspective. And then it doesn't always, then the violin section starts running off, over there somewhere.

Andrew Bluff:

Which is, yeah, I guess. Maybe it's just something that has to happen. I don't know, maybe. I'm sure there are lots of projects. I mean, I can't think of any but lots of projects where they don't have a producer and they have a more creative approach. And then just the thing never gets done. It never happens.

Interviewer:

Exactly. Exactly. People come to me all the time. And say, 'I have got this great project', I go, 'have you got a producer?' And they say 'no', and I like, want to stay away from that project. So that's the other angle. Ha, ha, you're screwed either way.

Andrew Bluff:

Yeah, basically.

Interviewer:

But um, okay, one other question about all that. So, I'm trying to write about this a bit in my thesis, and I've done kind of a version, but I'm not going to give you my version, because I'm interested to hear your version. So, you know, we were sending them our new Maya cameras, right, you were packaging up all that and sending them across, they would open

them with the video file from the red camera, and the world was just rotated right off. Completely off. Why didn't they line up?

Andrew Bluff:

Okay, so what we got from the robot was the exact path that the camera moved through, right? We've got the exact movements of the camera. Right. So that was, I think that was successful, I think that we did get the right, the right moves. Unfortunately, what we didn't have was any orientation about where those moves happened in space, and what angle those camera moves started with in space. And now, we did have the times and we did we did have the start time and the end time.

Interviewer:

Yeah, I think we did. Yeah. So that was fine. But it wasn't accurate in orientation. Yeah.

Andrew Bluff:

Yeah. So, so the process to line those things up, was basically trying to find something in the in the video footage, that would be easily identifiable in the scan set and then lining them up visually, which you could do, but it was you couldn't do it, so that it was 100% aligned on every axis, like, you know, if you just were off by a couple of degrees on one angle, you know, it would still look fine in the footage. But then when the camera panned, like five seconds later, when the camera moved, it was like, oh, no, actually, we've gone way off that way when we should have gone off that way.

So, it was like, for the quality of scans we had and the quality of footage, which was fine, it wasn't enough to get you amazingly accurate placement spatially and also to angles of rotation, was the problem really.

And then, you know, once you've figured out that you had gone on the wrong angle one way, you basically had to go back to the start and then realign it again and then go back again—like, you couldn't just find two points and say okay, that's lined up, and that's lined up now computer go and sought it out, which, there probably is a mathematical way to do that but wasn't built into our software and we didn't plan for it.

Interviewer:

Something for next time.

Andrew Bluff:

Yeah, maybe. I think a better way to do it perhaps is if we had some kind of three-dimensional widget, like a QR code or something, a three dimensional QR code that was physically attached to the sets, somehow, obviously in a placement that we didn't need to see in the actual footage, but that we could scan, you know, it wouldn't move, it would be scanned with the set. And then the first shot of the frame was always a good, maybe a good solid pan around that object or something. And then, and then you go and do your footage after that.

Interviewer:

A fix it button.

Andrew Bluff:

Ha ha. Yeah, I kind of feel like, if you're really, really going to pursue this, like you get some, you know, imaging specialists to build into maybe Maya or something. A thing where, where software can then just like see these widgets and determine where they are in space. And then that lines everything up.

Interviewer:

Yeah, we've been, we've been talking about maybe in a future test, experimenting, just without any scanning, just using the camera data, so the video files are, like the spatial locators. So, to try using photogrammetry to, to be how that process is done. So do want to move where the camera does a move around set, plug that in and see if we've got a decent scan, and then we know we're relocating relative to the film back exactly, theoretically, because it's actually the camera gathering the data rather than attaching another scanner, which then you got to account for the offset between the scanner and the camera. Right.

Andrew Bluff:

Yeah. And that's the thing, the scanning is good to the eye. But it's not 100% right, either way.

Interviewer:

It's a whole different world space, isn't it? It's a different world space, then you've got to go and align those two worlds.

Andrew Bluff:

Exactly.

Interviewer:

My next question, in a way, I think we've started talking about it before. So, you were on board, right from, you know, the first project, working on the *Jasper*, where we didn't really have, we had a pretty rough way of getting that KUKA working. But, kind of, the end result was quite nice. The *Jarli* project, which was a bit more like, like testing this thing within the context of a bigger production, with many more shots, many more sets, a more realistic environment in a way than *Jasper* was. And then so how would you? How would you approach, as a researcher, a third project? If we were to say, okay, learning from Case Study 1, to Case Study 2, if we were to go to a third case study or another production? What would you want to improve on in your approach to all that scenario?

Andrew Bluff:

Yeah, so, one, one thing that I was thought, which would be nice is, I wouldn't mind trying to line up, the camera moves with the camera itself. So, because I always kind of thought: That's what we care about, we care about the actual footage. In the end, we don't care about where the robots going, that's just a means to an end. What we actually care about is what the camera telling us. What the camera is saying. Yeah, so like I was saying with the widget, maybe if we had just like some dots on the set, which were in the scan would have a known location, you know, very accurately measured, that we're, you know, on, either side or on like on a corner using a corner piece of a set or something. And you've got like three dots on this corner and three dots on that corner, and you make the KUKA robot, using video software so that way you can see the

exact centre of the video frame point at each of those three dots. And then that should be enough. Still, yeah, I don't know, it's a good question and, yeah, I don't know. Ha ha.

Interviewer:

You're basically saying that, using the camera itself, which is sort of what the tracker does in a way, isn't it likely because we did end up tracking anyways. What I was interested in is, just to follow on from what you just said, was that how, I felt like I spent quite a lot of the time and those two case studies almost going, how can I avoid this tracking thing? Because that's kind of that's the post-production nightmare. But it turned out when we got to tracking on this one, while *Jasper* was tricky. But on the *Jarli* project, well, maybe because tracking has come along a little way, they did it quite quickly. Yeah, so the tracking wasn't something to be afraid of, you know, the process wasn't so time-consuming. Although, ha ha, the producer may not agree with me.

Andrew Bluff:

I was surprised that the tracking was so difficult on *Jasper*. I don't know why, why that was the case. I wasn't involved in it. But I was surprised. But it's good that in *Jarli* it went much better. And like, who cares? Like, do you know what I mean? Just have it as a thing.

Interviewer:

Right.

Andrew Bluff:

And in that case, you're all about, okay, so how do we get the best camera moves on the day so that we're shooting quickly and efficiently. And I actually think the, you know, the pipeline of like, basically getting a start and an end point in the robot. So, I think a good thing would be is if you or the camera operator, could just grab the camera, right, with the robot in passive mode, and just go, we want the shot from here. And we want it to go to here. And we record those two points in the robot. And it knows exactly where those two points are. Maybe a third point, whatever, if you want to get tricky. And then we just send that back to Maya and the Maya person can be like, 'okay, here's the exact path that we want to want to go through'. Or maybe you've already got the path set up. And it's just adjusting those two different endpoints. And then just send it back to the robot. I think we kind of did that a little bit. But yeah, without being able to actually grab the robot, I guess. And another thing, another thing would be nice, I feel would be to be able to have it in passive mode. So, the camera operator could just, unencumbered by the robot, just do a pass. And record that.

Interviewer:

Like you can with the smaller desktop robots. Yeah, that's basically exactly what [cinematographer] Evan says when I interviewed him.

Andrew Bluff:

Yeah. I mean, the problem with the small ones is they weren't that stable. Right, so it was good that we used the more robust ones. But I think, I don't know, I feel like there were instances where you would want to just be like, I kind of know

how to do this shot, I just want to go from here, and I just want to go over there. I just want to be able to just do that and have the robot say okay, that's what you do. And I'll record that.

Interviewer:

Yeah.

Andrew Bluff:

And let's just play back and let you tweak that and smooth it out if you want to. So, less emphasis on trying to remove the tracking or trying to you know, not even trying to line up the physical and digital unless we think that's worthwhile, but more emphasis on what creative opportunities does this give the workflow? So, asking more whether it is helping the hybridisation between physical and, and the motion paths of the robot on shooting day I think would be useful. Not worrying about the tracking side and just doing the tracking afterwards. Not worrying about where the cameras were laid out beforehand. Because the other thing I noticed is that, you know, you've got all these great pre-vis tools, like we had augmented reality there to be used, and we, you know, had all the digital scans and the shots of the characters in the digital world but you guys didn't really need, you had it in your head. Like you knew what you wanted to do. You know, the camera operator knows what they want to do or what looks good. They want to see it in real life. So, like, just improving that workflow on set. Having the robot not get in your way, but just sort of helping things, I guess. Yeah. I don't know if I actually said anything and all that rambling.

Interviewer:

That's all great! Really interesting. Yeah, just about the augmented reality. I agree, like it was really interesting to experiment with when we did. But then on set, I feel like we didn't ever feel like, 'oh, wouldn't it be great to have that now?' When you're in the sort of pressure of shooting? I think you're absolutely right, a good storyboard is fine, like, you know, that it's gotta just be a simple visual idea. Like, it's gotta start here, and it's going to go there. And the extra technical layer of pre-visualising that with an iPad or something was not really going to help that necessary.

End of Interview.

Although the research work on both animation case studies set out to simplify and streamline the technical process of combining 3D animated characters with miniature set shoots, at times this process focused to heavily on the technical complications of combining 3D animation with miniature set shoot footage. Perhaps our research approach focused a bit too heavily on trying to negate the need for any kind of camera tracking process. I set out on this research project with a somewhat naïve idea in mind: That if the team used motion paths published to a robot arm, then these same motion paths could be used straight into other departments like compositing and animation. This wasn't the case, and we may have spent too much time and resources realising this. Despite these technical complications, the research team made significant and positive steps towards the central aim of this research project, which was to realise an improvement in this hybrid animation production style while being able to freely design and realise moving cameras when and wherever we felt that the story required them.

All artists and technicians that I interviewed expressed a similar thought: That the end results of the two case studies were successful and that the overall creative value of this hybrid production style process was creatively rewarding and worth the effort. The team were able to make interesting inroads into ways to improve and facilitate this approach of making

animation, particularly in the use of robotic camera control. The development of this process from the first case study to the second showed a clear degree of technical improvement, facility and creative control. All of the artists and technicians expressed excitement and interest in further developing the style, proposing a range of different approaches to doing this.

Fellow researchers Andrew Bluff, Louis Pratt and Tran Dang discussed similar ideas of researching the camera location problem from a new perspective in a future case study. A common theme from a number of interviewees was using the camera film back itself as the location device through the use of photogrammetry.

APPENDIX E: ZOETROPE

During the production of the animation, particularly on the miniature set shoot, we used 3D printing as lighting references for our lighting and compositing team. Art director Louis Pratt uses 3D printing extensively in his art practice. Therefore, as a side experiment to Case Study 1, *Jasper*, we collaborated with ProtoSpace, the University of Technology Sydney's 3D printing facilities, to produce a working zoetrope with the Jasper 3D character model as a subject (see Figure E1).

Figure E1: Jasper zoetrope.

A zoetrope is one of several early developments in the art of moving pictures, before the advent of motion picture photography and modern cinema projection. It is considered one of the many mechanical devices developed as a precursor to animation and cinematic art forms.

Like other pre-cinema moving image devices, a zoetrope is a spinning mechanical wheel that displays a short sequence of movement, usually a second or less in duration, broken down into a series of rapidly displayed still images. Sometimes these images are shown through a view port or a frame; however, in more contemporary practice, zoetrope artists have used strobe lighting as a method of creating the illusion of a physical, sculptural image come to life.

We decided to use the run cycle that Greg Naud had done as an animation test and experiment. Greg went back to this test and refined the run, breaking it down into a number of different frame rates. Art director Louis Pratt and I tested different ways to break down the one second run into animation frames to be 3D printed and placed into a moving image sequence. Tran Dang and Gwyn Jones at the UTS Advanced Fabrication Lab engineered the structural component of the zoetrope and installed the electric motor.

With some testing back and forth between Greg Naud breaking down the animation and the zoetrope fabrication team, we arrived at a breakdown of 32 frames distributed into individual physical models, printed in nylon 5 at approximately 12 cm in height and installed onto 1.5 m diameter spinning disc.

Exhibiting the zoetrope at the Avalon Airshow was probably the most popular part of the exhibition experience. The effect of seeing 32 animation models as physical 3D frames come to life and run drew a crowd. It enhanced the thematic underpinnings of the exhibition by evoking in young audiences a sense of technical curiosity in how animation is made.

APPENDIX F: EXHIBITION AT THE 2019 AVALON AIRSHOW

The Australian International Airshow and Aerospace and Defence Exposition (Expo), known more commonly as the Avalon Airshow, is held every two years at Avalon Airport, located between Melbourne and Geelong in Victoria. Airshow organisers claim that it is the largest air show in the southern hemisphere.

Jasper's story and themes deal with the dream of flight. The animation was an attempt to spark interest in young people to engage in science, technology, engineering and mathematics. The project received funding from the Royal Australian Air Force. Therefore, the team decided that the Avalon Airshow was a fitting place to present a *Jasper* themed exhibition of the animation project.

The 2019 Australian International Airshow and Aerospace & Defence Expo broke exhibitor and trade day attendance records. Many school groups from around Australia attended the week-long event. It was a good interface for young children to engage with the animation project's themes and to gain perspective of how an animated film is made. We had approximately 50 m^2 of floor space in one of the principal exhibition areas. I was in attendance throughout the exhibition. Despite the heat, was a fantastic opportunity to engage with audiences and young people interested in aviation and animation.

We transported the miniature to the Avalon Airshow and set up a shot with the Blackmagic camera moving across the set on a smaller UR10 robot arm. This camera fed a live image to a screen beside the set. Audiences could watch the live camera feed on one wall of the exhibition, while on another wall they could see the animation film being played on a loop. This was effective for exhibition attendees, especially the younger school children as they had a simple a visual breakdown of an important part of the animation process without it being verbally explained. They had to look back and forth, arrive at an understanding and connect the two elements for themselves. The miniature world in front of them was the same world they were looking at in the movie. This was an interesting 'penny drop' moment to observe in many of the young children. I think it helped enhance the exhibition's thematic goal of encouraging young people to become interested in technical careers, whether in animation movie making or aviation.

As part of the Jasper exhibition, we wanted to create an experience that used a physical, sculptural installation work drawing on the themes of the animation. This included the dream of flight and the possibilities that an interest in science and technology open up a young person's career choices.

Exhibition outcomes

The exhibition event at the Avalon Airshow gave valuable perspective on the creative outcomes of this research project. We had a wide range of attendees at the exhibition including state and federal politicians, the Chief of Airforce (Australia), the Minister for Defence and many groups of primary school and high school students. From my perspective overseeing and managing the exhibition daily, all attendees displayed engagement and interested in the animated short film and also with the exhibition items describing how the animation had been produced.

It was an interesting experience as a director who has had most of my work distributed through film festivals and online streaming platforms such as Vimeo or YouTube, to have the opportunity for daily interaction and conversation with a wide variety of younger and older people. We discussed the nature of my animation work and I gained insight into those

elements of the production process that might be working well and those that did not translate clearly onto the final screen experience with the significance or effect I had anticipated in the reaction of audiences.