CREATEWORLD 2018
CREATIVITY IN PROGRESS

Conference Proceedings

AUC

Contents

Welcome

Welcome to CreateWorld 2018 - our 12th year year for this event, and the product of a successful and much valued partnership between the AUC and the Queensland College of Art at Griffith University.

This year, our theme is "Creativity in Progress". Creativity is recognised as an important defining trait of humans. But what is creativity like across disciplines and fields of research - is it the same, is it different, is it contextual or universal. The topic this conference explores is, what does creativity look and feel like in progress? What do projects, ideas and work in progress have to show us about creativity. Is Creativity evidenced more in process than outcome? Can the realms of computing offer insights into creative emergence?

The major conference tracks include peer-reviewed papers, posters and abstracts, presentations, workshops, an exhibition, and performances. There's something for everyone and I hope you're challenged and engaged throughout the event.

No AUC conference would be a success without the hard work put in by the paper authors, session and workshop presenters, exhibition contributors, and partners, and we thank them all for the many hours they've spent preparing, as well as the time they've given up to be part of the conference.

I'd particularly like to thank my co-chairs, Daniel Della-Bosca, Seth Ellis, Dale Patterson and Rae Cooper for the substantial work that they've done to bring everything together. Dale coordinated the peer review process, Seth coordinated the exhibition and performances, Rae ran our social media promotions and executed some incredible artwork as part of that promotion, and Danny did almost anything and everything else required to ensure this year's event is a success.

I hope that you find that the next 3 days inspire you, and encourage you explore new aspects of your own creativity in whatever field you're able to apply it.

I wish you a great conference!

Tony Gray,
Chair, AUC

Our Code of Conduct

We aim to provide welcoming and professional environments so that people regardless of age, race, gender identity or expression, background, disability, appearance, sexuality, walk of life, or religion can work together to share experience in the use of Apple technology.

Please be respectful of others and be courteous to those around you. We do not tolerate harassment or offensive behaviour.

Complaints about harassment or offensive behaviour may be made to the conference organisers. All complaints will remain confidential and be taken seriously.

Any person asked by an organiser, convenor or moderator to cease harassing or offensive behaviour must comply immediately.

At the discretion of the organisers, a person violating our code of conduct may be excluded from the conference without refund.

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- offensive verbal or written remarks related to gender, sexual orientation, disability, physical appearance, body size, race or religion
- sexual or violent images in public spaces (including presentation slides)
- deliberate intimidation
- stalking or following
- unwanted photography or recording
- sustained disruption of talks or other events
- disruptive intoxicated behaviour
- inappropriate physical contact
- unwelcome sexual attention
- sexist, racist, or other exclusionary jokes

Our full code of conduct can be found at:

> http://auc.edu.au/policies/code-of-conduct/

Program

WED 28 NOVEMBER

10:00

11:00 **11:00 Registration, Tea & Coffee Available**

12:00

12:45 Welcome and Conference Opening – S05 QCA Lecture Theatre, Room 2.04

1:00 **1:00 Keynote - Massimo Banzai**
S05 QCA Lecture Theatre, Room 2.04

2:00

2:15 Algorithmically Generating Musical Complexity Based on Textual Complexity; A Case Study
Daniel Field

3:00 **3:00 Afternoon Tea,** S02 Webb Centre Room 4.05B

3:30 Papers Track
Creativity, People and Ideas
S02 Webb Centre, Room 4.02E

4:00

3:30 Community Principles Powering the…
Mars Geldard
4:15 Mobile Technologies Supporting Creativity:
Brett Voss
S02 Webb Centre, 4.02F

5:00 **5:00 Exhibition Performances and Opening**
S02 Webb Centre, Room 4.02A

6:00

THU 29 NOVEMBER

9:00	

10:00 Papers Track
People, Creation & Play
S02 Webb Centre, Room 4.02E

10:00 Adobe Workshop
S02 Webb Centre, Room 3.07 Mac Lab

10:00 How Do I Game Design?
Workshop
S02 Webb Centre, 4.02C

12:00 Lunch
S02 Webb Centre, Room 4.05B

1:00 Papers Track
Building Games
S02 Webb Centre, 4.02E

1:00 Adobe Workshop
S02 Webb Centre, Room 3.07 Mac Lab

3:00 Afternoon Tea - S02 Webb Centre, Room 4.05B

3:30 Abstract/Poster Track
Creative Sound
S02 Webb Centre, Room 4.02E

3:30 Digital Art Out West
Iain Anderson
4:15 Game Engines and Machine Learning
Paris Buttfield-Addison
S02 Webb Centre, 4.02F

6:00 Conference Dinner
Ship Inn

FRI 30 NOVEMBER

9:00

10:00 Abstract/Poster Track
S02 Webb Centre, Room 4.02E

10:00 DIY PCB – Designing & Manufacturing Your Own Printed Circuit Boards
S02 Webb Centre, 4.02C

10:00 Game Development on macOS with Godot
S02 Webb Centre, Room 3.07 Mac Lab

11:00

12:00 Lunch
S02 Webb Centre, Room 4.05B

1:00

3:30 Abstract/Poster Track
S02 Webb Centre, Room 4.02E

1:00 RoboCoder: Robotics and Visual Programming Workshop
S02 Webb Centre, Room 3.07 Mac Lab

2:00

3:00 Conference Close - S02 Webb Centre, Room 4.02F

4:00

Keynote Speaker

Massimo Banzi

Massimo Banzi is the co-founder of the Arduino project. He is an Interaction Designer, Educator and Open Source Hardware advocate. He has worked as a consultant for clients such as: Prada, Artemide, Persol, Whirlpool, V&A Museum and Adidas.

Massimo started the first FabLab in Italy which led to the creation of Officine Arduino, a FabLab/Makerspace based in Torino.

He spent 4 years at the Interaction Design Institue Ivrea as Associate Professor. Massimo has taught workshops and has been a guest speaker at institutions allover the world.

Before joining IDII he was CTO for the Seat Ventures incubator. He spent many years working as a software architect,both in Milan and London, on projects for clients like Italia Online, Sapient, Labour Party, BT, MCI WorldCom, SmithKlineBeecham, Storagetek, BSkyB and boo.com.

Massimo is also the author of "Getting Started with Arduino" published by O'Reilly. He is a regular contributor to the italian edition of Wired Magazine and Che Futuro, an online magazine about innovation.

He currently teaches Interaction Design at SUPSI Lugano in the south of Switzerland and is a visiting professor at CIID in Copenhagen.

photo by David Cuartielles

Community Presentation Track

Algorithmically Generating Musical Complexity Based on Textual Complexity; A Case Study

Daniel Field, Griffith University

This presentation gives the audience a quick tour through the development process for the 'Word Score Sonifier', a Python script that takes English text as input and provides a four-part vocal score (soprano, alto, tenor, bass) as output in MusicXML. The Word Score Sonifier was rapidly developed for the 2018 National Science Week 'Textual Data Sonification and Algorithmic Composition Competition', where it won the open category.

The focus of the presentation will be on the musical and creative choices embedded in the algorithm, both express and implied. The presenter will trace the intent to create a flexible composition algorithm capable of producing outputs spanning a stylistic range; how that intent was incorporated into the algorithm by means of flexible procedures, and how the notion of textual complexity was used as a control parameter and mapped to musical complexity using common-practice tonality and major modal theory as a reference. The audience will hear examples of compositions and will be able to judge for themselves the extent to which the intent may or may not have been fully realised.

Community Principles Powering the Largest Ever Hand-crafted Virtual World*

Mars Geldard, University of Tasmania

*…we think.

Westeroscraft is a project based on the block-based building game Minecraft, in which a few hundred unpaid strangers have spent the last 8+ years tirelessly recreating the world of George R. R. Martin's A Song of Ice and Fire series block-by-block. Given that every piece of the world, even the terrain itself, was custom-made from scratch, several sources have suggested it to be the largest hand-crafted or contiguous virtual landmass ever made. It exists at the intersection of art and technology, and has been the topic of countless podcasts, articles, and Let's Plays, was featured in TIME magazine in 2013 and is currently showing in the Victoria & Albert Museum's Videogames: Design, Play, Disrupt exhibition in London.

Creating and promoting an expansive virtual world with a cohesive brand and vision, especially on free labour and across global timezones, is no mean feat. Westeroscraft is an open project like any other: people who don't know each other each want to see the realisation of an idea, so they come together and combine their segments of work to make a whole. This produces the same benefits we see in comparable software or collaborative projects, but suffers from the same issues: agreeing on the end goal or big picture doesn't mean there aren't disagreements on the best path to take or the implementation of specifics. It has many of the same needs as other projects: comprehensive documentation, conflict resolution, and finding the right balance of quality control versus creative freedom, in a structure with ambiguous or nonexistent hierarchy. Common issues are also exacerbated by our being entirely donation-funded, meaning poor community culture could make the difference between being able to keep the lights (or in this case, servers) on.

In this talk, a contributor from the project will reveal the administrative and community management practices employed by Westeroscraft to address issues including:

- planning and organisation strategies,
- decision-making and conflict resolution examples and techniques,
- review/quality control, and
- community engagement and non-contributor inclusion;

and discuss their applicability to other community or open source creative projects. Also, pretty medieval castle pics.

4:15 Wednesday - S02 Webb Centre, Room 4.02F

Mobile Technologies Supporting Creativity: Design Principles for On-Demand Technology Education

Brett Voss, Griffith University

Creativity in a modern sense requires engagement with the use of technologies. Often using these technologies requires learning techniques throughout the creative process. This is particularly the case in the area of music production, where learning and creating are intertwined. Mobile technologies that support the creative process have a part to play through providing on-demand learning opportunities. Designing learning environments to facilitate this process effectively, requires thoughtful consideration. This presentation will offer an insight into the design principles relevant to on-demand mobile learning in the creative arts. It will present a case study of how mobile technologies were used to support students learning skills in popular music production.

3:30 Thursday - S02 Webb Centre, Room 4.02F

Digital Art Out West

Iain Anderson, Training Brisbane

Earlier this year, I had the opportunity to travel to Blackall, to help the community with some digital art projects. I created a 360° photo trail that runs through the main street, and an iPad app as part of an exhibition in a local gallery.

This practical talk will show you how you it was all created:

- handling the 360° camera
- processing 360° HDR photos
- collecting and processing video interviews
- creating a user interface to link a real-world photo wall to the videos
- implementing the app in Tumult Hype
- packaging the HTML output in Xcode as an app

With the techniques discussed here, you could create similar projects to help preserve and showcase your own community's work.

4:15 Thursday - S02 Webb Centre, Room 4.02F

Game Engines and Machine Learning

Paris Buttfield-Addison, Secret Lab Pty. Ltd.

Learn how to use Unity to train, explore, and manipulate intelligent agents that learn. Train a quadruped to walk. Then train it to explore, fetch, and manipulate the world. Games are great places to explore AI. They're wonderful contained problem spaces. Learn how to use them, even though you're not a game developer.

This session explores using popular game engines, such as Unity, for machine learning exploration, training, and education.

Learn:

- how video game engines are a perfect environment to constrain a problem and train an agent
- how easy it is to get started, using Unity
- how to build up a model, and use it in the engine, to explore a particular idea or problem

This session is for non-game developers to learn how they can use game technologies to further their understanding of machine learning fundamentals, and solve problems. It's a little bit technical, a little bit creative.

Exhibition & Performances

Process Is Progress

CreateWorld has always been devoted to the real uses of emerging technology in education, art, and the crossover of the two. This year, the conference exhibition is a larger collection showcasing process-based work from local and national artists.

These are works that require participation to be activated—VR environments, wearable objects, interactive devices. They are also artworks devoted to exploration, and discovery through making. Like CreateWorld, the exhibition celebrates the idea that art, like technology, exists in motion, always in process, always going forward.

The CreateWorld exhibition features the work of Paul Bardini, Sebastian Beswick, Andrew Brown, Daniel Della-Bosca, Mark du Poitiers, Mars Geldard, John Ferguson, Nina Grima, Leah Gustafson, David Harris, Grace Herrmann, Nina Mizraei, Kierra-Jay Power, Gerard Rutten, Jessica Salmon, Pamela See, and Ning Yi Yeoh.

Webb Gallery, opening event 28 November 6-8pm

Associated Exhibitions

Shifting the Posts

Shifting the Posts is an exhibition that brings together a selection of visual artists whose emergence coincided with the advent of post-digitalism and Griffith University researchers who are engaged with expanding this germane field of practice.

The contributing artists include: Anastasia Tyurina, Blair Coffey, Luis Cantillo, Raymond Ghirardo, Megan Roberts, Lily & Honglei, Li Gang and Pamela See.

Webb Gallery, opening event 28 November 6-8pm

The Art of Science Communication

CreateWorld will also host the re-mounting of the exhibition *The Art of Science Communication*, curated by David Harris at the Sydney Powerhouse for the Australian Science Communicators 2018 conference. This work will be on display with the CreateWorld exhibition in the Webb Centre, level 4.

No Bodies Perfekt

No Bodies Perfekt features selected outcomes of David Sargent's Doctor of Visual Arts research project. Exhibited work explores the use of hand-lettering and augmented reality to communicate body shape diversity and disrupt physical advertising spaces.

Grey Street Gallery, opening event 30 November 6-8pm

Paper, Poster & Abstract Track

Each session runs for 20 minutes, with 5 minutes breaks between sessions.

3:30 **The Divinity of the Machine**

Phil Aitken

This article is an extract from my PhD. In my research I considered the primacy of meaning, consumption and the divinity of the machine. The era of interest was the machine age. This was an era of rapid scientific and technological development, declining religiosity, and the acknowledgement of the individual in western culture. Considering the enormity of this paradigmatic change, I consider the notion that the machine has paramount importance, not only in preserving, sustaining, and advancing humanity but also in the deepening process of how we construct meaning and spirituality in a mass–production and mass–consumption society. I suggest that perhaps the machines producing our items of consumption have taken on a divine importance within adapting cultural systems and continued technological advancement. In this extract, I considered how some 20th century artists have utilised and considered the machine in their work and how a sense of the divine can be applied to the machine.

3:55 **Design is Like… Making Sense of Things**
Through the Creative Use of Analogy

Mike McAuley

This study discusses analogical reasoning and its role in creative problem solving. Specifically it looks at how novice first year university design students responded to the task of communicating a complex topic through the generation of a visual analogy; in this instance the task of explaining some aspect of what design is. Students were introduced to various theories about design and design process. They were also introduced to theories around analogical reasoning, particularly those around mapping. The students were then asked to demonstrate their understanding, not through critical discourse, but through applied creative practice. To provide a context, students had to create an illustration with the title 'Design is Like…'. The findings suggest that the praxis based approach acted as an empirical bridge between theory and practice, providing students with an identifiable creative strategy and meta-cognitive awareness of their own design process.

4:20 **The Journal of Brief Ideas: An Intervention into the**
Academic Publishing Ecosystem

David Harris and Arfon Smith

In this paper, we describe a contribution to the scholarly publishing sphere in the spirit of artist intervention. The Journal of Brief Ideas (JOBI) is based on the idea of papers as microcontributions having a maximum of 200 words and one figure. JOBI is wrapped in the academic norms required for broader recognition as an incentive for authors to participate in this experiment. It has published 239 papers since launch in February 2015 and been cited in top tier journals and covered in news reports in leading journalistic publications. We present a descriptive content, citation, and commentary analysis of the journal with discussion its existing and potential influence and roles. We conclude with a brief discussion of the connection between the journal's structure and ideas in creative ideation.

10:00 "You've Got A Friend in Me!": The Fellowship of the 'Others'

Charulatha Mani and Taana Rose

This paper describes a creative work in progress. Two women vocal performers from diverse traditions come together with technology to create a textured soundscape. Using artistic practice as process, the methodological framework adopts artistic experimentation as the key method. Adopting the overarching philosophy that Otherness comprises of the marginalised, the vulnerable and the machine, we draw on Donna Haraway's notion of 'becoming-with' technology. We draw on lullaby from the South Indian tradition of music as the primary content. Drawing on key syllabic elements from the lullaby tradition, we compose and improvise using technology as the facilitator and partner, on a technologically created textured substrate. The outcomes showcased here include sound files of failed and successful attempts, as well as spectrograms depicting the key moments in the composed-improvisations.

10:25 Realistic vs Stylistic: An Exploration of the Expressive Abilities of Stylisation in 3D Art

Angus McMeekin and Reza Ryan

Video game art styles have a great impact not only on how a game is initially perceived by an audience but also on how it is experienced. Through an understanding of the capabilities of each art style, developers can better design experiences that utilise their chosen art style to enhance gameplay, themes and emotions. However, these capabilities have not been fully explored, particularly within video games. For example, a small amount research in visual media outside video games suggests that non-photorealistic art styles typically contain more expressive qualities. This study aims to further explore this art trend through an expressive analysis of the stylised art style compared to the realistic art style, fill the gap in knowledge and as a result, provide a better understanding of the expressive qualities of the stylised video game art style. This research first explores what expressive qualities stylised art contains and collaborates them into a framework that can be used for the development of expressive stylised art. This framework is then applied to a stylised recreation of a AAA quality realistic environment. Both environments are then comparatively evaluated using participant testing consisting of playtesting followed by questionnaires. These questionnaires survey the participants on whether they felt either environment effectively expressed a mood, which moods they were able to identify and whether either environment displayed 'artistic qualities'. The data gathered from these questionnaires will then be analysed to provide a conclusion on which art style displayed more expressive qualities. It is expected from this data that the stylised art style will be received more favourably for its expressive abilities while the realistic will be perceived as more artistic. The conclusion drawn from this study can then be utilised by developers and artists to better guide the design process, providing a deeper insight into the abilities of each art style and how they may impact their games.

10:50 Digital Play – Making New Links in the Brain

Dale Patterson

This paper explores the way the human brain functions and how digital play causes differing elements of the the brain to interact with each other in ways that they normally would not. The potential for this play driven cross brain activity is aimed to inspire new creative thoughts and outcomes for the player. The paper explores the use of game-play based systems in a number of applications and demonstrates the capacity for such digital play systems to enhance our personal capabilities in education and creative practice.

11:15 Re-directing the Lens

Sonia York-Pryce

This paper seeks to examine the role of the older, experienced dancer through digital documentation. This is followed by a discussion regarding the project and its aims to make visible the older dancing body on screen, a rare occurrence within Western society. It questions why in the Western dance world, the sentiment is no different, ageing remains a taboo issue, holding prejudice towards the corporeal difference of the older, experienced dancer.

1:00 Search-Based Procedural Generation for First-Person Shooter Maps

Dylan Ward and Reza Ryan

Over the past three decades, video games have become one of the most popular forms of entertainment in the world. This increase in popularity comes with a demand for frequent and quality content from consumers, however, delivering on this demand costs companies time and money.

The aim of this research is to identify, develop and evaluate a method of procedurally generating maps for multiplayer first-person shooters using a genetic algorithm (GA). Past research in the field of search-based procedural generation in first-person shooters (FPS) has allowed for little customization, not used evaluation techniques based on proven level design techniques and has not been verified via user testing.

The objective of this research is to design an algorithm to generate maps automatically in a way that requires little manipulation from designers and test the generated maps on participants. The quality of generated maps is evaluated based on measuring the tension levels of an AI agent in a simulated match. Previous research in this field has allowed for little customization, this algorithm will be easily customizable, allowing designers to create levels of various shapes and sizes and allowing designers to use 3D asset packs for level construction. The algorithm has also been designed in such a way that it can be integrated into any real-time game engine with ease.

1:25 Creating a Virtual Reality Horror Experience

Travis Jeffery and Reza Ryan

This research considers the numerous studies into the genre of horror in the entertainment industry with the growing commercial success of virtual reality (VR). While there is an increasing number of studies conducted into these VR systems, there is limited research on developing a framework to create horror games using VR. This practice-led study aims to design a framework which utilizes the VR systems with the techniques of horror design: visual components of light and color; audio localization and hallucinations; obscurity. A prototype game is developed alongside the framework and then tested to see the effectiveness of the design on the experience of fear. The findings of this research aim to establish a framework suitable for horror game development.

1:50 A Framework for Player Traits and Behaviours

Jackson Fuller

Since Bartle's taxonomy of player types, various researchers have attempted to identify and categorise player behaviours. However, player types have proven to be inefficient which has paved the way for trait models instead. Research into player traits is fairly recent and so far, has only been used in subjective questionnaires. This can lead to a lack of understanding of how players make certain decisions in game scenarios.

This project attempts to address this problem by creating a framework that defines various behaviours that players exhibit in relation to their player traits. An artificial agent will be created to display these behaviours in a video game setting to provide an understanding of how a player's trait orientation can inform their actions in each scenario. The scenarios created for the agent to interact in will be informed by the subjective survey questions designed to identify player traits.

It is expected that the knowledge from this project can be used to predict player behaviours based on the scenarios that developers have created. This leaves the potential to personalise a game for multiple player traits or cater towards a specific one.

2:15 **Creating Digitally-Enhanced Acoustic Performance Spaces for Pipe Organ and Choir**

Philip Matthias, David Cornforth and Nathan Scott

This research is a preliminary examination of how real-time digital processing can enhance the performance of pipe organ and choral music in acoustic performance spaces. It considers the issue of matching repertoire to appropriate acoustic environments in addition to creating new spaces through digital processing It investigates two techniques to digitally enhance acoustic spaces and discuss the tools, aesthetics and issues faced when using these two instruments. These issues are explored in two live music performance events where the aims of this study are realized, providing performers with a variable acoustic space and the audience with an enhanced listening experience. The innovation of this work lies in the treatment of the particular instruments and the control of their blend to create a new, definable acoustic space.

2:40 **Stochastic Weather Modelling to Generate Rain, Snowfall and Wind**

Ceegan Kohere and Reza Ryan

Within the past decade development and quality of weather phenomena in virtual environments has rapidly increased. However, there is a lack of documented framework to create a dynamic and optimized weather system suitable for real-time environment.

This research is a critical inquiry of current research and the implementation required to create such a weather system in real-time. In this research a dynamic weather model was created using different weather component generation techniques such as Particle emission, Markov chains, Cellular Automata, Tri-Planar projection and Depth mapping. The weather model was designed and tested through the design science research methodology to ensure functionality. This framework can be easily integrated into existing real-time engines.

Creative Sound
3:30 Thursday - S02 Webb Centre, Room 4.02E

3:30 **Inside the Spark: Pondering the Creative Process of Fast Songwriting**

Ross Mclennan and Ross McLennan

Songwriting is typically an art form which results in three or four minutes of sonic, structured, poetic time. However, songs typically take hours, days or even years to compose. But some of the greatest songs have been written fast. They seem to have spontaneously appeared from the ether in a state of relative completeness. This self-study explores the creation of such a song – composed in just five minutes – evaluating fast, compared to slow-form creations: the nature of the modern muse; the use of everyday technology to capture the spark of creativity; and the perceived benefit of a long-form honing process thereafter.

3:55 **Visually Exploring the Acoustic World**

Leah Gustafson, Chris Carter, Susan Fuller, Leah Barclay and Charles Dacosta

The complexity of soundscapes is difficult to express to general audiences, and the most common ways of visualising the audio generated from the acoustic data of a soundscape recording are difficult for the lay audience to interpret. The creative work "Wild Soundscapes" experiments with the use of 360° video in a mixed reality (MR) environment as a backdrop for visualising soundscapes.

4:20   New World Immersion: A Creative Inquiry into Enhanced Dynamic Music in the Open Worlds of Medieval-based Roleplaying Games

Melissa Nichols

A study by Gasselseder (Gasselseder, 2014) explored the immersive presence, emotional behaviour and arousal in players through the use of dynamic and non-dynamic music in an action-adventure video game. The study concluded that subjects experienced "enhanced [immersion] when being presented with dynamic music" (Gasselseder, 2014). Open-world games, particularly medieval-based role playing games (RPG), have been criticised for their overly-cluttered content and information resulting in reduced immersion. Their "design has reduced what should be immersive worlds into expensive yet meaningless filler between objective icons." (Parish 2015). Consequently, this study will explore how dynamic music can be used to enhance immersion in such open-world games. Based on a pragmatic action research methodology the study will focus on the development and refinement of a musical prototype. Brainwave measurements, questionnaires and semi-structured interviews will be used to inform the refinement phases. It is envisaged that results from this study will be valuable to game developers who plan to create huge open-worlds with improved immersion levels.

Paper, Poster and Abstract Presentations
10:00 Friday - S02 Webb Centre, Room 4.02E

10:00 Refining the Zone: Enriched Video Game Immersion in Hub Zones through Phases of Musical Re-Composition

Benjamin Lang and Ross McLennan

Immersion is a vital aspect of the video game experience (Brown, E. Cairns, P. 2004), and game audio plays a significant role in its design and consumption. Favourable audio has been shown to have a marked effect on the experience of immersion in video games (Gasselseder, H. 2014), while undesirable audio can negatively affect sensory and imaginative immersion (Brown, E. Cairns, P. 2004). As video game hubs in hub-based game designs are such an integral part of the overall experience, audio elements within hub zones must be as immersive as possible. This study will attempt to improve levels of game immersion in hub zones by improving one aspect of audio design – the music. The research will require ten participants to interact with a re-composed hub environment for a duration of ten minutes. During this interaction, visual observations of the participants will measure any visual indicators of enjoyment and immersion. After the interaction period is complete, participants will be interviewed: how did they feel; how much time had they felt had passed and how much of an influence did the music have on their levels of enjoyment and immersion. The research will be conducted using the methodological framework of action research, a cycling system of research where a product is created, tested, results reflected upon, then refined and created again using the information gathered. In order to gather enough data to create an effective immersive hub composition, three cycles of action research will be conducted. If successful, this iterative re-composition process could help improve immersion in hub environments – and video games in general.

10:25 Painting's Facture and its Digital Translation

Chris Worfold

Analogue painting is a form of chirographic picture making which is indexical to the artist's gesture. Photo imaging technologies are commonly used to reproduce paintings, representing them as digital images. However, this reproduction process results in the loss of painting's material facture. In this sense digital images are not reproductions of analogue paintings rather they are tokens for them. Increasingly audiences are experiencing paintings indirectly via token digital images, where the uniqueness of the sensory encounter with a painting's facture; its mark making, materials and scale, is removed. This paper investigates the discourse surrounding the digitisation of analogue painting and identifies attempts to digitally translate painting's material facture.

10:50 Responsive Animation – An Examination of Character Animation for Responsive Game Feel

Justin T Carter

The animation of player controlled characters in real-time video games plays a key role in shaping player perception. The game system's ability to offer an instantaneous response by reacting quickly and positively to input from the player can influence how a game feels to play. Animation techniques adopted in traditional high fidelity forms such as film possess the potential to introduce effects such as system latency or lag which can create a form of dissonance between the player input and the sensation of control in the game. The challenge for animators is that they must use animation techniques specific to real-time control in order to create realistic high fidelity illusions of motion and physical actions while maintaining system responsiveness. This paper investigates the contemporary animation techniques applied in order to maintain and enhance sensations of control in real-time games.

11:15 Musical Manipulation 1 – Qualitative Correlations Between Harmonic Dissonance and the Emotions

Ross Mclennan and Ross McLennan

Music's emotional impact is ubiquitous. It is used to scare us on our screens, to soothe us into a state of consumer comfort in shopping centres and excite us into a frenzy of excitement at sports events. Yet this mainstream emotional manipulation, which seems so obvious, is in many ways still shrouded in mystery. This qualitative study analyses the manipulative power of one musical dimension – harmony – by comparing emotional reactions to a number of common and less well-known chords of varying levels of dissonance on music and non-music student participants. The results will be used to create a rudimentary harmonic/emotional framework to aid media composition students to manipulate their intended audiences. It is envisaged this framework will also act as a foundation for future research into musical/emotional manipulation.

11:40 Speculating the Void

Grace Herrmann and Ross McLennan

The void is a multifarious subject with roots in ancient philosophy, spirituality, science and art. It is both multifarious and profound, suggesting a space of nothingness, silence and darkness, yet also the infinite and the sublime. In the visual arts, it has inspired prolific exploration from the works of Yves Klein to well-known, contemporary exponents like Anish Kapur.

This project will explore the void by integrating augmented reality (AR) into creative practice and employ the three defining characteristics of AR: combining the real and the virtual; interacting in real time; and registering in 3D (Avram, 2016, p.12). The resulting artwork will utilise virtual imagery projected onto sculptures, and motion sensors to allow audience interactivity in a physical space.

The project approaches AR as a concept rather than a technology, to focus on the creation of a meaningful experience of the void, without the barriers to immersion inherent using screen-based devices such as tablets and smartphones. The resulting artwork aims to create a new way of depicting and exploring the void using contemporary methods that build on the history of art.

1:00   Photogrammetry: Techniques for Independent Game Developers

Sean Backhouse, Justin Carter and Ross Mclennan

Photogrammetry involves the process of accurately measuring photographic image properties in order to acquire information relating to surface detail. Information collected during this photogrammetric analysis is then applied to computational models that attempt to accurately recreate three dimensional representations from the image data. The use of photogrammetry by the video game industry is on the rise as developers attempt to use these techniques to create more realistic three dimensional assets in shorter time frames. This shift in production methodology has implications for independent developers of games that typically work in smaller teams with less funding. This paper provides an overview of an investigation into what implications exist for independent developers by first investigating current applications of photogrammetry adopted by the games industry. These techniques are then explored through a practice-led research approach that aims to investigate solutions for independent developers. Finally the paper presents a cost effective strategy for independent developers to effectively create real-time game assets.

1:25   Mapping Input: Balancing Virtual Simulation and Responsiveness

Arden Sedmak and Justin Carter

Fundamental to the creation of real-time games is establishing how parameters within the game will behave in response to player input. The challenge for designers is that they must bridge the gap between the physical nature of the input device and the procedurally generated virtual simulation. Complexities arise in the modulation of position and rotation parameters when attempting to provide appealing physical simulations while maintaining instantaneous response. The challenge for the designer is to match the player's preconception of how an object should behave within the physical simulation while maintaining the systems ability to respond in a timely manner. This paper provides the results of a practice-led study that investigates how parameters of movement can be measured and modulated over time while maintaining system responsiveness. This is achieved by examining how signals from the input device can be mapped to changes in position and rotation within a selection of case studies. Findings from these case studies are then applied in the development of third person character action game. The paper concludes by presenting an approach for measuring and analysing position and rotation parameters in relation to responsiveness during production phases of development.

1:50   Integrating Consumer Friendly Microtransactions Encouraged Through Gameplay that Promotes Product Advocacy

Travis New, Justin Carter and Ross McLennan

The Implementation of microtransactions within console game products has become increasingly more prevalent. The development of new strategies for increasing game revenue whilst maintaining positive gaming experiences has become increasingly important to developers and publishers of games. To date, the implementation of microtransactions in game development has predominately been applied within the mobile gaming market. In recent years an increasing number of console game developers with significantly higher development budgets have attempted to implement these existing strategies with varying levels of success. An important consideration in the application of microtransaction strategies is consumer advocacy. Through reviews, forums and online gaming communities, there is a rise in levels of consumer advocacy in the games industry. This notion of advocacy can have a significant effect on the acceptance of microtransaction strategies within game development and therefore becomes a key consideration for developers and publishers. This paper presents the findings of an investigation into contemporary micro transaction strategies within the console game industry. Beginning with an exploration of existing micro transaction strategies the study illuminates the transaction experience through the lens of the consumer specifically focusing on the effects these strategies have on advocacy. Finally, the study provides key insights into the implementation of microtransactions for developers and publishers of video games.

Workshops

10:00 Thursday - S02 Webb Centre, Room 3.07 Mac Lab

Adobe Tools Workshop

Adobe Staff

Adobe will offer a video focused workshop that will firstly introduce you to Premiere Rush, a brand-new app that makes shooting, editing and sharing online videos fast and easy and across all your devices from mobile to desktop.

Following that, we will give you an introduction to Motion Graphics in After Effects. Simply drag and drop spreadsheets into new data-driven Motion Graphics templates to quickly generate data visualisations.

Lastly explore Adobe's VR tools with 180 and 360 VR effects and transitions – see how to easily create amazing content fast with tools for 180 and 360/VR effects and transitions in After Effects CC and auto-aware VR detection in Premiere Pro CC.

10:00 Thursday - S02 Webb Centre, Room 4.02C

How Do I Game Design?

Paris Buttfield-Addison, Jon Manning, Tim Nugent

While video games are the most glamorous of the electronic arts, splashy graphics and amazing sound isn't the defining feature of games. Rather, games are games because they are the world's only interactive medium. Good interaction needs to be designed, and the master creatives of engaging interaction design are game designers.

In this session, you'll learn about game design: the art, science, and creativity of designing enjoyable, engaging games. This is entirely non-electronic; we're not talking about programming, game engine development, or how to approach a publisher with your totally rad idea about how you can have, like Mario only there's explosions. Instead, we'll be taking a deep dive into game design theory.

Understanding games means understanding user engagement and interaction. In this session, you'll learn a fresh perspective on user experience design by understanding how users engage with the fastest-growing form of entertainment in the world.

Topics covered in this session include:

- Why games work, and how to analyse and build engaging experiences
- The Mechanics-Dynamics-Aesthetics framework: what it's good for, and how to use it
- How to understand what a game's doing, and how to build for fun

This session will be a paper-and-pens (and other bits and pieces) hands-on exercise in learning what makes a game a game. It's not about video games. It's not about board games. It's about the creative processes involved in making something 'fun', and exploring exactly what 'fun' means. This session will be useful to anyone and everyone!

1:00 Thursday - S02 Webb Centre, Room 3.07 Mac Lab

Adobe Tools Workshop

Adobe Staff

A repeat of the 10:00 workshop.

10:00 Friday - S02 Webb Centre, Room 4.02C

DIY PCB – Designing & Manufacturing Your Own Printed Circuit Boards

Matt Gray, VixVerify

This workshop is an introduction to designing your own printed circuit boards (PCBs), and getting them manufactured. If you are using Arduino, Raspberry Pi or other electronics in your creative or educational projects, this workshop will give you a basic understanding of what is involved in producing customised, high quality circuit boards.

We will spend time comparing some PCB design software, learn some basics using AutoDesk Eagle, and look at manufacturing options – which are probably much cheaper than you would think. (Download the free version of this software at https://www.autodesk.com/products/eagle/free-download.) Attendees can bring their own laptop to work on, or use the machines in the lab. Some basic electronics knowledge would be an advantage.

10:00 Friday - S02 Webb Centre, Room 3.07 Mac Lab

Game Development on macOS with Godot

Paris Buttfield-Addison, Jon Manning, Tim Nugent

The wait for a high-quality, free, open-source game engine that can build games for iOS, macOS, and beyond, is over! Godot is here.

This workshop will walk you through building 2D games using the open source game engine Godot.

You'll get a hands-on, rapid-fire introduction to using Godot's IDE and its programming language, GodotScript, as well as VisualScript—a visual block-based environment—as you learn how to build games that run on almost any platform in a powerful, entirely open source environment.

By the time you're through, you'll have no excuse but to go forth and build games using Godot!

Topics include:

• How to install and set up Godot
• How to import assets, like sound and art, into Godot
• How to set up your scene in the Godot editor and create nodes and scene objects
• How to create input actions to receive input from keyboard, mouse, touchscreen, and the like
• How to add scripts to objects
• How to export and build your game

This is a relatively technical session, and attendees should be comfortable with code (or at the very least copy-pasting code, or following along with code). We won't dive into the technical specifics too much, so if you're comfortable with an advanced Adobe product, or something like Unity you'll be fine here!

1:00 Friday - S02 Webb Centre, Room 3.07 Mac Lab

RoboCoder: Robotics and Visual Programming Workshop

Alex Jacobs, Coder Kidz

Workshop participants will program an entry level 3D printed drawing robot "Axel" whilst learning essential programming concepts. Using custom drag and drop software, and a simple open source robot chassis, this workshop developed by the Coder Kidz team is designed for set a foundation for computational thinking. Skills and technique gained in this workshop are designed to be taken back to the classroom and expanded upon as these fundamental skills in visual programming are the perfect stepping stone for any programming language.

Attendees are encouraged to bring their own laptop to work on, or can use the computers provided in QCA labs. The only software requirement to attend this workshop is Google chrome web browser.

General Information

Registration Desk

The registration desk will be based at S02 Webb Centre, Room 4.05A.

Meals & Refreshments

Start-of-day refreshments, **lunch and afternoon tea each day** will be served in S03 (Webb Centre) on level 4, in room 4.05B.

The **conference dinner** will be held on Thursday night at the Ship Inn, a short walk from the Webb Centre. Spaces are limited to people who indicated they would be attending at the time of registration.

Caterers have been provided with special dietary requirements as specified by delegates at registration time. Please understand that it may be impossible for caterers to address any special requirements not notified at least 7 days in advance of the event.

Please note that QCafé in the Grey St. Studios building is privately owned and operated, and not part of the catering for CreateWorld. You are welcome to purchase food and beverages at your own cost.

Internet Access

Wireless internet access is available and access details will be provided at registration time. If you are from an institution that supports **Eduroam**, you can use your originating institution credentials to connect.

Emergency Contacts

QCA Campus Security - dial 7777 (from internal telephones) or call 3735 6226.

For all emergencies, call triple zero, 000 or 112. Most mobile phones will call 000 (for Emergency Services) even when no credit is on the SIM card.

Conference Contacts

Daniel Della-Bosca - 0419 735 095
Seth Ellis - 0490 220 740

Partners

We couldn't host CreateWorld without the generous support of a number of people and businesses.

We extend our thanks to Dr. Tim Kitchen and the team from Adobe for their support and for running workshops on Adobe's latest Creative Cloud products.

Thanks to the extraordinary team from The Queensland College of Art (QCA), a specialist arts and design college founded in 1881, and the oldest arts institution in Australia. The South Bank facility comprises public exhibition spaces, a cinema, conference rooms, a multimedia art gallery and the most modern and versatile studio facilities in Australia.

And thanks to Griffith University, our long term event partner. Griffith University was created to be a different kind of university—challenging conventions, responding to trends and pioneering solutions. Ranking in the top three per cent of universities worldwide, its future-focused degrees are developed in consultation with industry, based on cutting-edge research, and taught by Australia's most awarded teachers.

Conference Chairs

Daniel Della-Bosca is a lecturer in fine art, design and interactive media at the Queensland College of Art, Griffith University. He has worked and exhibited nationally and internationally as a designer and artist and is committed to the advancement of art and design education. Daniel's primary research focus is the application of fractal mathematics to the field of aesthetics, and his specific skillsets are the interdisciplinary bridges between art, design, CAD software and algorithmic generation of image and form. Daniel has a portfolio that spans public sculpture, exhibit design, jewellery and animation, all for the purpose of engaging in visual and haptic discourse.

Seth Ellis is senior lecturer in interactive media program at the Queensland College of Art, Griffith University, where he is program director of the Bachelor in Creative and Interactive Media. He is a narrative artist and interface designer; his work draws upon local history, allegorical narrative, and experience design to create stories both historical and fictional in new, experiential forms. Seth as worked with local museums and galleries on their collections and exhibitions; his own projects have shown in galleries, streets, symposia and festivals throughout the U.S. and Europe, and at a few places in the Atlantic Ocean.

Dr. Dale Patterson is a computer scientist and lecturer in Digital Design, Visualization and Interaction. Dale has worked in the field of computer science both commercially, in education and research for more than 20 years (focusing on 3D computer graphics and its applications). Dale's primary areas of interest include human computer interface design, VR & AR, 3D computer animation, visual effects and games. Dale also has strong research interests in computing as applied in bio-medical applications (e.g., scientific visualization, applied games & learning, artificial intelligence).

Rae Cooper is a lecturer and researcher at Griffith University, Queensland College of Art and a descendent of the Worimi people of coastal New South Wales. She combines her academic focus on design politics with over ten years' experience as a commercial visual communication designer across private and government sectors. Creating connections between people, design theory, technology, contemporary professional practice in an increasingly unpredictable society is central to her work.

Tony Gray has been Chair of the AUC since late 2010. He is a software developer and educator with over 25 years of experience providing IT support in the University sector, and is co-chair of the AUC's other two conferences–**/dev/world** for software developers and **X World** for system administrators. Tony also writes for O'Reilly Media on the Swift programming language.

About the AUC

The AUC was established towards the end of 1984 as a partnership between Apple Computer and nine Australian universities.

At the heart of the relationship was the ability for departments, staff and students to obtain Apple technology at reduced prices and to enable the development of innovative solutions using the Macintosh. The AUC grew to form a network of educational technologists across the universities of Australia and New Zealand, growing to 37 member universities by 2012.

The history of the AUC is one of adapting to change, and in 2013 we reinvented ourselves as a not-for-profit association with no formal relationship with Apple. Our mission is to support and build communities around the use of Apple technologies by sharing experience, insights and know-how amongst members, developing people as leaders, and inspiring and fostering innovative use of technology.

Each year, we hold three conference events for specific subsets of our community. **X World** is for system administrators and support staff, **CreateWorld** is for performance artists, teachers, and those working in the creative spaces, and **/dev/world** is for software developers. Our conferences are open to all.

Learn more, including how to become a member, at www.auc.edu.au.

Conference Committee

Tony Gray, Seth Ellis, Daniel Della-Bosca, Dale Patterson, Rae Cooper

Conference Proceedings edited by, Tony Gray, Daniel Della-Bosca, Dale Patterson

"The Createworld 2018 papers contain cutting-edge and insightful research articles in the field of creativity applied through the use of technology. Overall we had 34 submissions, from which 14 were selected as full papers, and 8 as poster. A number of workshops, seminars and artworks were also submitted and presented.

All submissions were thoroughly evaluated in a review and meta-review process by the Program Committee consisting of distinguished experts from around Australia. We are grateful to all our reviewers and sub-reviewers for their hard, timely, and meticulous work that provided extensive and constructive feedback to all our submissions and had a decisive contribution to the success and high quality of this event.

The Keynote for Createworld 2018 was Professor **Massimo Banzi** from SUPSI - Scuola universitaria professionale della Svizzera Italiana.

The paper refereeing process was conducted according to the specifications of the Australian Government for the collection of Higher Education Research Data

International Peer Reviewer Jury:

Dr Tim Kitchen, Adobe (Senior Education Specialist) & Swinburne University of Technology
Dr Jason Nelson, Griffith University (Fulbright scholar - Norway)
Dr Dale Patterson, Griffith University (Interactive Media, Visualisation & Immersive Design)
Mr Daniel Della-Bosca, Griffith University (Visualisation & Immersive Design)
Mr Seth Ellis, Griffith University (Interactive Media)

These proceedings are available online at …….http://auc.edu.au/createworld/sessions-2018/

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The Divinity of the Machine

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Abstract

This article is an extract from my PhD. In my research I considered the *primacy of meaning, consumption and the divinity of the machine*. The era of interest was the machine age. This was an era of rapid scientific and technological development, declining religiosity, and the acknowledgement of the individual in western culture. Considering the enormity of this paradigmatic change, I consider the notion that the machine has paramount importance, not only in preserving, sustaining, and advancing humanity but also in the deepening process of how we construct meaning and spirituality in a mass–production and mass–consumption society. I suggest that perhaps the machines producing our items of consumption have taken on a divine importance within adapting cultural systems and continued technological advancement.

In this extract, I considered how some 20th century artists have utilised and considered the machine in their work and how a sense of the divine can be applied to the machine.

Keywords

Machine. Art. Consumption. Divinity. Meaning. Technology.

Introduction

In *Machines and Art*, Jasia Reichardt contends that "Since there is no cure for progress, we may assume that machines will play an increasingly significant role in every area of our lives."[1] Progress is a constant part of human evolution, and early tools and weapons have developed into technological advances we experience today. Essentially, humanity is immersed in a process of continual progress and there is no escape.

The Machine Age signalled a new epoch in communications, transportation, and the mass production of consumer goods. There was a shift from a predominantly rural, religious society to an urban, modern world of motor vehicles, radios and electric appliances. The Machine–Age provided a lens through which society could re–focus its self–image.[2] It was the promotion of a constructed environment with new urban and industrial landscapes from which mechanical forms and forces presented themselves as inspiring symbols of unparalleled human development. The Machine Age accelerated progress, and as Reichardt argues, "the image of the machine as an unstoppable force is prophetic of our contemporary world."[3] Humanity has a continual and growing reliance on machines, a reliance that borders on totality that is not only for commercial and medical uses but for the pleasures of basic sustenance and entertainment. These aspects of total reliance are interesting; for Reichardt, the machine is not so much a metaphor for labour but "a metaphor for the world itself."[4] The machine is a multi–faceted life support system and as well as being used to support our existence, they offer us reasons for existence.

The process of mass production was changing the way people worked and the reasons for working. The order of discipline had changed to a process of industrialisation, and as the world became more mechanised, industry and commerce became the driving force of life. The machine had a lot to offer; it can be seen as being of benefit to humanity and that an increased individual freedom would result from industry and technology, but it could also be seen as dehumanising and enslaving through the effects of mass production, standardisation, and consumption.

Andreas Broeckman suggests that labour and knowledge, the physical and the mental aspects of being human, "are all subsumed into the machinery, as well as in the modes of subjectivation and socialization."[5] Broeckman also considers Karl Marx's writings and that it is not the machine that serves the worker but the worker who is serving the

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[1] Jasia Reichardt, "Machines and Art," *Leonardo* 20, no. 4 (1987): 367.

[2] Alan Trachtenberg, "The Art and Design of the Machine Age," *The New York Times*, 21 September 1986.

[3] Reichardt, "Machines and Art," 367.

[4] Ibid.

[5] Broeckmann, *Machine Art in the Twentieth Century* (Cambridge: MIT Press Ltd, 2016), 24.

machine. This integration could be considered as a dehumanising form of submission, or as a positive form of cooperation between human and technology, between human and machine. Either way, Broeckman proposes that "the direct and necessary coupling and companionship of human and machine are undisputed."[6] The machine is more than mere functional object, it is a force that has direct impact on human life and as human in Western culture, it has become important to engage with the technology of the machine. There is a utilitarian spirit in the machine, as human we live among machines and the machine has become an outward expression of the self. There is a seduction between humanity and machine, and there is an attempt to see the best in ourselves and perhaps to find a stronger sense of meaning or purpose in life. The machine has become important in this expression of meaning.

Francis Picabia was heavily influenced by the processes of mechanisation. The artist started using the machine as an ironic metaphor for human life after visiting New York in 1915 and sighting the impact of an industrialised culture. Discussing Picabia's symbolic visual language, Willard Bohn proposed that Picabia, reflecting on the symbolism of the human body and of the machine in his work such as with *Daughter Born without Mother* (figure 1), considered that there was indeed a relationship between the two seemingly disparate forms, the body and the machine. Bohn focuses on Picabia's sexual symbolism, a sexualisation of various objects that may not be immediately obvious but is made manifest on inspection and is realised for its deliberate intention. Picabia's machine paintings present impersonal yet intrinsically human qualities.[7] Looking to machinery for influence and through referencing feminine and masculine qualities, Picabia came to define the machine as "a part of human life—perhaps the very soul." [8]

Figure 1
Francis Picabia *Daughter Born without Mother* 1916–17
Gouache and metallic paint on printed paper
50 x 65cm

With *Homage to New York* (figure 2)[9] Jean Tinguely was considering and satirising a modern advanced society fully immersed in the process of the mindless overproduction of material goods and the obsolete technologies of a changing world.[10] Tinguely's was a self–destroying kinetic sculpture that was set in motion in the grounds of the Museum of Modern Art in New York City in 1960. The primary intention of this kinetic work was that it lived in order to destroy itself. This machine was brought to life and then set to its own devices, and as it is with human existence and mortality, it came to its demise. As Jenkins states, "Tinguely's performance piece helped redefine the machine by allowing it to be symbolically linked to human mortality."[11] If Tinguely's notion of machines as art being brought to life with the intention to die has justification, it would seem natural to follow with a notion proposed by Jack Burnham. Burnham argues that Western culture, in full control of the machine, has a Faustian goal; that it is possessed by "an unstoppable craving to wrest the secrets of natural order from God—with the unconscious aim of controlling human

[6] Ibid.
[7] Willard Bohn, "Picabia's 'Mechanical Expression' and the Demise of the Object," *The Art Bulletin* 67, no. 4 (1985): 674.
[8] Picabia cited in Pepe Karmel, "Francis Picabia, 1915. The Sex of a New Machine," in *Modern Art in America: Alfred Stieglitz and His New York Galleries*, ed. Sarah Greenhough (Boston: Bulfinich Press, 1977)., 203.

[9] In 1960, Tinguely created a sensation with his first large self–destroying sculpture, the 27–foot–high metamatic entitled [Homage to New York](), whose public suicide he demonstrated at the Museum of Modern Art in New York City. The event was a fiasco, with the complicated assemblage of motors and wheels failing to operate (*i.e.,* destroy itself) properly; it had to be dispatched by city firemen with axes after having started a fire.
[10] Jenkins, "Humanizing the Machine," 43.
[11] Ibid.

destiny, if not in fact becoming God itself."[12] The machine has the potential to give us anything we may want, including a sense of power and wealth. But is this a deal with the devil and have we handed over our soul as we search for other meanings in existence? Rather than the machine being a metaphorical expression of the human form, the machine becomes perhaps a metaphorical expression of humanity, and of what it is to be human.

The machine then, may indeed have or be imbued with not only human–like qualities but perhaps also that of the divine. Tinguely himself implied that *Homage to New York* was a "simulacrum of catastrophe," a "cynical object, both luciferian and phantomatic in nature."[13] Perhaps the machine has become sacred rather than just *humanised*, and we have indeed signed a deal with the devil.

Figure 2 Jean Tinguely *Homage to New York* 1960 Various found objects

Eric De Bruyn references Burnham in regard to sculpture's Faustian goals and advises that "kinetic art creates a false copy, a simulacrum of life."[14]. However, De Bruyn is perhaps implying that there is a transparency to the machine; as a false copy or simulacrum the machine can be seen through, and it is not something to be trusted or to be believed in. Burnham's presentation of the machine

wresting power from god is both acknowledged and challenged by De Bruyn and this builds on Burnham's commentary about Tinguely's *Homage to New York* as a mechanical simulation of life, as a machine or mechanical contrivance brought to life only to die.[15] The machine *is* mortal.

Commenting on the transformations to human behaviour and human identity over the last two centuries, Julie Wosk discusses how artists have reflected on the impact of technology. Wosk discusses various aspects of the Machine Age, observing that technologies can "enhance and expand our human capabilities,"[16] as well as potentially cause alarm and anxiety due to our need to adjust to new advances in technology. In her introduction, Wosk presents the concerns of novelists and social scientists alike, noting that these technologies can be "dangerously dehumanizing."[17] The human–machine interaction may initially be considered as being beneficial; however, there is also the danger of becoming automatons ourselves and that we may cultivate insensitive, self–destructive qualities. But perhaps those qualities have always been present, and it is just that the machine exposes them for what they really are and in turn further exposes aspects of the human condition. Wosk also considers that contemporary artists are charging themselves with the taming of technology and that through creative expression, the artist is looking to bring a sense of civilisation to the machine.[18]

By acknowledging the power of the machine, there is also the need to consider that there is a continual battle with machine–age technologies, and that despite the potential for advancement, moral implications are also involved. Wosk's discussion continues about the desire for material goods and their sociological and psychological functions. The human–object relationship is part of, or fundamental, to a material/non–material culture and is extended to an object when used in a self–defining process as adopted by

[12] Jack Burnham, "Robot and Cyborg Art," in *Beyond Modern Sculpture* (New York: George Braziller, 1968), 314.
[13] Tinguely cited in Eric C. H. De Bruyn, "Ghost Story," in *Artforum International*, 51, no.1 (2012), 527.
[14] De Bruyn, "Ghost Story."

[15] Ibid.
[16] Julie H. Wosk, "The Impact of Technology on the Human Image in Art," *Leonardo* 19, no. 2 (1986): 145.
[17] Ibid.
[18] Ibid.

the individual. Wosk concludes that we "must temper our technologies or risk deformation and death."[19]

The potential for the machine to change existence for the good and the bad is also acknowledged by Barbara Zabel, who suggests that Dada artist Man Ray "soon found in the machine a means to express the dilemmas of twentieth–century existence."[20] Zabel also considers two of Ray's contemporaries, Morton Schamberg and Henry Adams, as "identifying the machine as a new religion of the modern world,"[21] with Adams equating such things as forty feet (12.2 metre) dynamos to that of the early Christian notions of the cross for its moral force. Here, is the power of the crucifix as an icon of the religious institution being challenged by the dynamo as an important humanity–defining object of the early twentieth century. These aspects are important, so too the considerations of Man Ray and his contemporaries, as probing the metaphysical nature of the machine and the machine's ability to affect human existence and man's relationship with god. The interrelationship between people and machine is a complex one.

Indestructible Object (figure 3) is described by Zabel as being Man Ray's "most powerful and ambivalent combination of the human and the mechanical… the work represents Man Ray's commentary on how the machine has come to set the tempo in twentieth–century life."[22] Zabel suggests that by fixing an eye to a metronome, the artist gives the mechanism a "seemingly human consciousness."[23] However, Ray's description of how he came to assemble such a device seems rather unassuming and humorous. He would set the metronome in motion and paint to its regulated frequency. Then, deciding that a painter needed an audience, Ray fixed the photograph of the eye to the swing arm, thus creating an illusion of being watched. As a kinetic construction, this Surrealist work alludes to the 'all–seeing eye' or the notion of a watchful god, which implies that our days are numbered. The object represents a god–like figure with an unyielding stare, and

the days become measured by a monotonous beat. Has humanity, like Ray, looked to the machine for support but in the process created a reliance on the machine; and has humanity become ceremonious and habitual to the routine of the machine, in work *and* in play?

Figure 3 Man Ray *Indestructible Object (or Object to Be Destroyed)* 1923
Wooden metronome and photograph
21.5 x 11 x 11.5cm

Re–created a number of times since its origin in 1979, Mona Hatoum's *Self Erasing Drawing* (figure 4) is representative of deliberate and repetitive process and purpose. *Self Erasing Drawing* is continuous in its motion and appears to carry on regardless, but it also shows that that which is given, or is constructed can just as easily be taken away or destroyed.

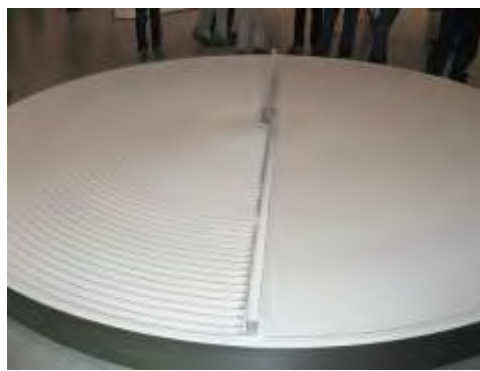**Figure 4** Mona Hatoum *Self Erasing Drawing* 1994
Sand, steel, aluminium and electric motor
27 x 400cm

[19] Ibid., 152.
[20] Barbara Zabel, "Man Ray and the Machine," *Smithsonian Studies in American Art* 3, no. 4 (1989): 67.
[21] Ibid.
[22] Ibid., 78.
[23] Ibid.

This work references the patterning of the Ryoanji Zen gardens in Kyoto, Japan, a reference that perhaps suggests a tranquil and reflective nature to the work. However, this potential is disrupted by its continuum of construction and destruction, repeated in an automatic manner with a concealed driving force that is literal and metaphorical, a hidden agenda. The rate at which the arm cycles, 5 rotations a minute, potentially destroys any sense of rest or quietening that might be reasoned; and any that is reasoned is certainly of a temporal nature. This work is heavily influenced by Hatoum's Palestinian and Lebanese heritage. Themes of alienation and displacement, and issues of violence and oppression are considered along with notions of collective memory and belonging. Its cyclic nature, its repetitive and potentially meditative action, is simultaneously constructive and destructive. A sense of peace to be disrupted thus creates a sense of tension as the next arm approaches. But which arm is constructing and which arm is destroying? Thus, confusing and disrupting the viewer experience. What is also evident in this work is that someone else or perhaps *something* else has the ultimate power.

Conclusion.

Machines demonstrate our existence in terms of various human collectives as well as of being an individual. Perhaps, rather than being a metaphor for the world as Reichardt contends, the machine is a metaphor for life and the machine has become important in the sense of the self and what it means to be human. Humanity is creating new industrial landscapes, but, as Wosk counsels, humanity must consider the moral imperative of the machine, given that god–like, the machine can giveth and the machine can taketh away.

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Images

Figure 1 Francis Picabia *Daughter Born Without Mother* 1916 – 17
    Source: National Galleries, Scotland, accessed 19 March 2014,
http://www.nationalgalleries.org/collection/artists-a-z/P/3677/artist_name/Francis%20Picabia/record_id/2195

Figure 2 Jean Tinguely *Homage to New York* 1960
Various found objects
Source: Tate Gallery, London, accessed 7 April 2014,
http://www.tate.org.uk/context-comment/articles/homage-destruction

Figure 3 Man Ray *Indestructible Object (or Object to Be Destroyed)* 1923
Wooden metronome and photograph
21.5 x 11 x 11.5cm
Source: Tate Galleries, London, accessed 6 May 2014,
http://www.tate.org.uk/art/artworks/man-ray-indestructible-object-t07614

Figure 4 Mona Hatoum *Self Erasing Drawing* 1994
Sand, steel, aluminium and electric motor
27 x 400cm
Source: MoMA, New York, accessed 29 April 2014,
http://www.moma.org/collection/artist.php?artist_id=7447

Design is Like… Making sense of things through the creative use of analogy.

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ABSTRACT

This study discusses analogical reasoning and its role in creative problem solving. Specifically it looks at how novice first year university design students responded to the task of communicating a complex topic through the generation of a visual analogy; in this instance the task of explaining some aspect of what design is. Students were introduced to various theories about design and design process. They were also introduced to theories around analogical reasoning, particularly those around mapping. The students were then asked to demonstrate their understanding, not through critical discourse, but through applied creative practice. To provide a context, students had to create an illustration with the title 'Design is Like…'. The findings suggest that the praxis based approach acted as an empirical bridge between theory and practice, providing students with an identifiable creative strategy and meta-cognitive awareness of their own design process

KEYWORDS

Design, Analogical Reasoning

INTRODUCTION

Within the context of a changing paradigm which seeks to make designerly thinking methods more explicit (Augustin and Coleman, 2012, Conole and Willis, 2013, Cross, 2001, Lawson, 2006) this study takes the opportunity to focus on one, identifiable thinking method and determine its value in, not only making sense of a given problem, but in providing an opportunity to visually communicate such understanding to an audience. In this instance, we are referring to analogical reasoning and how it can be positioned as an identifiable designerly thinking method. Certainly, according to Sloman and Lagnado (2005, p.99), all humans, not just creative people, are "pre-wired" to think analogically. However, as Goldschmidt (2001, p. 211) cautions, novice design students will not necessarily respond to a design problem "spontaneously" by thinking analogically (Goldschmidt, 2001, p.211). Therefore, within an educational context, where all learners are "sense makers" (Mayer 1996, p.364) we can ask the question 'Does the applied method of using analogical reasoning facilitate novice design students creative development and meta-cognitive awareness of process?

DISCUSSION

Gentner and Medina (1998) suggest that we are endowed with two cognitive systems, both independent but interacting. One system is associative and similarity based, the other is symbolic and rules based. While there are significant differences among individuals and their approaches to problem solving, their theory is based on the premise that most ill-structured design problems are best addressed through the associative and similarity based cognitive system. When it comes to novice design students, according to studies carried out by Newstetter and McCraken, (2001) and Wilson (2002), students who have not yet learned how to think like designers will approach design problems from a well-structured, rules based perspective which may be based on naive misconceptions of design process.. Goldschmidt's (2001) findings that student's will not necessarily consider analogy as a creative strategy, are also supported by McAuley (2010) who found that only a small proportion of design students, when given the task of conceptualising a piece of expository text into an illustration, developed analogical concepts. Therefore, it is argued in this paper, that analogy as a creative strategy can be identified, learned and developed. Visual analogy as a creative process is, says Goldschmidt (2001), similar to sketching. Complex ill-structured problems require a variety of strategies, "Since no rules are at hand to reason with, the immediate goal is to generate visual representations that are rich with clues that may potentially lead to a solution by way of similarity" (Goldschmidt, 2001, p. 210). Goldschmidt suggests that using pictures as triggers generate transformations through a process of transfer she describes as candidate source and candidate target. Pictures are inspected with the intention of recognising within them clues that might facilitate a connection with the problem to be solved. Koestler, 1975, p. 201) points out that analogies are not "hidden" but "created" by imagination through a process of "Selective emphasis". Bonnardel (2000) claims that selective emphasis results from being in a "constrained cognitive environment" (p. 505). The implication here is that creativity and ideas are selected as a consequence of the constraints of the situation.

Goswani (1991) says analogy is "a notoriously difficult term to define", but that "What is largely agreed upon is that at the core of analogy lies "relational reasoning" (1991, p.1). Analogy is, says Holyoak, a "special kind of similarity", (2005, p.117). Two situations are analogous if there is a recognisable pattern of relationships among constituent elements despite the actual differences between both sets of elements. The two elements are referred to as analogues. One analogue is easier to understand or

is more familiar than the other analogue. This first analogue is called the source and the other, less familiar analogue is the target. Asymmetry is the basis of analogical transfer, where the source, because of its ease of semantic access, is used to generate inferences to the target—that which requires further explanation or understanding. This is the basis of analogical reasoning. Analogical reasoning goes beyond the new information, using systematic connections between the source and target, with the outcome being the generation of plausible, but fallible, inferences about the target. Similarity-based inductive reasoning uses the mechanism of mapping to achieve its purpose, through the relationship between target and source. Analogy in relation to the creation of plausible predicates is therefore, a form of inductive reasoning (Holyoak, 2005, p. 117; Holyoak & Koh, 1987, p. 332; Sloman & Lagnado, 2005). The human mind is, says Sloman and Lagnado, (2005,
p. 99) pre-wired to extract relations of similarity and causality and apply them to new situations.

MAPPING

The target situation, that which requires elaboration, provides a retrieval cue for the creation of a source analogue. When this happens, says Holyoak (2005), a mapping (the purpose of analogy) is established. This aligns the elements of the source and target. As a consequence of the mapping, one can make new inferences about the target "thereby elaborating its representation" (p. 118).
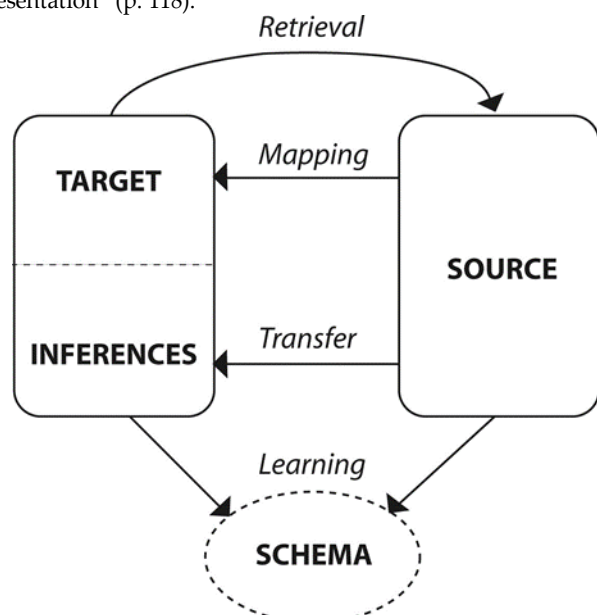

Figure 1 Major components of analogical reasoning. From Holyoak (2005, p.118).

Figure 1 from Holyoak (2005) traces the major component processes in analogical transfer. The target acts as a retrieval cue for the creation of a potentially useful source analog. If

successful, a mapping, or a set of systematic correspondences that align the components of the source and target, occurs. While the immediate purpose is to make a connection between the source and target and transfer understanding from one situation to the other, Holyoak suggests that, in the aftermath of analogical reasoning, "some form of relational generalisation may take place, yielding a more abstract schema for a class of situations, of which the source and target are both instances" (p. 118). In other words, new knowledge and connections, beyond that contained in the mapping from source to target can be attained. Analogy in relation to the creation of plausible predicates is therefore, a form of inductive reasoning (Holyoak, 2005, p. 117; Holyoak & Koh, 1987, p. 332; Sloman & Lagnado, 2005).

METAPHOR

Some brief discussion should be made about the distinction between analogy and metaphor, both which are essential forms of relational reasoning. Holyoak (2005) provides a clear description of the difference between the two. He claims analogy and metaphor are closely related. While similar in general, metaphors are characterised by blending and semantic asymmetry between target (conventionally termed tenor) and source (vehicle) domains. Holyoak provides an example. The target/tenor in the expression "the evening of life" is life. The target is contextualised and understood in terms of the source/vehicle which relates to time, evening being a time of day. The key domains, evening and life are connected, thus mapping occurs.

Metaphors are a special kind of analogy in that the source and target are always semantically distant… and the two domains are often blended rather than simply mapped (e.g., in "the idea blossomed," the target [idea] is directly described in terms of an action directly derived from the source). In addition, metaphors are often combined with other symbolic "figures" – especially metonymy (substitution of an associated concept), (ibid p. 120).

Holyoak notes that there is contention as to whether metaphor should be seen as a type of analogy and offers a resolution that novel metaphors are interpreted by very similar mental processes as is the case with analogies, but also suggests that everyday, conventional metaphors are interpreted as general schemas. According to Lakoff and Johnson, most of us associate metaphor as a device of poets, a form of "rhetorical flourish." (2003, p. 1) They also point out that metaphor is largely associated with language rather than thought or action. They suggest metaphor is far more pervasive in everyday life, "Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature" (p.1). This supports Sloman and Lagnado's (2005) claim that we are 'pre-wired' to use similarity to make sense of situations.

Lakoff and Johnson claim, "The essence of metaphor is understanding and experiencing one thing in terms of another"

(2003, p. 5). Because it is so frequently used in everyday language we are hardly even conscious of how they operate. They say, "The most important claim we have made so far is that metaphor is not just a matter of language, that is, of mere words. We shall argue that the human conceptual system is metaphorically structured and defined" (p.6). They add that an understanding of one kind of experience through another shows that they are structured by "natural dimensions of experience" (p. 235). What they mean by this is that they are not just creations; they are based on how we experience the world and are therefore linked to cognition. They also suggest that our conceptual structure is not simply a matter of intellect but is directly linked to all dimensions of our experience such as colour, shape texture and sound. Also, even though they are so integral to experience, they do not only relate to the mundane, every day experience, but our aesthetic experiences as well. Engaging with artworks leads us to "new experiential gestalts", that is new ways of understanding reality, and indeed the artwork itself is "a means of creating new realities" (p. 236).

SIMILARITIES BETWEEN ANALOGY AND METAPHOR

Holyoak (2005) talks of analogies as a special kind of similarity and Lakoff and Johnson (2003) talk of metaphor as understanding something in terms of something else. One could easily add that analogy is also understanding something in terms of something else. To meaningfully negotiate the subtleties and differences between metaphor and analogy I refer back to Holyoak (2005) who says metaphor uses semantically distant mechanisms and that the domains are blended (as in "the evening of life") rather than transferred from one to the other as is the case with analogy (an atom is like a solar system). There is also a structural, genuine similarity, whether it be physical or conceptual when one deals in analogy. Both use inference and association, but the key difference is that at a recognisable level, the similarities between a source and target analog, whether they be in reference to a visual or conceptual similarity, must be based, at some level, on a perceived similarity to be seen as an analogy. Metaphoric similarity is therefore more symbolic than real. The word "evening" is not similar to "life", it acts as a symbol of the different stages we go through in life; morning would, for example relate to birth and early childhood (ibid, 2005).

Gangulyi (1995) also describes analogies and metaphors as close relatives. He frames their differences by saying "While metaphors compare implicitly, analogies compare explicitly the structure of two domains" (p. 244). His work relates directly to how analogy and metaphor can be used as thinking methods in science teaching. However, I note many parallels in design to what he says about science. He talks of how science deals with aspects that we in many cases cannot see literally. This is one reason why imagination is so vital to the enquiry process. On metaphors and analogies he says, they "anchor" thought processes by "generating a pattern that

would thematically bridge the gap between the seen and the unseen" (p. 242). As a learning tool he says they are ways of getting closer to the problem by making parallel connections with something that can be seen or is already known (ibid). While Gangulyi describes the value of metaphor and analogy as learning and teaching tools in science, I am able to make the connection with the field of design where, design problems are also 'unseen'. There would seem to be some resonance here for illustration, a visual method which often has to act as bridge between the seen and unseen. One only has to consider how an internal mental state can be conveyed pictorially to appreciate how illustrations aid understanding of non visual states. This is when associative thinking can be valuable as a communicative device. To conclude this section, I propose that we acknowledge the idea that analogies seek to make explicit, as opposed to implicit connections between different situations and that analogies and metaphors are both closely aligned forms of associational reasoning.

DEFINING DESIGN

As this paper discusses how design students used analogical reasoning to develop a concept about design, I will now briefly discuss a few definitions of design.The first four entries in Merriam-Webster's *Third new international dictionary unabridged* (1986, p. 611) define design as a verb "1. a: to conceive and plan out in the mind, b: devote, consign, destine… c: to make up one's mind to set apart, d: to plan or have in mind as a purpose: intend, purpose, contemplate". Herbert Simon, in his seminal text *'The Science of the Artificial'*, defines design as "courses of action aimed at changing existing situations into preferred ones" (1996, p.111). Schön (1983) identifies design as " a conversation with the materials of the situation", (p.78). He continues, "In a good process of design, this conversation is reflective" (p.79). Manzini says, "design is first of all a process" (2015, vii). Edelson (2002, p.108) describes this process in terms of it being "a sequence of decisions made to balance goals and constraints". He continues on the same page, "The process of design is complex. Its open-endedness and reliance on creativity have made it a challenge for researchers to characterise and explain".

While Edelson (2002) talks of three design processes; *design procedure*, *problem analysis* and *design solution* and Swann (2002) lists six: *problem – analysis – synthesis – execution – production – evaluation*. Cross (2001b) identifies four stages of designing: *problem structuring, preliminary design, refinement and detailing*. Wilson, (2002) identifies nine phases of design: *problem identification and definition, task planning and management, research and evaluation, ideation, idea selection and decision making, action and implementation, reflection in action, evaluation of process and progress, refinement and completion*. To some extent this adds further to the notion that design is a neoteric field, borrowing as it does its terminology from other fields. These different terms do not necessarily suggest difference of opinion as to what designing involves. They are, in my opinion, simply different categorisations of the same thing. However, Swann's list most successfully shows that the creative process is cyclical, not linear, "The design process is iterative. It can only be effective if it is a constant process of revisiting the problem" (2002, p. 53). Many of these terms and definitions of design were introduced to students in this study. This leads me to a discussion of the
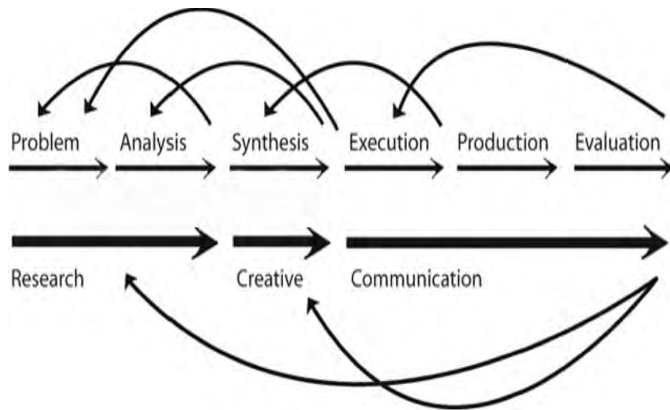
specific learning activity.

Figure 2. Swann's Design process model (2002). A development from Lawson's (1980) analysis-synthesis- evaluation model.

METHODOLOGY

This study is a phenomenological heuristic inquiry. A characterising feature is an intention to unearth the essence of personal experience. The heuristic element is crucial when the researcher's have empatheitc understanding, personal insight and experience with the phenomena under scrutiny. Patton, (2002, p.107) points out, "The reports of heuristic researchers are filled with the discoveries, personal insights, and reflections the researchers". As with action research, this methodology can utilise an 'insider's perspective'. In this instance, the researcher is a former editorial illustrator whose professional work often used analogies and metaphors to conceptualise editorial content. This study is also a naturalistic inquiry. Naturalistic inquiries are non controlling and non manipulative (Patton, 2002, p. 39). No research took place during teaching and student work used for data analysis was only used once the actual work had been assessed and handed back to students. On completion of the class project a request was made to use the work as data for a research project. This approach complied with Griffith University's ethics policy.

THE LEARNING ACTIVITY

QCA 1530 Applied Practice is a first year course in the Bachelor of Design Degree at Griffith University. The course descriptor says:

This course will explore some of the methods, principles, processes and theories that makes design a special form of human inquiry. From analysis to synthesis, students will apply their understanding of 2 and 3 dimensional space through a series of linked, practical exercises, active visual experimentation and resolved production.
Through 'praxis', i.e. the convergence of theory and practice, students will apply their understanding of design to real outcomes.

The learning activity was based around a one hour lecture and a two hour tutorial. The lecture itself was the first lecture in the course and it discussed design in general, introducing some key ideas and definitions about design from academic literature. Terms such as analysis, synthesis, divergence, convergence were explained. It defined design in terms of a verb and as a

noun. It also introduced a sample of design process models such as Lawson's 1980 model, the IDEO model and Cal Swann's 2002 model. It also introduced the idea that design is a form of multiple solution problem solving. Analogical reasoning as a creative strategy was also explained to students. Students were then asked to consolidate their understanding of the lecture on design by creating a visual analogy which creatively illustrated their understanding of design through a piece of creative work. The provocation for the illustration were the words 'Design is like…'. Their image, as an analogy was to be used to communicate an idea which advanced understanding and definitions of what design is. Students were also asked to write a short piece of expository text which critically discussed design, analogies and the role analogies play in explaining things

ANALYSIS

An ethics application at Griffith University was submitted and approved. All students studying design for the first time were eligible. Seventy Five students agreed to participate in the research. Analysis is based on a questionnaire, design outputs written rationales and recorded presentations. Names used are pseudonyms.

In relation to what students thought about creating an analogy to describe design, here are a few representative comments. The comments also reflect student's interest in physical, hands on activity.

Figure 3. Student comments around analogy and exploring theory through practice.

Each student had to create their own illustrated analogy for an ebook. The Ebook itself was a 12 page book which covered various topics. The analogy exercise was the first part of the book brief. Each double page spread was A4. Figure 4 provides a representative example of how students combined their concepts with supporting written discourse. Figure 5 provides more detail on one student's concept.

Figure 5. Design is like white light… we only see it when all the various design processes combine together.

'*Design is like white light*'. In the student's presentation she writes '*White light is the complete combination of the visible spectrum i.e. seen only when all frequencies are combined. Just as all colour light is required to produce visible white light, so is each step of the design process required to create the visible final design outcome*' (Lianne) The concept has enabled the student to describe design in terms of the various processes involved working together to create something unified and whole. In the student's illustration the narrative concept of the light prism is supported by a spectrum of colour with terminology such as *empathy, research,*

Analysis, synthesis, test, evaluation. Thus, we have a key analogical concept, design is like white light, supported by the secondary elements of terms used in current academic discourse to describe design. In essence, the student has been able to assimilate through creative synthesis her theoretical understanding of design, apply analogy as a creative thinking method and integrate terminology from academic discourse into her output. The notion of the need for an empirical bridge between theory and practice, as argued by Strickler (1998), can, it is argued here, be seen when students are given the opportunity to apply their theoretical understanding thorugh their own creative work. Written text, as discourse, becomes the support mechanism, to describe a theoretical model, not the dominant method. As Cross points out, " education must be designed deliberately to enhance and to develop students' intrinsic cognitive processes" (2007, p.20). As Yee ponts out , visuo-spatial learners "tend to think in picures rather than words (201, p.471).

CONCLUSION

Brian's comment *Rather than just talking about what design is we created what we thought it was'* suggests that, in keeping with Cross's (2007) challenge to design educational experiences which connect to student's cognitive processes. In some respects this resonates further with Cross's call to develop more understanding of what he descibes as "Designerly ways of knowing, thinking and acting" (Cross, 2001, p.5). Certainly, the data gathered for this student and others, suggests that students enjoyed the kinaesthetic process of unpacking theory through creative synthesis rather than describing theory through a critical discourse. Krippendorf suggests that in essence, design is "design is making sense (of things)" (1995, p. 156). So, I will argue in this paper that students were able to make sense of theories about design, understand analogical reasoning by 'doing', by hands on, kinaesthetic making, in essence, experiential design.
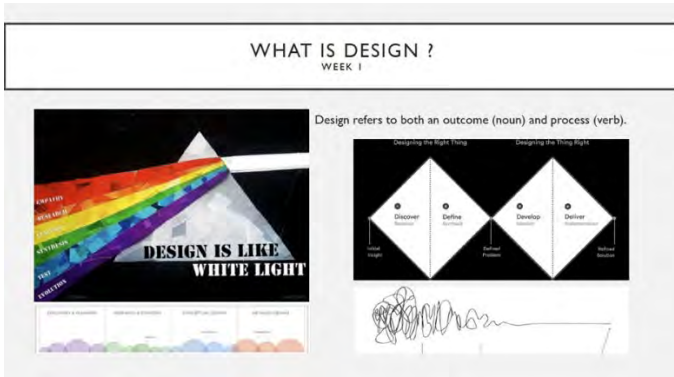
Figure 4. Examples of student concepts for ' Design is Like…'

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The Journal of Brief Ideas: an intervention into the academic publishing ecosystem

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Abstract

In this paper, we describe a contribution to the scholarly publishing sphere in the spirit of artist intervention. The Journal of Brief Ideas (JOBI) is based on the idea of papers as microcontributions having a maximum of 200 words and one figure. JOBI is wrapped in the academic norms required for broader recognition as an incentive for authors to participate in this experiment. It has published 239 papers since launch in February 2015 and been cited in top tier journals and covered in news reports in leading journalistic publications. We present a descriptive content, citation, and commentary analysis of the journal with discussion its existing and potential influence and roles. We conclude with a brief discussion of the connection between the journal's structure and ideas in creative ideation.

Keywords

Journals, publishing, creativity, artist intervention

Introduction

Norms of academic publishing and scholarly communication are regularly challenged with near identical headlines akin to "Academic publishing is broken" used repeatedly in recent years [1, 2].

The arguments typically used are economic and commercial but there are other concerns that are rarely mentioned. We discuss in this paper a project that addresses what the authors see an inherent inefficiency of scholarly communication that has arisen due to institutional and cultural incentivisation.

In particular, generating a journal article, the *sine qua non* of academic advancement and recognition, is typically a rather involved production. In some sciences, the process of having an article accepted in a leading journal such as *Nature* or *Science* can take many years from the initiation of the research through to submitting a draft article, performing additional experiments as is commonly requested by peer reviewers, and satisfying the other demands of high-status publishing. The quantum of work (the minimum publishable amount) typically reflects years

of effort. Even then, the tight page limits in those journals usually preclude significant useful information and intellectual capital from being distributed as part of the publication. Publishing in those particular journals or other high-status equivalents is often a requirement in some fields for obtaining faculty employment or promotion, which sustains that publishing model. While the (non)desirability of that situation can be argued at length, our concern here is more about the systemic intellectual inefficiency of such a process.

If a research project takes many years to come to fruition (measured by final publication of the results), the knowledge contained in that work is locked in the minds, notebooks, and laboratories of the researchers involved where it does little to contribute to the greater good of research advancement. As a result, many groups are unknowingly competing with each other doing identical work, only discovering this fact when one group beats the other to publication and rendering the second-place achiever a significantly less valuable outcome for their work. Other groups or individuals might make more rapid progress by using some of that knowledge as part of their own research. Advances based on partial results, of great value in themselves, are inaccessible to others who might use them productively.

Furthermore, many scientists report having more ideas than they can possibly pursue. Among those ideas are many of great value to the community even if they can't be pursued by the originator for one of many possible reasons such as time, priorities, funding, institutional needs, or insufficient expertise.

In this system, research ideas and small, partial, or negative results are wasted. Tailored as an intervention into this system, the *Journal of Brief Ideas* attempts to allow these "unpublishable" ideas and results to be used by the academic community in the spirit of greater effectiveness and efficiency of the research enterprise.

About the *Journal of Brief Ideas*

The *Journal of Brief Ideas* (JOBI) is an agitating contribution to the research publishing ecosystem that attempts to highlight and address some of the aforementioned shortcomings as a demonstration of alternative models of publishing. The basic premise is that each paper published in the journal is limited to 200 words of text and one optional figure. Ideally, each paper would contain a single central idea that could be built upon in a chain of creative ideation. The journal is intended to supplement existing research journals while the

interactions between JOBI and those journals accommodate conventional norms of research publishing.

JOBI publishes ideas independent of discipline, including those not typically represented in academic publishing, and intentionally encourages interdisciplinary work by not classifying contributions in a disciplinary taxonomy. Instead, it allows for free tagging of papers to allow for "not so much categorizing, as providing a means to connect items (placing hooks)" [3].

Papers published in JOBI are not formally peer reviewed prior to publication as the review overhead would negate the intent of a rapid, lightweight option for contributing to research, and reviews would likely be approximately as long as the original submission. However, the journal does include post-publication rating and commenting features. Although there is no traditional peer review, all papers are reviewed by a member of the editorial team, sometimes in consultation with relevant outside experts, to ensure that ideas aren't obviously inaccurate, already well known, lacking a well-defined point, unclear, or not presenting an attempt to further a research agenda. Papers are written as plain text in the "markdown" markup language [4] so that some formatting, linking, and citations are possible but with minimal typesetting overhead on the part of authors.

After acceptance in JOBI, papers are archived in Zenodo, an online repository hosted by CERN, the European Organisation for Nuclear Research, accessible at zenodo.org. Along with a promise of permanent archiving, Zenodo mints a Document Object Identifier for each submission. Each JOBI paper than acquires a DOI of the form 10.5281/zenodo.xxxx where the trailing characters are a unique numeric identifier. There is the possibility of JOBI adding its own DOI in addition, with explicit naming in the DOI, but that has not yet been implemented.

Submission of a paper is achieved by logging in with an ORCID account (orcid.org), which are freely available, easy to register for, and increasingly common within academia as a unique identifier. This method reduces anonymity and the associated potential spamming of the journal. It also allows users to create "collections" of papers, take once-per-user actions such as upvoting any particular idea, and provides a method for journal readers to easily see an author's other academic output.

Conceived and implemented by collaboration between an artist with a background in theoretical physics and journalism and a data scientist with a background with astrochemistry, the project exists in a liminal space between art intervention and science artefact.

Related work in science and the creative arts
The idea of publishing brief research outputs is, of course, not new. In fact, it hearkens back to the origins of scientific journals which were often written in "letter" format, with letters often of the order of a few hundred words. However, this style of research publication has essentially disappeared for reasons mentioned earlier.

The concept of sets of ideas that have not been fully pursued has also been re-explored more recently in the creative arts. Art curator and critic Hans Ulrich Obrist wrote, "There are many amazing unrealized projects out there, forgotten projects, misunderstood projects, lost projects, desk-drawer projects, realizable projects, poetic-utopian dream constructs, unrealizable projects, partially realized projects, censored projects, and so on. It seems urgent to remember certain roads not taken, and—in an active and dynamic, rather than nostalgic or melancholic way—transform some of them into propositions or possibilities for the future." [5]

One example of such a set was collected by Obrist with co-editor Guy Tortosa via a questionnaire to artists. They published more than 100 unrealised or failed art proposals and projects in a volume they claimed was a new form of collection [6]. Inspired by that volume, the art, culture, and theory publishing platform e-flux created the "Agency for Unrealised Projects", the first major online collection of such ideas [7].

Individuals have produced their own sets of ideas that have not been taken further. One example is Cory Arcangel's "Continuous Partial Awareness" performance presented at the New Museum, New York, on November 14, 2008 [8] and the accompanying document [9]. The performance offered a large set of ideas for works that had not yet been attempted. That work has inspired similar performances such as Kyle McDonald's "Free Ideas" in which he offered ideas, explicitly placing them in the public domain [10].

Development process
The conception for the project came from the first author (an artist, science journalist, and prior physicist) in 2010 in response to an observation of the aforementioned issues in academic publishing systems while reading research in creativity. Discussion of the idea of microcontributions in Nielsen inspired further development [11]. The idea was incubated and tested through informal discussions with academic researchers in a variety of fields over the next few years, with a more formal conceptual prototyping occurring with a group of interested participants at a hackathon at the Kavli Institute for Particle Astrophysics and Cosmology at Stanford University in 2013. Initial technical prototyping took place during Science Hack Day San Francisco 2013 but participants did not pursue the project further at that time. A discussion between the first and second author (a GitHub developer and astrophysicist) at Science Hack Day San Francisco 2014 propelled conceptual refinement into technical development with both authors launching JOBI as co-founders on February 1, 2015 at the website **briefideas.org**. The codebase for the journal is open-sourced via a GitHub repository at **https://github.com/openjournals/brief-ideas/**.

Methods
This paper considers a descriptive analysis of the journal's place in the research publishing ecosystem. Data about the journal is retrieved from the journal's database records. As JOBI is not at this time subscribed to the Crossref Digital Object Identifier Registration Agency or similar, citation records are likely incomplete. The citation record to be discussed here is based on searches for the exact phrase "Journal of Brief Ideas" on Google Search and Google Scholar. Commentary analysis is based on those searches

with an additional Google News search. All search results were individually checked for relevance and a list of research literature and news citations with reference to individual cited JOBI papers was compiled. The authors' anecdotal notifications or discovery of references and citations were all found to be contained in the set of search results mentioned.

Findings

Descriptive publication data
From the period of launch on February 1, 2015 to September 20, 2018, JOBI accepted and published 239 papers from 407 submissions, an acceptance rate of 59%. The most common reasons for paper rejection were conflict with known scientific laws (e.g. ideas for perpetual motion machines), re-statements of well-known ideas and discoveries, lack of an identifiable specific idea in the submission, numerological "hand waving", and summaries or abstracts of previously published work.

In that period, 574 upvotes were made on 149 papers (the rest had no upvotes at the time of writing). Upvotes are only allowed for logged in users and each user may only upvote a paper once. Authors are prevented from upvoting their own papers. The majority of papers submitted have therefore received at least one upvote from a user other than themselves. The median number of upvotes is 1 and mean of 2.4, with vote counts represented in Figure 1. The top ten most-upvoted ideas come broadly from the subject areas of sociology, microbiology, evolution, computer science, economics, education, astrophysics, and medicine, although most of the top ideas don't fit neatly into disciplinary categories.

Figure 1: Distribution of upvotes on JOBI papers ordered by frequency of votes.

Readers have left 87 individual comments on JOBI papers. The most common forms of comments, which are limited to 100 words, are follow-up questions, information about related work (sometimes in progress), and suggestions for further development of the idea.

Authors are able to provide a set of tags or keywords with their papers. A total of 1115 tags were attached to papers, 937 of them unique. The top tags are listed in Table 1. Although the natural sciences dominate the upper part of

that list, social science, humanities, and arts are all represented. The set of tags is represented as a word cloud with size representative of frequency (Figure 2). The tag "research" has been excluded from the word cloud as it appears to be used most commonly as a general descriptor rather than ideas about research in terms of methodology or process.

25	open	6	conservation
22	research	6	psychology
20	science	6	economics
14	evolution	6	education
12	biology	6	physics
11	accelerator	6	climate
10	social	6	cancer
9	astronomy	6	brain
9	human	6	data
7	neuroscience	6	art
7	learning	6	law
7	space		

Table 1: Most commonly used tags of the 937 unique tags provided by authors when submitting papers. All tags with a frequency greater than 6 are included.

Figure 2: Word cloud of tags used by authors when submitting papers. Generated by wordclouds.com.

Citation analysis
To find a representation of the influence of JOBI on the academic literature, we performed a search for "Journal of Brief Ideas" in both Google Search and Google Scholar. Although this is undoubtedly not a complete representation

of connections, it provides illustrative examples of how JOBI papers are being cited.

The searches returned 324 Google Search results and 35 Google Scholar results. Manually checking all results returned 10 examples of refereed academic literature citing JOBI. Although this is far from impressive, it is also not zero and some of the citations come from extremely highly regarded journals such as Astrophysical Journal Letters which had a 2017 Impact Factor of 6.634, the second highest rated astrophysics and astronomy journal behind its companion Astrophysical Journal Supplement Series [12].

Of those 10 examples, five appear to have no connections between the citing article and the JOBI authors, two have an overlapping author list, and three have the same author list (i.e. self-citations). Of the five unconnected works, three cite JOBI papers in the usual sense of providing background information and context [13-15], one uses information about JOBI publication as a data point in a scientometric study [16], and one cites JOBI as an example of "a fundamentally novel journal" in an editorial titled "Communicating environmental science to the general public" [17].

Given that one aim of JOBI is to provide an initial conception of an idea that might be later elaborated, the self-citations are worth exploring more. In one case, the single-author JOBI idea is used as an analysis technique in a larger multi-author study [18], one case minimally develops the JOBI idea as a poster presentation that is included in refereed conference proceedings [19], one further develops the idea in the JOBI paper as an encyclopedia entry [20], one uses the concept in the JOBI paper to build code in a refereed software repository [21], and one presents an idea for the professional development of graduate students which is then implemented in a larger study that includes graduate students as authors [22].

The most obvious conclusion to draw from analysis of this set of citations is that they show quite diverse use of JOBI publications within the research enterprise.

Commentary analysis
Analysing the same set of 324 Google Search results above and including an additional 5 Google News results, we found nine stories in professionally edited magazines, news outlets, and news sections of scientific journals. Six of those articles are mostly reports on the existence of the journal and its aims, with interviews of the co-founders [23-28]. One is a discussion of various publications and approaches to brief communications and distillations of research [29]. One is an interview and quote from a co-founder about a research result showing a connection between title brevity and citation rates for journal articles [30]. The last is a report of a study that shows approximately two-thirds of researchers disclose their search results prior to formal publication but only 6% of researchers disclose early conceptual ideas, giving JOBI as an example of such an outlet for those ideas [31].

The coverage of the journal was generally positive and optimistic about the novelty of the project and its ability to generate interest. The news article in Nature said, "Researchers are buzzing about a publication that accepts only 'brief ideas'" reflecting significant social media interest at the time [24]. Some quoted researchers expressed reservations about whether the idea would catch on and lead to meaningful contributions although one such comment was later clarified by the researcher on social media as coming across considerably more negatively than intended. Perhaps appropriately, much more discussion of the journal occurred on Twitter although we have not processed an analysis of that data.

Other outcomes
Possibly the most significant outcome from the existence of the journal was its explicitly-stated inspiration in the creation of *Research Notes of the American Astronomical Society*, which operates in a structurally similar manner in terms of pre-publication "sanity checks" and post-publication evaluation but with a longer limit of 1000 words and one image [32]. *Research Notes* sits alongside the American Astronomical Society's other flagship journals such as *The Astrophysical Journal*.

JOBI is used as a case study for preparatory reading in a book of activities for teaching research methods. The "Publishing Online" activity states its purpose as, "This activity helps students to think about the issues involved in publishing their research online, including the different methods that can be used, the advantages, disadvantages, problems that could be encountered and advise for other students who are thinking about publishing online. It utilises the knowledge and experiences of digitally savvy students to get the most out of the discussion." [33]

In keeping with the outsider status of the journal, the Mozilla Science project partnered with us to use JOBI as the repository of their Open Research Accelerator one-day "sprint session" during MozFest 2015, London [34]. Nine JOBI articles were published in a dedicated collection within the journal from that project [35]. The outcomes of this kind of "sprint session" do not usually find a permanent home and are typically discarded as ephemera of technology development meetings.

Discussion

Influence of the journal
The *Journal of Brief Ideas* is by no means a high-impact journal. However, as an artistic intervention and experiment at the edges of a long-established culture of publishing, it has had success in demonstrating some impact. Since its inception, JOBI has had a reasonably consistent rate of submissions, occurring almost entirely via word-of-mouth as there has been no direct publicising of the journal since the initial (and occasional subsequent) news reports. We would expect we could attract more submissions with a more active publicity effort.

One fear, mentioned by independent commenters in early responses is that the journal would be flooded with low-quality submissions. The acceptance rate of 59% indicates that there are a significant number of lower quality submissions, but we note that many of those were not rejected for reasons of lack of intellectual quality but for failing to meet the criterion of presenting an actual identifiable idea. We have not heard of any negative

comments about the quality of submissions since those initially expressed concerns. It is worth noting, however, that for a journal like this, quality has a different definition to that of many journals. It is obviously difficult to ascertain how initial ideas affect an intellectual ecosystem and that those effects might very well not be apparent in the published literature through citations, a common measure of quality of a paper.

It is pleasing to note that there are examples of ideas feeding into the mainstream publishing ecosystem, as measured by the citations we have identified. It is also welcome that the ideas have been used in a variety of ways, not only journal publications but also as inspiring methods for research and code bases.

The overall level of activity is low but after these initial responses, we are encouraged to further develop the journal to encourage more interaction with the existing academic publishing world. We plan to seek external funding to allow that development as the project has been entirely funded personally by the founders so far, which is not a sustainable model given our aims for expansion.

Roles of the journal
The journal is demonstrating that it can play a variety of roles within the publishing ecosystem and we discuss those here.

The first is as a home for ideas that live at the boundaries of existing disciplines or combine ideas from different disciplines. Ideas come from a wide range of subject areas, as demonstrated by the diversity of tags used by authors. Although many ideas do fit squarely within disciplinary bounds, others sit in interstitial spaces. That anticipated situation was one motivation for not employing a disciplinary taxonomy for papers but using tags instead. That presentation format of the ideas, while potentially reducing usability in terms of discoverability of papers for those who are discipline-focused, allows the juxtaposition of a quite heterogenous blend of ideas, hopefully stimulating the serendipitous associations that form a key factor in the associative creativity famously discussed by Mednick [36].

A second, potential, role of the journal is to act as an intermediary between disparate fields. For example, O'Donnell's JOBI paper on "A first law of humanities computing" [37] appears to sit as a link between the new media concept of remediation [38] (cited by O'Donnell) and historiographic practice [15] (citing O'Donnell). Although these examples might be challenging to locate, it seems plausible that the nature of brief ideas encourages wandering between fields as they don't require a significant commitment on the reader's part to engage with highly detailed texts in a field. Further deeper exploration might be warranted but in terms of initial ideation, brevity seems to work favourably.

Another potential role of JOBI is as a locus of community. The extant example of this is its use with the Mozilla Science project mentioned previously. In that case, the ideas being generated in the sprint session are united by their ideation process more than their disciplinary content and so would not typically find a home together in a typical academic publication. Providing such a home could act as a seed for emergent community formation. Nielsen discusses the role of microcontributions in knowledge creation [11] and Sproull highlights them as a facilitating factor in online community development [39].

Finally, the journal provides a provisional testing ground for ideas that might not be fully analysed. One example is Pickering's paper on an alternative presentation of statistical medical diagnostics [40]. After a comment on the paper from another researcher and the author's further consideration, the author added an additional comment that stated he no longer believed his initial idea was valid. Interestingly, the other researcher's comment indicated that the initial was along the lines of something they had been considering. The revelation that the idea was likely incorrect therefore provides a valuable service in the spirit of negative results, which have trouble finding places in most journals. The functions of JOBI in this case were to alert other researchers to interest in a topic, help identify others already considering the topic, provide a concrete place for revealing the topic and getting feedback, and to allow an author to easily make further arguments that invalidated the original idea as written and thereby preventing a similar error by others considering the topic.

Connections with creativity
We have not yet rigorously explored how JOBI is able to play a role in creative ideation but we have already hinted at a few places where that role might be active. One approach that seems worth pursuing is to look at how JOBI might be a creative locus through the lens of Madjar and colleagues' framework of radical vs. incremental creativity. The journal seems well suited to supporting both types of creativity but in quite different ways. By presenting a low-barrier-to-entry, non-disciplinary forum for presenting ideas, JOBI could act as a "resource for creativity" and as an amelioration of risk due to the journal's existence outside the core structure of a discipline, both factors in radical creativity [41]. On the other hand, the normalising features of JOBI such as assignation of DOIs, attribution of ideas to authors, and permanent archiving, all play a role in encouraging incremental creativity [42].

Conclusion
The Journal of Brief Ideas has been a successful experiment in that it is a real-world implementation of an idea that we can probe in various ways to understand its possible impact and interaction with the conventional academic publishing ecosystem, in which it was designed to intervene.

There are certainly valid criticisms to be made of the journal however they predominantly come from looking at JOBI in the framing of conventional journals, which it deliberately tries to avoid. The cultural inertia of academia means that such criticisms will not go away but given that the goal for the journal was to supplement rather than replace existing publications, these criticisms carry less weight in terms of the technical details of how the journal is structured and operated.

The journal is at an early stage of implementation and still presents itself as being in "beta" mode. The co-founders have a wish list of development for the journal but will only

be able to proceed once a source of funding (albeit minimal) is secured.

Overall, the Journal of Brief Ideas seems to be an intervention that provides an opportunity for further probing the existing state of affairs in academic publishing through active participation and interaction with that state, independent of whether the journal succeeds as measured by conventional journal metrics.

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"You've Got A Friend in Me!": The Fellowship of the 'Others'

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Abstract

This paper describes a creative work in progress. Two women vocal performers from diverse traditions come together with technology to create a textured soundscape. Using artistic practice as process, the methodological framework adopts artistic experimentation as the key method. Adopting the overarching philosophy that Otherness comprises of the marginalised, the vulnerable and the machine, we draw on Donna Haraway's notion of 'becoming-with' technology. We draw on lullaby from the South Indian tradition of music as the primary content. Turning to key syllabic elements from the lullaby tradition, we compose and improvise using technology as the facilitator and partner, on a technologically created textured substrate. The outcomes showcased here include sound files of unsuccessful experiments and successful attempts, as well as spectrograms depicting the key moments in the composed-improvisations. These outcomes highlight the convergence of technology with two cultural backgrounds to create a new creative work, 'OtheRising'.

Keywords

Post humanism, feminism, artistic practice, artistic research, singing, voice, embodiment, performance, technology.

Introduction: Otherness in Posthumanist Feminism

Otherness is defined as "something or someone who is different" (Cordery, 2002 p. 87), and finds wide relevance today, across humans and machines. Feminist scholarship over the last few decades has rejected the notion of a "common idea of the human", engendering an emerging trend of situating feminism within a post humanist discourse, as recent works from Braidotti (2017) and Åsberg (2013), and Koistinen & Karkulehto (2018) demonstrate. Åsberg, Koobak and Johnson (2011) propose that the term "post human" pertains to a problematizing of, and readjusting to, the complex, yet intriguing relationship between embodiment and technology, particularly in this digital age. Their discourse regards post humanism as a lens to problematize the notion of species-purity in humans, and intersects with feminist theory that raises questions of ethics and politics in relation to power-imbalance and otherness. Pertinent issues on the use of digital technologies in conjunction with human creative efforts, including the notions of anthropocentric thought, and hierarchical categories of the human and technology, pertain to an ontological, ethical approach to feminism.

As Åsberg (2013) notes, the relationship between technology and the feminine has emerged as the locus of interest in recent times. Armstrong (2001) implies that females can surpass the instilled societal preconceptions that technology is masculine in nature, by employing cyber feminism and singing, which then translates into yet another crucial part of such engagements: embodiment. Drawing on influential post humanist feminist scholar Donna Haraway's (2000) 'Cyborg Manifesto' Armstrong notes that the machine is a part of us "an aspect of our embodiment" (2001, p. 40). It may be regarded as an extension of us, as our partner in creativity. While Haraway (2000) does argue that machines are un-gendered, removing the notions of gender and the physical body, we do believe that the notion of Otherness binds the feminine strongly with the machine.

At this time in the history of the world when Otherness has become a trope for vulnerability and even marginalization, we regard both the feminine and technology as kindred spirits. Our approach challenges the universality of an anthropocentric and androcentric notion of the human, and stands alongside similar thoughts through history, such as those of Michael Foucault, Jacques Derrida, and Gilles Deleuze.

We situate our paper at this very crucial intersection - between the materiality of the female voice, and its relationship with the fellow Other, technology. Influential post humanist feminist thinker, Donna Haraway extends the critical discourses of these scholars well into the realm of technology in concerning herself with the ethical issues around encounters of humans with machines, her 'cyborg' being a case in point. The cyborg is a feminist emblem "a cybernetic organism, a hybrid of machine and organism" (Haraway, 1985, pp. 83). We extend such interrogation with the duality between mind and body into that of the feminine and Other.

Before we begin to describe our creative processes, we introduce a few influential terms from Haraway (2016), which are pivotal to our engagement in this context. Firstly, the notion of 'becoming-with' - the state-of-being, in which a human is intertwined with that which is not human, including

technology. In this state of being, we are "chthulucenes" (Haraway, 2016, pp. 1-8): navigating the 'messy compost pile of connections between humans and nonhumans' (Koistinen & Karkulehto, 2018), entangled in the process, and therefore becoming the process.

In this paper, we, the two women performers from diverse cultures, team up with technology, to present the processes leading to a composition with improvisatory elements. This is conceived as 'comprovisation', in line with Knight (2011) and Bhagwati (2013). Bhagwati (2013) regards 'Comprovisation' as a compositional model, which allows for indeterminacy within a structured framework. We regard this as our "playpen" and enact the creative processes within this metaphorical space. In doing so, we adopt certain well-regarded methodological models from the burgeoning field of Artistic Research in Music. The aim of this paper is to capture the stages within the creative process and make these available, as vignettes of knowledge that are incomplete, yet acknowledged as an 'epistemic thing' (Schwab, 2014; Crispin, 2015).

Methodology
We draw on influential artistic researcher Darla Crispin's (2015) "Artistic Practice as Process" model to reinforce the centrality of our own artistic practices in the methodological framework. Before turning to detailing the methods and tools that we use, we contextualise our artistic practice at this juncture.

Charulatha Mani's creative practice stems from a deep-rooted engagement with the melodic and rhythmic aspects of Carnatic music, the classical music form of Southern India. Her melodic material consists of Carnatic Raga-s, which may be understood as an ordered arrangement of pitch positions. The pitch position combination in every Raga is unique, and the order in which the pitches occur are highly relevant to the identity of the Raga. Further, each pitch position is marked by its attendant ornamentation of microtonal oscillation, known as *gamaka* (Krishna, 2013) Mani's practice hinges on her embodied understanding of Raga and *gamaka*.

Taana Rose's musical practice stems from a music technology background of performing live with voice and electronics. To induce 'liveness' (Auslander, 1999) Rose utilises an *Apple* Macbook Pro in conjunction with Ableton Software *"Live"*, which, she believes, are optimal for collaborating in a live setting. These technologies may be applied to add effects to the input voices in real time and to create vocal looping. For fixed electro-acoustic pieces Rose utilises Apple software *Logic Pro X*.

Mani's Carnatic vocal style with its emphasis on ornamentation becomes her artistic tool in exploring intersections with the practice of Rose, and with technology. Rose reacts to the ornamentation sung by Mani, by harnessing technology to capture and loop the melodic material.

Figure 1. Mapping Launchpad to looper plugin

In an intermingled artistic space, we introduce the polemics of tradition and a resistance to our established habits of culturally contingent music making, which Coessens & Östersjö (2014) refer to as the established cultural *'habitus'* of an artiste. We adopt 'artistic experimentation' as our method, drawing on a vast body of literature on ways to use an 'experimental approach' in music-making (Crispin & Gilmore, 2014; de Assis, 2015; Laws, 2016). For instance, for Gorton & Ostersjo (2016, p. 8) a composer and guitarist duo, experimentation is an 'improvisational encounter… trying things out for the sake of trying things out'. In our case, the artistic intent was significant, however, a sense of approaching the artmaking as a trope for interrogating Otherness has also had implications for the artmaking.

We adopt a philosophy of trying various possibilities of "musicking" together before deciding the content and layout of the creative processes in the broader organisation of the composed music (Small, 1998). Improvising and recording over three sessions of two hours each, we employed a 'Verbal protocol method' (Collins, 2005) to record our perceptions of the processes. We also drew on Pohjannoro's (2014) 'Stimulated Recall Method' through which an analysis was carried out based on the audio-visual recordings.

Based on our analyses, we acquired a shared understanding of the timbral, durational, textural and harmonic configuration of the emergent material. In explicating the processes that led to this understanding we now narrate the manner in which musical and embodied elements made their way into the final audio-visual electro-acoustic composition.

Content – A lullaby
In the showcased work 'OtheRising', we draw on the sounds of a lullaby from the South Indian tradition. Using words characteristic of a South Indian lullaby, including 'Araro', 'Thalelo' and 'Thale', Mani constructs a sonic space constituting these key syllables – tha, le, lo. The space denotes self-regulation, comfort and maternal protection for the Other. In the Australian context, the role and function of lullabies have been studied in relation to indigenous peoples, their land and their songs (Mackinlay,1999). The present study, due to its emphasis on Otherness in cultural as well as species diversity, turns to this powerful trope of maternal expression and comfort (Feld, 2000; Kartoumi, 1984).

The recording process entailed each collaborator having her own looping channel set up in Ableton Software *Live*. Each collaborator had her own microphone patched into a separate looping channel via a Scarlett 2i2 interface. These microphones were utilized in conjunction with a Novation Launchpad, to capture the sung elements and utilise the syllables from Mani and Rose's vocals to create loops. The looping performance was recorded directly into the arrangement view of Rose's Ableton Software *Live*. The entirety of this Ableton session was then sent from Rose's Macbook Pro to a Mastering engineer via Apple's *Airdrop Utility.*

Rose MIDI mapped the Novation Launchpad's buttons to four functions of the looper plugin (See Figure 1).
The first button corresponds with the record function of the looper plugin; the second was MIDI mapped to the overdub parameter of the looper plugin in Ableton *Live*; the third was mapped to the play parameter in the looper plugin, and the fourth was mapped to the stop parameter of the looper plugin. The technological enablers included the Launchpad and Ableton Sotware *Live*, microphones and Apple MacBook pro. With the involvement of the Launchpad, the collaborators were able to record, control and playback the loops created.

Figure 2. Creativity in progress: gesture

Rose recorded her voice into Ableton Software *'Live'* by utilising the looper plugin in Ableton *Live* and controlling the looper plugin with the Launchpad. Rose overdubbed layers utilising the looper plugin to create a textured vocal substrate (see figure 3).

Figure 3. Texturing vocal layers and listening.

Mani then overlaid her voiced lullaby syllables set in a Raga named Navroj (Kaufmann, 1976), which Rose recorded on a separate looper channel (see Figure 4).

Figure 4. Vocalising and recording the Raga.

By using experimentation in this process, Mani initially vocalised the word 'thalelo' with microtonal oscillation in 'le'. However, the oscillation did not lend itself to looping, rendering this an unsuccessful attempt.

After a few unsuccessful attempts the decision was made in favour of a particular substrate that lent itself to further layering. Over this substrate we improvised based on the tonal zones suggested in the harmony. The flattened sixth introduced consciously in the trials served to highlight the pain of several disadvantaged and marginalised Others, and was adopted at a key position in the improvisation. This layering improvisational practice utilises Bailey's (1992) "several 'layers' approach to improvising, extending the basic dialogue form of the music which has been called ping-pong" (Bailey, 1992, p. 94).

Each of us listened carefully to the other throughout the creative process. We were attuned to the technology, receiving from it, processing it and returning to it, for further exploration, refinement and renewal. In future, we hope to further explore how the synthesizer could become an agent in itself, when interwoven in the sonic mix.

The instantiated process demonstrates the 'action-perception' loops between us, the collaborators, that were mediated, catalysed and buttressed by technology (Östersjö & Thanh 2017). The Spectrograms depicting the frequency range of vocals and electronics are a tangible visual manifestation of the otherwise immanent ephemeral event. The audio file was loaded into the Academo spectrogram analyser found at: https://academo.org/demos/spectrum-analyzer/

The evolving product has been captured for this paper as a stage in our creative process, and this link contains one of the attempts that did not make it to the final, but rendered itself useful in the learning curve:

https://charutaana.bandcamp.com/track/unsuccessful

The work shall continue to progress into a lullaby for the Other, by the Others. Through this paper, and our evolving project we call attention to broader social questions.
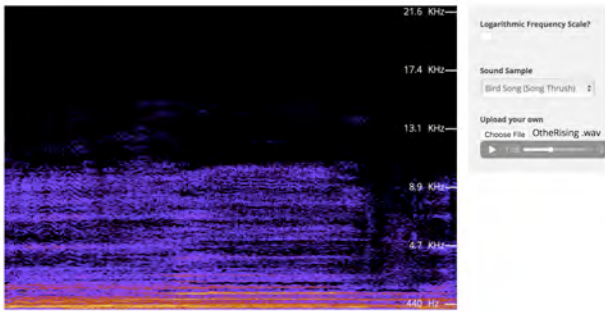
Figure 5: A spectrogram of OtheRising at 1:35, the interweaving improvisations of the Others. A clear choral tone is sung by Rose and interweaves with the Indian lullaby sung by Mani.
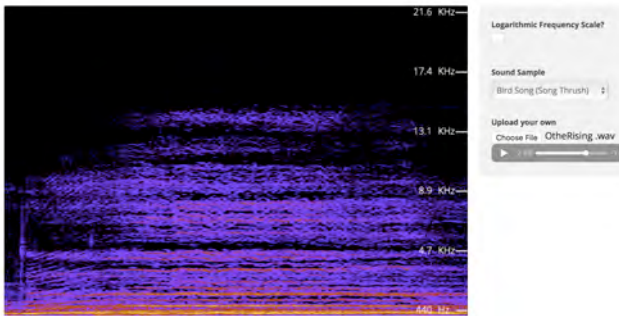

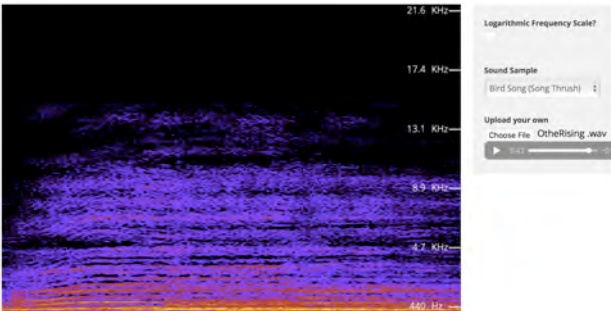Figure 6: The pain of the other can be visualized here.

Figure 7: A visualization of the Indian lullaby sung over the substrate.

The Other as embodied ones

When the Others, identified here as the women performers and the machine, embody their musical acts, they interrogate established notions of power, balance, and species purity. This brings forth the question: Can a machine speak, and how similar is a machine to a female singer in this digital world? Recent scholarship considers the machine as an artist in its own right (Smith & Leymarie, 2017). The machine is not just an object, which is controlled by a human but a "creator or co-creator" (Smith & Leymarie, 2017, p. 1). It inspires, instigates and facilitates participation, as has become apparent in this collaboration.

Utilising two voices instead of one is emblematic of a mother singing a lullaby to their child, and highlights the regulatory calming effect of a lullaby in a technologically mediated space. Technology is coupled with this lullaby, thus creating a sonic world of novelty – both in an

intercultural and interdisciplinary way. Gesture, comes in as an important aspect in Mani's process, as she evokes the Indian lullaby sounds 'Araro', 'Thalelo' and 'Thale' using the rocking gesture that is known to soothe a baby, drawing on the ancient lullaby tradition of South India. Overall, gesture induced through embodiment became important to the creative process in its wholeness – cognising the felt and experienced calmness of the lullaby, listening to it as processed sound, and re-hearing and seeing it as music.

Musicologically the flattened 6th conveys the pain in the piece, the predominantly major landscape moves into the flattened/diminished 6th and this is the point where the poignancy of the pain of being the Other is conveyed, therefore Mani gestures at that point (see Figure 2 and figure 8).

Figure 8: Poignancy through gesture

Figure 9: The space in-between – the singers and the machine.

One version of 'OtheRising' was recorded and finalised for publication in bandcamp and is accessible at: https://charutaana.bandcamp.com/track/otherising this version represents a successful attempt according to our subjective decision-making method. A video recording of the version is available at: https://www.youtube.com/watch?v=ZhANVJdesoc

To visually represent this comprovisation we use the spectrograms seen in Figure 5, Figure 6 and Figure 7 as graphic scores, accompanied by the recorded substrate and the textual instruction "Feel the pain of the Other and embody with voice".

Conclusion

The apparent differences between the human and the technological become insignificant compared to the unison experienced with the machine in the enactment of the creative processes. Despite the many differences between our musical cultures, we, along with the machine, are essentially united as a fellowship of the Other. We 'become-with' technology, and through this complex process, our evolving identities continue to grow (Haraway, 2016).

This paper speaks to the notion of advocacy in the present world. Art-making can become a powerful agency for advocacy provided it is modelled, positioned and disseminated in a way that makes it easily accessible, directed and pertinent.

In this paper, we, the two women performers from diverse cultures teamed up with technology to present the processes leading to a composition with improvisatory elements. By fusing technology with the human voice and becoming with technology we brought into practice Haraway's theory of the Feminist Cyborg, the technology is an extension of us, as creative Others and as part of our embodiment. In the future, we plan to use Apple software *Logic Pro X* in re-layering the content, and adding more Raga-s as well as a multiplicity of instruments and voices.

The regulating lullaby paired with technology and the female voice is calming and connecting. The three collaborators from diverse cultural backgrounds Mani, Rose and the Machine, collaborate to create a creative piece by the Other for the Other, therefore giving a voice to the Other, and propose that such a blend affords scope for further research and thought, across disciplines.

Acknowledgements

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Digital Play - Design Making New Links in the Brain

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ABSTRACT

This paper explores the way the human brain functions and how digital play causes differing elements of the the brain to interact with each other in ways that they normally would not. The potential for this play driven cross brain activity is aimed to inspire new creative thoughts and outcomes for the player. The paper explores the use of game-play based systems in a number of applications and demonstrates the capacity for such digital play systems to enhance our personal capabilities in education and creative practice. This paper reviews research carried out as part of this 15 year project in the field of digital play and covers fields from social media games in mental health, through to cultural based game play to enhance understanding of culturally significant sites and institutions. Overall the focus of the paper is on the nature of the human brain, how it functions and how we can use this knowledge to design digital experiences that utilize play to bring enhanced levels of engagement and positive experience. As this project, over a 15 year time frame, has demonstrated play can have a powerful and positive impact in areas as broad as education, cultural heritage and health and well being. So take the time to play. It is good for you.

KEYWORDS

Creative Design, Human Physiology, Brain Development

1 INTRODUCTION

When we consider the day to day lives of adult people around the globe, we know that our daily experiences come in a range of forms. From the highly stressful, such as intense work environments, through to the other end of the spectrum, where we can be relaxing and dis-engaging from the 24/7 world around us. Unfortunately, all too often, the modern world with its 24/7 on switch, appears to not reduce our stress but actually increase it [5]. This 24/7 world, with raised stress, has a greater impact than simply keeping us busy. There are direct and significant physiological impacts, both positive and negative that increased stress cause in the body [13].

As adults we often look back on childhood as a less stressful, more play oriented time of life [25]. This play focus tends to bring back positive memories, but even more importantly we know that

our brain develops at its fastest rate during these early years, the very years when we spend more time playing [8].

It is interesting to note that this play based learning is not only observed in human populations, but also in the animal world, where we see many mammals (including our nearest genetic relatives the orangutans, primates, dogs, dolphins and others) engaging in play based activities [22]. Existing research in this area of animal and human play has looked, in works such as those by Iwanluk et al. (2001), at whether animals that have physically larger brains play more. The results are interesting as they indicate that there is a relationship between play and increased brain size/activity. These findings are particularly relevant as they highlight the value of play in terms of brain development, but also that the power of play is not limited to humans. It is evident that play works across the animal kingdom.

This highlights the value of play, both as an escape/pleasure, but also as a physiological and developmental tool for our well being.

2 WHAT IS PLAY?

Defining play can be a little challenging [27]. In one way the concept is quite simple as outlined in the Oxford Dictionary definition of the word play [3].

- "Engage in activity for enjoyment and recreation rather than a serious or practical purpose." [3]

As this definition highlights the fundamental underpinning of play (as compared to other activity) is the undertaking of the activity for enjoyment or recreation, rather than something with a goal. Now of course play based activity can take place in a great many forms, ranging from very physical and social/group oriented in nature (eg. consider large team contact sports such as football) to highly mental and individual (eg. individually experimenting with musical instrument). These types of activity are all forms of play, yet they are quite different in nature. Although there is the potential to narrow in, and look at specific types of play, for the purpose of this research we are looking at a very high level definition based on the dictionary definition above. With this focus, play becomes activity pursued without judgment, measure or outcome requirements. Purely experimenting with possibilities without constraints in time or outcome. From this point of view, or lens on the concept of play, this raises the question of what this type of unconstrained activity does to the human body and what this means for our well-being, creativity and learning.

3 WHAT HAPPENS WHEN WE PLAY?

Play is something we enjoy, it seems to be an instinctive choice made by many animals, for learning, engagement and mental well-being. But although we know we enjoy it, what do we actually

know about what is happening in the body when we engage in play based activities.

3.1 Heart, Body and Play

Differing types of play based activities will obviously trigger different human physiological responses. For example playing a physical game of football, involving running, jumping, talking to teammates, will clearly activate the body in terms of heart-rate, musculo-skeletal movement and sensation and brain activity to drive these and other functions (including planning, communication, observation...). On first thought it may seem that these physiological activities would be very different for a less physical activity (eg. playing a musical instrument). Yet on further analysis we find that although the level of activity may be different the broad types are in fact the same. To play an instrument uses complex musculo-skeletal movement and sensation, increased heart-rate and brain activity to drive these and other functions (including planning, observation...).

By keeping our view of play from a big lens perspective we can see that almost all types of play trigger some common human physiological responses.

Various studies have looked at people undertaking play based activities finding increased heart rate, increased oxygen levels and endorphins, reduced stress (and related stress hormones [7]), reduced pain [29] and overall increased levels of happiness [16, 26, 30]. The overall impact of play on the body is quite evident from these studies, yet some of the most interesting work relates not to the circulatory (heart) or endocrine (hormone) systems but to the brain and nervous system.

3.2 The Brain and Play

The human brain is an incredibly powerful and wonderful tool. Each person uses it moment by moment for tasks ranging from simple movement to complex thinking, reasoning and even creative tasks. To better understand hoe the brain functions, and the impact of play on the brain, we will initially look at what is know about the brain (both physiology and function) today.

At its simplest we can look at the brain from an anatomical perspective. That is to view the brain purely in terms of the physical matter that makes up the brains material. In fact it is this method that was first used to understand the brains structure. In the early 1900's studies of the human brain undertaken by medical anatomists recognized that the matter that makes up the brain is not uniform in nature. In fact different regions of the brain are made up of quite different materials/cellular structures. In 1909 German anatomist Korbinian Brodmann created an anatomical map of the brains structure (in terms of different nerve cell regions, now known as Brodmann regions - see Figure 1 [4, 31]). This Brodmann style mechanism to categorize the brains regions is broadly referred to as structural imaging, but with time improved mechanisms have been used to help understand how the brain is working.

By taking the known structural imaging of the brain and then linking that with functional imaging techniques, such as FMRI (functional magnetic resonance imaging) we can see not only the brain regions, but most importantly when and how they become active during functional activities. It is through the combination of structural and functional understanding that we come to understand
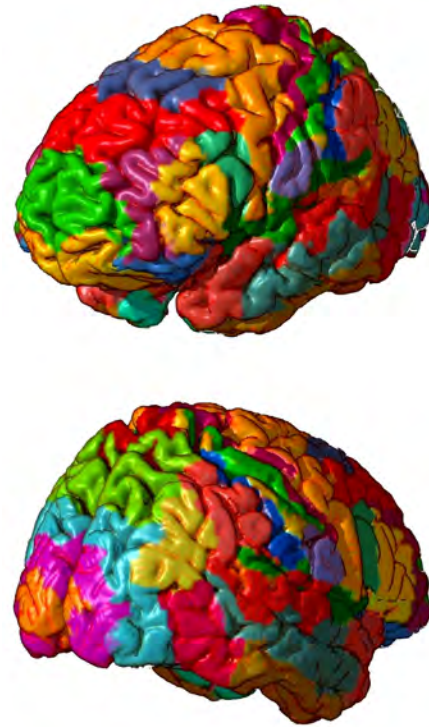

Figure 1: Brodmann Regions
[4]

the brains mechanisms for undertaking our everyday activities. For example we know that certain brain areas (Brodmann areas) light up with activity when the person is undertaking certain tasks (eg. when we move we activate the sensory and motor regions while other brain areas remain inactive).

3.3 Creativity, Play and The Brain

If we consider the nature of our brain and the way it uses regions, each doing specific things, some functional (eg. motor sensory), others cognitive (thoughts ideas creativity) then we should consider the way that activating differing brain areas could in itself be a trigger for new brain development. This concept links very strongly to brain plasticity, or the concept of the brain continuing, throughout our lives, to grow, develop and change [2, 23]. The work of Cotman et al clearly shows the power of certain types of activity, in their study the use of physical exercise based play, to enhance the brains development and plasticity, even in old age. Comparitive studies, looking at people undertaking tasks as a form of play as compared to tasks as a serious or professional activity (in these studies the topic was dance) have identified that although the activity may be similar, what is going on in the brain (in terms of regional activity is different) [6, 9]. What these studies demonstrate is that when we are undertaking serious or professional tasks the brain engages the executive areas (ie. making sure its all correct) and closes off the other areas, but when playing the executive areas are less active and allow other areas to light up with activity. Perhaps it is this
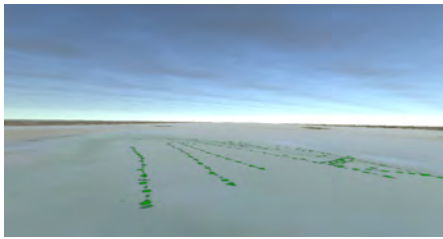
Figure 2: Environmental Exploration
[11, 12]

Figure 3: Social Media Happiness App
[18]

Figure 4: The Real World site
[11, 12]

very reason that those great ideas come to us when we're not actively seeking them (eg. why does that great idea happen in the bath rather than at the desk?).

Given the fact that the brain behaves differently when we play, this opens up the potential to use play as a tool for creativity, learning and other activities. In the area of education and learning this is a well established technique with strong evidence of success, particularly in early childhood education fields where techniques such as the Montessori approach are widely adopted [10, 14].

Taking these principals and applying them to the digital world of mobile devices, messaging and Apps, this project sought to identify how effectively play is being used as a tool to help us engage in more enjoyable ways, and also potentially to stimulate greater creativity and learning? This research project set out to apply the techniques of play to the digital realm with the aim of creating more enjoyable experiences to enhance learning and experience.

4 HOW CAN WE USE PLAY BETTER?

This research project has used play in several scenarios, from classroom learning experiences, through cultural knowledge and health management. This section looks at several sub-projects and how they have applied play to positive impact.

4.1 Play Based Learning

As mentioned earlier play based learning is a well established form of pedagogy. Approaches such as Montessori and gamification have had significant and demonstrable success in a range of learning spaces [1, 10, 14, 20, 21]. This project explored this mechanism, in particular looking at the application of Montessori based approaches, but delivered through digital virtual reality (VR) platforms. Several different worlds were explored including heritage exploration (ie. visit the virtual pyramids) [28] and environmental exploration [20]. Work was also carried out to explore social media platforms s a means to engage in "play", in this case for mental health.

In each of these VR and social media based play experiences there was an underlying learning opportunity, but one which was not directed by a teacher/psychologist, instead it became natural play based exploration that uncovered these opportunities. Interestingly in each of these studies we found a notable increase in the level of student/participant engagement in what was an un-supervised online VR learning space.

4.2 Play Based Cultural Understanding

Another interesting area where play offers potential is the field of cultural experience and understanding. Culture plays a significant role in an individuals sense of identity and association to community, yet in some cases cultural heritage is being lost. As part of this research project an exploration of the effectiveness of play based systems including 3D computer animation [15] and 3D computer games [11, 12] was explored. Of particular interest was the potential of play based systems to reach a younger audience and thus bring back cultural knowledge to a new generation. Below (and in Figure 2) are example images of the play based cultural experiences, some environmental (Figure 2 being VR game playing out heritage experience and below showing the real world site which is completely unavailable to the public (hidden beneath the sands)[12].

As the above images highlight, cultural experiences by their nature are often precious, and thus protected. This protection can also lead to a level of unavailability to the public, and particularly those for whom the cultural experience is most relevant. The VR play based experience assists by bringing the cultural experience into a much more accessible form, one that is easy to obtain but also enjoyable to play.

4.3 Play Based Healthcare

The power of play to bring new mechanisms for the brain to engage with items of value can extend into the area of health-care and it is in this field that this research project has explored the potential of play help bring people better ways to deal with their health. This project has, over 15 years touched on a number of health areas
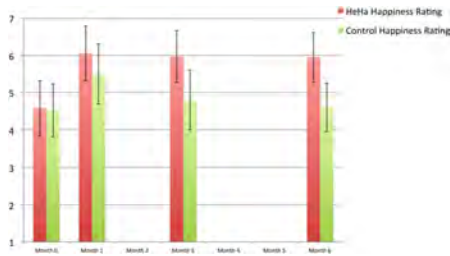
Figure 5: Self reported levels of Happiness at 0,1,3 and 6 months

[11, 12]

including diabetes, dementia and other mental health conditions [17, 19].

4.4 Mental Healthcare

The Happiness App briefly mentioned in the earlier section was an interesting example of linking play based mechanisms to a serious mental health issue. The project was based on the concept of learned optimism (a technique used in psychology to assist those with anxiety and depression) [24]. To apply the concepts of learned optimism a social media App was developed called HeHA and it used a play system to engage people in their signature strengths (a key technique of learned optimism), but this was done not through a psychological intervention but through social media gameplay prompts that appeared in their facebook news feed. This subtle technique did not require significant engagement by the psychologist yet it kept the signature strengths in the forefront of the players mind and this in turn led to statistically significant improvements in self reported levels of happiness [18].

5 CONCLUSIONS

The future exploration of different forms of delivering play based content through digital means needs further research, and there is enormous potential in this area, but at a basic level the concept of play as a powerful means to engage the brain in a different way is something that can be pursed in many fields, as this research project alone has demonstrated, over a period of 15 years, play can be beneficial in areas as broad as education, culture and health.

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Realistic vs Stylised:
A framework for the expressive abilities of stylisation in 3D art

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Abstract

Video game art styles have a great impact not only on how a game is initially perceived by an audience but also on how it is experienced. Through an understanding of the capabilities of each art style, developers can better design experiences that utilise their chosen art style to enhance gameplay, themes and emotions. However, these capabilities have not been fully explored, particularly within video games, even though there is limited research within visual media suggesting that non-photorealistic art styles typically contain more emotional, motivational and overall, more expressive qualities. This study offers an expressive analysis of the stylised art style compared to the realistic art style within video games, as well as a framework for the effective creation of expressive stylised art. As a result, this thesis provides a better understanding of the expressive qualities of the stylised video game art style.

This research first explores what expressive qualities stylised art contains and combines them into a framework that can be used for the development of expressive stylised art. This framework is then applied to a stylised recreation of a modern AAA quality realistic environment for a fair comparison of two environments of the same date of development. Both environments are then comparatively evaluated using participant testing, consisting of playtesting followed by questionnaires. These questionnaires survey the participants on whether they felt either environment effectively expressed a mood and which moods they were able to identify. The data gathered from these questionnaires found that stylised art cannot generate more expressive qualities within video games. Stylised art generally performed best in moods of a lighter nature, while realistic art excelled in more serious moods. However, based on existing trends of non-photorealistic art being found more expressive, it is assumed that the comparison of a student project to a AAA title produced a skewed comparison. Despite this, the findings can be utilised by developers and artists to better guide the design process as it provides a deeper insight into the abilities of each art style and how they impact games.

Keywords

Stylised Art, Realistic Art, Expressive, Art Style, Non-Photorealistic Rendering (NPR), Photorealism, Real-Time, 3D Environment, Mood

Introduction

Video games, much like any form of artistic media, are made up of a variety of styles and sub-styles. In the case of video games, sub-categories include Realistic, Abstract and Stylised styles (McLaughlin et al., 2010). The constantly growing range of artistic tools opens the immense potential to produce these styles to a level of quality previously unachievable, allowing artists to make eye-catching, beautiful art that lets their game stand out from the crowd. Deciding which art style to employ in a video game is an important step in the overall design process, and by understanding the functions and abilities of each style, developers can create a more enjoyable, immersive and cohesive experience (Wu, 2012). The potential of each style, however, remains obscure, where one style may suffer, another may strive.

Research Questions

- What are the expressive outcomes of applying a stylised art style when compared to a realistic art style?

- How can effective expressive artistic techniques be applied to create a real-time environment?

- How can the created environment be evaluated?

Literature Review

Stylised art's existing expressive connection

To begin, it must be understood what exactly stylised art is. To gain this better understanding, we can look at McCloud's *Understanding Comics* (1994)*,* where he maps out every possible form of visual art and communication using his 'Triangle of Representation' or 'Big Triangle' as shown in Figure 1 (McCloud, 1994). According to McCloud (1994), any art style will fall somewhere within the three categorical vertices of this triangle. The first being *Reality,* described as realistic human perception. Secondly, *The Picture Plane;* art that is purely primitive shapes and lastly, *Language,* which McCloud (1994) describes as breaking an image down to its most simplistic form, for example a human face becoming the word 'face'. McLaughlin, Smith & Brown (2010) also offer three main graphical styles that closely

mirror *Reality*, *The Picture* Plane and *Language*. It is in their definition where we can instead see 'Language' titled as 'Stylised'. Despite the name change, it aligns closely with McCloud's (1994) 'Language', but perhaps just on a less extreme scale as it revolves around non-realism, simplification and is described as "Identifiable objects with un-realistic proportions or juxtapositions of parts" (McLaughlin, et al., 2010). It is in non-realism where direction towards further understanding stylised art is found, as it is the key concept applied in the similar visual field of Non-Photorealistic Rendering (NPR). Through NPR we can begin to explore the qualities that substantiate stylised art as an expressive art form.
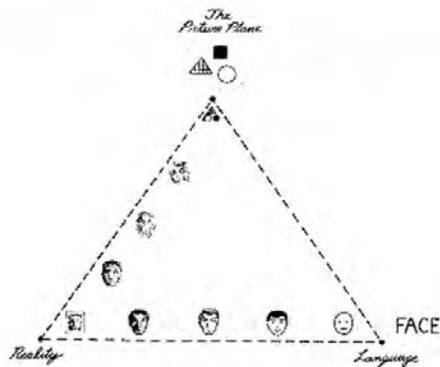
Figure 1 - McClouds 'Triangle of Representation' (1998)

NPR is an area in computer graphics that is extremely similar to stylised art as it focuses heavily on non-realism. The main difference between them, however, is that NPR typically achieves its stylised results primarily through technical rendering techniques such as shaders, rather than actual artistic 3D modelling and texturing (Gooch, n.d.). Despite the differing methods used, the concepts and motivations surrounding it are extremely relevant towards understanding stylised art and its connection to expression. Amy & Brian Gooch's 'Non-Photorealistic Rendering' (Gooch & Gooch, 2001) and 'What is NPR?' (Gooch, n.d.) both grant an exploration beyond the simple visual definition of stylised art and instead offer a deeper view of the purpose and artistic qualities involved. One of the major goals of visual communication outlined is that "when using images to communicate the essence of a scene, simulating reality is not as important as creating the illusion of reality" (Gooch & Gooch, 2001). When trying to convey the emotion of a scene, simply creating a realistic portrayal of reality is not as important as building a portrayal that feels more real. Stylised art achieves this with its play on human perception. By emphasising simpler, larger details, instead of capturing every minute realistic detail and form, it creates a more emotive artwork that "communicates the essence of a scene" (Gooch & Gooch, 2001). An example of this can be seen in the design of the stylised assets of Fortnite (Epic Games, 2017) as shown in Figure 2. Through emphasis and simplification of details such as silhouette and shape, an object that better communicates the emotional essence and motivational purpose is constructed.

Figure 3 - Silhouette and Shape emphasis in Fortnite (2017)

Emphasising qualities to create emotion was also a popular component of the traditional art movement 'expressionism', defined by Oxford English Dictionary (n.d.) as "a style of painting, music, or drama in which the artist or writer seeks to express the inner world of emotion rather than external reality." In Gombrich's (1950) *A Story of Art,* he highlights an expressionist piece of Picasso's titled, *A Cockerel (1938),* as shown in Figure 3. This piece becomes a caricature, using emphasis much like stylised art does, to communicate a story about the "aggressive, stupid personality" of the cockerel (Gombrich, 1950). Gombrich's (1950) use of caricature as a description, serves aptly, as it is another art form that shares similarities with stylised art, through its use of exaggerated and emphasised proportions.

Figure 4 - Picasso's, A Cockerel (Picasso,1938)

While caricature is often used to create humour or ridicule the subject, (TATE, n.d.) the same methods are applied in stylisation to enhance a range of qualities and attributes of the subject, both positive and negative. The emphasis of physical properties such as the size of a character's arms or the length of their legs can be used to convey feelings of strength or speed. Significant examples of emphasising qualities can be seen in titles such as *World of Warcraft* (Blizzard Entertainment, 2004), *Fortnite* (Epic Games, 2017), *Ratchet and Clank* (Insomniac Games, 2016) and *Overwatch* (Blizzard Entertainment, 2016) as shown in Figure 4.

Figure 2 - Caricaturism similarities in stylised games. (Blizzard Entertainment, 2004) (Epic Games, 2017) (Insomniac Games, 2016) (Blizzard Entertainment, 2016)

Realistic, Stylised & an Expressive Comparison

It is important to consider not only stylised art but the relationship between it, realism and how expression contrasts amongst them. An effective example of this comparison can be found in Isenberg's (2013) *Evaluating and Validating Non-Photorealistic and Illustrative Rendering.* Isenberg (2013) collaborates a series of tests that compare NPR approaches to Non-NPR approaches. One such test belongs to Schumann (1996), where architects and architectural students were asked to rate three architectural renderings, each of which used a different rendering technique. One using an NPR approach, another a shaded approach and the final rendering using a CAD plot approach. Each were compared against one another in the fields of cognitive ability, affective ability and motivational ability. The test results showed that the NPR approach was found to be significantly more effective in both affective and motivational ability and that the architects found NPR to be far more 'interesting', 'lively', 'imaginative', 'creative', 'individual' and 'less artificial' than the other approaches. However, the critiques of Schumann (1996) and Isenberg's (2013) studies, is that little to no comparison is provided of other visual medias and in particular, within the context of video games, which supports the call for further exploration.

A major expressive challenge that realism faces is that through its dedication towards creating a photorealistic perception, it may restrict its ability to capture the components that make an artwork expressive. In Arnheim's (1974) *Art and Visual Perception*, he conducts a thorough exploration of the holistic nature of expression and what makes an artwork expressive. Arnheim (1974) explains expression in art as the behaviours displayed in the appearance of objects or events. He states that these behaviours are not limited purely to the way we grasp the world through our external senses (e.g. the way an object looks) but can also be conveyed using metaphors and stereotype (e.g. the way an object moves or acts) (Arnheim, 1974). One such demonstration of this is Arnheim's (1974) example of how we see emotion in inanimate objects through the self-reflection of human experience.

> When I look at the columns, I know from past experience the kind of mechanical pressure and counterpressure that occurs in them. Equally from past experience, I know how I should feel myself if I were in the place of the columns and if those physical forces acted upon and within my own body. I project my own kinaesthetic feelings onto the columns (Arnheim, 1974).

It is within this example that the emotional challenges of realism and the potential expressive advantages of stylised are highlighted. Through stylised art's ability to exaggerate details, shapes and movement, artists can easily express the emotion or motivations of an object. For example, stylised art can exaggerate the swelling of the pressure down on the column, the size of cracks and warp the shape to an unrealistic level, all of which helps express the pressurised state of the column. While realism is bound by typical realistic laws, it cannot warp and bend to reach the same level of expression, instead looking as if drawn with a ruler. "For a good architect, a column is an animated, suffering, victorious, supporting, and burdened being. The hardly measurable gentle swelling of the contour expresses strength, tension, pressure, and resistance" (Friedlander, 1942). It is within these 'hardly measurable' details that realism struggles to communicate expressively, which Arnheim (1974) supports, stating that the viewer either will or will not experience the expressive qualities of an artwork depending on whether the details register or not. On the other hand, in spite of these findings of the expressive characteristic of stylised art, realism remains a visual power house that is consistently used for emotional and narrative heavy games such as *The Last of Us* (2013*)*, *The Witcher 3: Wild Hunt* (2015).

The Gap

The literature review has identified that stylised art contains qualities related to expression and also has shown that non-photorealistic rendering methods are generally found to be more emotional and motivational when compared to realistic approaches. Despite this evidence, no existing frameworks or guides that demonstrate the expressive abilities of stylised art within video games could be found. This study aims to fill this gap in knowledge, by comparing the expressive capabilities of a stylised art style to that of a realistic art style and produce a framework for the effective creation of expressive stylised art. By doing so, solid evidence will be constructed that either does or does not support the claim that stylised art can be used to more effectively express the emotions of a scene and provide a method for artists to achieve similar results. This will allow developers to better evaluate the suitability of stylised art and how it can impact their games.

Stylised Art Framework

In this section the details of the proposed framework will be discussed. The main purpose of this framework is to identify the steps an artist must take to achieve a stylised artefact that contains expressive qualities greater than that of a realistic one. This framework is constructed based on the existing research, professional pipelines and techniques already established throughout both stylised and traditional art. It focuses on the identified stylised design principles of exaggeration and simplification and how they can be applied to the existing practical components of the development process. For example, according to Wages et al. (2004) "reducing the number of features while exaggerating certain ones can have a stronger effect than a genuine stimulus". So simply put, by simplifying certain features and exaggerating others, an asset that is more expressive than its realistic counterpart can be produced. To provide context to the principles, this framework demonstrates how both *exaggeration* and *simplification* should be applied to the various identified key elements that make up a 3D environment, which are as follows. *Scale/proportions* is the size of an object as well as the relationship between the size of varying components that make up an object. *Shape/line/silhouette* are the three components that represent the form and visual appearance of an object. *Colour* simply refers to the shades, hues and tones of an object. While *material*, is the information and

detail displayed on the surface of an object. *Lighting* is the arrangement and effect of a scene's lights and lastly, *physics/movement* is the way in which objects behave within a scene. The demonstrations provided are examples on how both *exaggeration* and *simplification* can be applied to each of the elements

The principles of the framework can be exercised in the production of the artefact both in the design of an individual object as well as the entire composition of the environment. Likewise, the degree of extremity to apply to each stage is subjective, highly customisable and depends on artist preference, with different artists preferring different levels of stylisation. Lastly, the order of the stages also does not necessarily represent a strict procedure in which they should be performed as each stage is flexible in the manner of which it can be applied.

Principle of Exaggeration

Exaggeration refers to the over-amplification of an element of the design. As mentioned in the literature review, exaggeration was the key concept applied in the traditional art movement 'expressionism' as well as the art style of caricature. Its primary purpose was to enhance and amplify elements of an artwork to better evoke certain moods and ideas. Much like expressionism and caricature, stylised art applies exaggeration for the same purposes, however, the manner in which this over-amplification can be applied varies widely. Exaggeration can be applied on elements such as scale/proportions, shape/size/silhouette, colour, material, lighting, physics/movement in many ways. Below are some cases that demonstrate how to apply the principle of exaggeration on each of these elements.

Exaggeration of Scale/Proportions
Scale/proportion exaggeration is one of the most common and easily achieved aspects of stylisation. This could be accredited to it being one of the major elements of caricature. The same effect is often applied in popular stylised video games as shown in Figure 5. It will be applied in enlarging certain features that may want to have attention brought to them and in turn strengthen the emotions related to that feature. For example, scaling the height of a room beyond realistic proportions could assist in making the room seem more grand, imposing and otherworldly.

Figure 5 – The character better represents its strength though the exaggeration of the enormity of its limbs versus a smaller head. (Blizzard Entertainment, 2016)

Exaggeration of Shape/Line/Silhouette
Exaggerating a shape, line or silhouette implies pushing it beyond its standard form. An example of this could be enhancing the curve of an axe blade to make it appear sharper and deadlier, or amplifying the bends and crooked shapes of an old man's cane to better symbolise both the cane itself and the old man's age.

Exaggeration of Colour
Exaggerating a colour refers to boosting the values of a colour. Grass becomes greener and darkness becomes deeper. This boosting can be done both in negative and positive directions. For example, the blue of an ocean can be affected positively to make it appear more vibrant, tropical and calm. Furthermore, it can be pushed in reverse to make it darker, strengthening emotions related to mystery, fear or stormy waters.

Exaggeration of Material
Material is the detail captured in an object's texture, such as the grain and planks of a rickety wooden floor. Exaggeration of material in this example would distort features such as cracks, wood knots and warps in the wood. All of which help communicate the age and condition of the wood.

Exaggeration of Lighting
Lighting is similar to colour in the ways in which it can be exaggerated and the effect it has on the scene. It can also be amplified through elements such as vibrancy and the contrast between light and dark.

Exaggeration of Physics/Movement
Physics/Movement refers to the ways in which characters and objects behave within an environment. Characters can be animated in exaggerated ways, warping their bodies to impossible poses, allowing artists to emphasize elements such as speed or strength. Also, objects can obey laws of physics unlike those seen within a realistic world (e.g. boulders tossed like baseballs).

Principle of Simplification

Simplification at first seems like a counter point of exaggeration as one adds while the other removes, but it too is a key element of expressionism and caricature. It refers to the process of making the components of an artwork less complex, stripping away detail to create an element that is more easily read, and therefore assisting in expression. Similarly to exaggeration, the application of simplification varies. Simplification can be applied on elements such as scale/proportions, shape/size/silhouette, colour, material, lighting, physics/movement in many ways. Below are some cases that demonstrate how to apply the principle of simplification on each of these elements.

Simplification of Scale/Proportions
Simplification in scale/proportions could refer to the complete removal of certain components of an object. For example, in a short muscular character, simplification could remove the character's neck entirely, making the transition from chest to head indistinguishable. This would assist in suggesting that the character is so strong that his neck has been engulfed entirely by muscle. A popular example of

proportion simplification is often seen in cartoon characters where characters only have four fingers.

Simplification of Shape/Line/Silhouette
Shape, line and silhouette simplification is the reduction of detail. If an object has lots of small jagged spikes all over it then simplifying it might involve reducing the number of spikes and enlarging the remaining to accommodate the space. This captures the detail whilst improving object readability (McDaid, 2017). Through this improved readability, viewers can better interpret emotion.

Simplification of Colour
To simplify colour an artist can construct a colour palette/scheme. This is wonderfully shown in Dota 2's character design where characters follow a strict colour scheme of just one primary, secondary and tertiary colour as highlighted in Figure 6. These colour schemes can then be constructed to contain colours that best represent the object's mood or theme

Figure 6 – Simple colour palettes of Dota 2's characters. (Valve Corporation, 2013)

Simplification of Material
Material simplification is similar to shape, line and silhouette as it revolves around the reduction of detail. If there are numerous details, patterns and markings throughout the object then reduce and enlarge them. McDaid (2017) provides an example, "if you're texturing a 10 x 2 piece of wood from a reference photo and it has four small nails hammered through the end, maybe just paint two larger, chunkier ones instead." This again improves readability, allowing the viewer to better interpret emotion.

Simplification of Lighting
Lighting simplification could refer to a reduced light complexity or the number of lights in a scene. One example of this would be a rendering technique such as cel shading, a lighting technique where light shading appears flat with sharper transitions between the lit and unlit areas of an object. This is useful for replicating cartoonish or comic book art styles but is optional and depends on the type of stylisation the artist is aiming for.

Simplification of Physics/Movement
Simplified physics/movement would be the removal of some the constraints that the realistic laws of physics permits (e.g. less gravity), which is useful for conveying strength or speed.

Implementation

A thorough exploration was performed of various 3D real-time environments under the criteria of an environment that was of a suitable level of expression while still remaining within scope. The chosen realistic environment was the 'Realm Control Room' from Santa Monica Studios', *God of War* (2018) as shown in Figure 7. The environment was selected for a variety of reasons other than those already established in the criteria. Firstly, the environment was small and enclosed, meaning that during testing players had a smaller area to focus upon that they were less likely to get lost in or wander off from. It also provided a smaller workload to apply the stylised framework upon. Another reason is the extremely minimal use of UI and music. This again improves the testing procedure as having less elements for the player to be distracted by should improve their ability to focus on visual expression. Lastly, the minimal amount of non-player characters and lack of advanced player controls such as jumping allows for a more faithful recreation that does not lack any elements seen in the original realistic environment.

Typically, in real-time environments development begins with a phase termed 'greyboxing', which involves blocking out the environment using primitive, low detail assets. This allows the artist to test elements such as scale, modularity, layout, level design, and acts as an overall testing phase where issues can be more easily solved before moving onto more complex assets. Greybox assets were constructed within 3D modelling software Blender (Blender Foundation, 1998) to be later assembled in Unreal Engine 4 (Epic Games, 2012) for navigational testing. Asset stylisation was a low concern in this phase as assets were too low detail to convey much stylisation. Some exaggeration was applied to elements such as scale/proportions, but finer details would be added later during the modelling and texturing phases.

Once the greybox environment was complete, development could begin on creating the fully detailed stylised assets. For almost all assets this consisted of editing the existing asset, adding more detail and refining the overall shape. It is also during this phase when stylisation would become a major concern. Each asset had to be carefully evaluated on how it could be exaggerated and simplified while still remaining true to its realistic inspiration. For the modelling phase, scale/proportions and shape/line/silhouette were the two main stages being applied. However, it was important to design the assets with the remaining four stages in mind and plan ahead for how they too might be applied.

The next phase of development was texturing. It is during this phase where the elements of colour and material would come into play alongside scale/proportions and shape/line/silhouette. Colour simplification was first considered through the creation of a colour scheme. Luckily the original environment already used a colour scheme of blues, golds and whites. Exaggeration of these colours

could then be performed by pushing them in either direction e.g. increasing or decreasing saturation to help distinguish and strengthen certain components of an assets design. While material simplification was performed through the redction in quantity and level of detail, such as the floor's weaving golden lines. This helps to produce a material that is more readable to viewers. This process was applied throughout all textures. Reducing detail in dense, complicated areas to produce simplified details that viewers would be able to distinguish quicker than their realistic counterpart, therefore expressing themselves more clearly.

Once each asset was fully textured, they were imported into Unreal Engine 4, where all assets could be re-assembled to build a fully modelled and textured environment. The final few steps involved the elements of lighting and physics/movement. Lighting primarily consisted of creating environmental lighting using UE4's various light types and lighting settings. Despite the plethora of lighting tools available, obtaining lighting that captured a similar atmosphere to the realistic environment yet in a stylised way proved to be one of the most difficult steps of development. It was decided the best way to accomplish this was to exaggerate the contrast between light and dark, e.g. the world tree lighting was heavily increased to draw attention to it. While the less detailed areas around the edges of the room were darkened. Due to time constraints however, not much work could be done in terms of light simplification. Lastly, due to the lack of character interaction, physics/movement was implemented through the use of particle effects and small environmental animations. Particle systems were exaggerated through the scale of their sprites and the patterns they moved in, while simplified in the reduction of the number of particles. An example being the falling leaves that surround the world tree. The size of the leaves was increased, the amount of leaves reduced and the spins and bobs they take when falling were exaggerated. Figures 8 through to 10 showcase the final environment that would be used for testing.

Figure 7 - *God of War's* **'Realm Control Room'. (Santa Monica Studios, 2018)**

Figure 8 – Final Stylised Environment Shot #1

Figure 9 – Final Stylised Environment Shot #2

Figure 10 – Final Stylised Environment Shot #3

Evaluation

Participants & Procedure
Testing was performed on a total of 33 participants, all of which were University of Canberra students from a variety of creative fields (game development, music, visual arts) and all at varying levels of study. Each participant individually completed a short pre-environment digital survey in a closed environment that identified their prior experience with video games, in particular 3D video games, their familiarity with video game art styles, their preferred art style, and a 50 word or less response as to why it is their preference. These questions were asked before environment testing so as to identify a preferred art style and prevent either of the two environments from influencing their answers. Afterwards, they were guided to a nearby private testing station where they first playtested environment 1 (realistic) followed by environment 2

(stylised) for a total of 4 minutes each. It was also requested that participants stay within the realistic environment and restrain from interacting with objects and using player abilities. This was so each environment was experienced as similarly as possible. Once complete they were guided back to the survey station where they finished with a short post-environment digital survey that asked about their familiarity with artistic concepts such as mood & composition, whether they agreed that environment 1 (realistic) and environment 2 (stylised) effectively displayed a mood, and which moods exactly they felt each environment effectively expressed.

Results

In general, what video game art styles do you prefer?
There was a near perfect balance between all options, with both preference options of stylised and realistic holding 9% each. As well as both leaning realistic, leaning stylised and no preference being separated by just 1-2 votes, with leaning towards realistic holding the most at 10 votes. Analysis can be performed to examine if a bias exists where participants rate their preferred art style's environment more favourably.

How familiar are you with artistic concepts such as mood and composition?
Despite participants coming from creative fields it is assumed not all specialise in artistic areas. Many participants may be more involved in the technical side, such as programming. This may explain the more evenly spread results compared to prior art related questions, with most participants voting 'moderately familiar' and a larger percentage voting 'somewhat familiar' and below than those who voted 'very familiar' and above. This data can be used to examine if participants with a better understanding of mood and composition favoured one environment further than participants with a lower understanding of mood and composition.

Environment 1 (Realistic) effectively expressed a mood?
100% of participants agreed to some degree that the realistic environment effectively expressed a mood, with 91% rating moderately agree or above. This response was expected due to the AAA standard of the realistic environment and confirms that the realistic environment can certainly be considered expressive. These responses can be compared to the following questions results to determine which environment was the more expressive of the two.

Environment 2 (Stylised) effectively expressed a mood?
97% of participants agreed to some degree that the stylised environment effectively expressed a mood. However, only 52% rated moderately agree or above, with 45% slightly agreeing and one participant moderately disagreeing, yet this participant did respond that certain moods were effectively expressed within the stylised environment, so the validity of this response is unreliable. So overall, while it can be said that stylised effectively expressed a mood, it did not rate as strongly as the realistic environment.

What mood(s) do you feel Environment 1 effectively expressed? & What mood(s) do you feel Environment 2 effectively expressed?
Nine identified moods were provided as possible responses, with the option for participants to specify any others that they identified. These moods were: Peaceful, Mystical, Energetic, Regal, Magical, Godly, Monumental, Powerful and Ancient. Of these nine provided moods, stylised scored higher than realistic in peaceful, was equal in mystical and scored less but very closely in both magical and energetic. The remaining five moods, which realistic scored better in, ranged between 4–15 votes of separation.

Discussion

From the results gathered it can be stated that the stylised environment was **not** the more expressive of the two art styles. It was considered expressive, although not to the same degree as the realistic environment. Realistic garnered more responses in the categories of 'strongly agree' and 'moderately agree, while stylised held most of its responses in 'slightly agree'.

Despite these results it was identified that stylised scored best in the mood, 'Peaceful' and also highly in 'Mystical' and 'Magical'. These moods could be considered the lighter of the nine provided as they generally denote a friendlier or happier tone and could indicate that stylised art styles excel in moods of a lighter nature. Realistic however, scored much better in the moods of 'Powerful', 'Ancient' and 'Godly'. All moods that could be considered more serious. This mirrors stylised as it could indicate that realistic art styles excel in moods of a more serious nature.

It can also be determined that participant art style preference does not contribute towards a bias on how a participant recognises expression in their preferred styles environment. With their being very little difference between the rating averages of all responses. For example, on average, participants who leaned towards realism actually voted the realistic environment the least favourably of the two environments and the stylised environment the second most favourably. Also, despite those who strongly preferred realism voting realistic the most favourably, there were only 3 participants within the category, giving the score very little weight. The same goes for the three participants who prefer stylised art who voted the stylised environment the least favourably. Even when merging participants who lean towards a certain art style with those who strongly prefer the style, no bias could be identified. The score averages for both are near identical. More participants would be needed to draw a more solid conclusion upon this possible bias.

Lastly it was found that on average, participants who were more familiar with artistic concepts such as mood and composition rated each environment higher than those who were less familiar. Also, the difference between the ratings for each environment grew smaller as artistic concept familiarity increased. This suggests that participants who are not quite as familiar with mood are more critical and/or struggled to identify moods and expression as clearly as those who were more familiar.

Conclusion

Overall, this research found that stylised art does not contain greater expressive qualities. Stylised art was found to perform well in moods of lighter and friendlier nature, while realistic art excelled in moods of a more serious or dark nature. Lastly, it was found that on average, the greater a person's familiarity of artistic concepts such as mood, the more they favoured the stylised art style.

Answers to Research Questions

What are the expressive outcomes of applying a stylised art style when compared to a realistic art style?

Prior research from other fields of visual media and knowledge from traditional art forms indicated that non-photorealistic art styles typically contained more expressive qualities (Isenberg, 2013), (Gombrich, 1950) (Arnheim, 1974). However, this did not hold true within the creative production of this research as stylised was found to contain less expressive qualities than realistic. Stylised was found to be best at conveying moods of a lighter nature while realistic performed best in moods of a darker nature.

How can effective expressive artistic techniques be applied to create a real-time environment?

Findings from the literature review, existing stylised work, prior research, pipelines and techniques and formulated that stylisation contains the expressive principles of exaggeration and simplification. These were then applied against each of the key design elements involved throughout environment production, which were also identified as scale/proportions, shape/line/silhouette, colour, material, lighting and physics/movement. These principles and elements were combined to construct an expressive stylised framework that was applied throughout production as outlined during Implementation.

How can the created environment be evaluated?

The created environment was built within Unreal Engine 4 and comparatively playtested against the original realistic environment. Playtesting was carried out by participants who were surveyed on each environment's ability to convey a mood and which moods they felt each environment effectively conveyed. Results were then evaluated to identify which environment scored higher, determine which environment contained more expressive qualities and which moods each environment excelled in.

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Creativity and Aesthetics

Re-directing the lens

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Abstract

This paper seeks to examine the role of the older, experienced dancer through digital documentation. This is followed by a discussion regarding the project and its aims to make visible the older dancing body on screen, a rare occurrence within Western society. It questions why in the Western dance world, the sentiment is no different, ageing remains a taboo issue, holding prejudice towards the corporeal difference of the older, experienced dancer.

Keywords

The older dancer, ageing, aesthetics, digital technology,

Introduction

"In the absence of the mirror, the recording of the face and body by the camera through photography becomes the dominant mode for representing the body image, and also of imagining one's body image." [i]

This paper is concerned with the relationship of the older dancing body and the viewer, experimenting with how this is portrayed through digital technology. Through practice-led research for the PhD: Ageism and the mature dancer, I continue with the investigation regarding prejudice towards the older dancing body. Dance is consumed with perfection and ideal young bodies, whilst the stigma regarding ageing continues. There has long been held prejudice regarding the mature dancer and its lack of place, sallied with today's emphasis on a youth culture, weighing heavily in the current Western dance world. As evidenced by dance scholar, Efva Lilja, who states "I am also frightened by the fact that the ageing person is rarely seen in art, and when it does happen, that body is so alien to most people that the way its age is seen gets in the way of what the person wants to communicate." [ii] To see older, experienced dancers on screen is an important step to keeping them visible in the current ageist dance world. To be able to see seasoned dance artists on screen is an essential advance to keeping them visible and valued within our ageist Western dance culture.

documentation regarding ageing and dance, for the work *Interprète/Inappropriate Behaviour,* I collaborated and filmed eight older, experienced dancers, four from Sydney and four from London. They were asked to respond to a dance motif of mine choreographed whilst a student at the

Laban Centre, London in 1987. Please refer to this link: https://vimeo.com/112907186

I filmed each dancer at site specific locations in Sydney and London, where they re-interpreted the motif, thus creating eight new individual versions. These eight solos were later exhibited in the White Box Gallery, Queensland College of Art, Gold Coast campus, in 2015, screened large scale, highlighting their craft and corporeality, inviting a dialogue regarding the older dancing body.

Please refer to this link for the 8 solos: http://soniayork-pryce.com/portfolio_PhD_InappropriateBehaviour.php

After the exhibition I decided to experiment further, by editing the eight solos into one film, *Interprète/Inappropriate Behaviour*. This investigation was to celebrate the mature dancer's corporeal difference and how their practice rather than their age defines them.

Please refer to this link: https://vimeo.com/136466421

The film went on to win a gold award in the UK for films featuring older dancers.

Please refer to this link: https://www.pdsw.org.uk/dance-devs/joie-de-vivre-dance-film-competition-2015/

From this juncture I decided to broaden my film experimentation which produced the new work, *utterly (in)appropriate* filmed and edited by myself in 2017. This new project brings the work full circle, as a direct response to the eight older experienced dancer's solos and positing an additional view of the older dancing body.

Approach

The body which experiences or gives off intensities which refuse to cohere into a distinctive image, complicates the assumptions about body image in consumer culture. [iii]

The inspiration for this work came from Hege Haargenrud's, *use my body while it's still young,* a work featuring four well known European older, experienced dancers, aged from sixty to eighty years of age. Haargenrud was very conscious of older dancers being excluded and invisible in Western

dance culture and wanted to draw attention to this. She states,

there were no elderly dancers visible, a lack of them, we don't see them in society today – where are the older dancers? The audience wants to see that body, on stage, that is not flawless, that is marked by age, but can still do remarkable things, I really think people want to see that.[iv]

Please refer to this link: https://vimeo.com/151040531

Haargenrud directly influenced the concept of further exploration of documenting the older form. For the research I decided to use myself as the subject and explore through film the possibilities of exhibiting the physicality of a mature woman's body. For the project I focus the camera lens at my own *corporeal difference* to challenge the stereotyped version of a dancer, usually associated with youth as opposed to maturity, as a direct response to the eight dancers who featured in my film *Interprète/Inappropriate Behaviour.* As a visual artist and older dancer, I aim to discuss the aesthetics, body image and visibility regarding the older, experienced dancer through film documentation. For the practice-led research I direct the lens at myself to create further dialogue regarding the aesthetics surrounding a dancer's body, this was not an easy decision. At the beginning of the project I had not envisioned that I would become the subject for the next section of investigation. The confronting of the imagery of my body in the film serves as a constant reminder as to why I am addressing the taboo subject of the ageing dancing body; as it addresses my own kinesiology, by physically exhibiting I am no longer the preferred or accepted form but own an alternative 'other' body. This singular perspective highlights the physical variance of myself as an older, experienced performer, my physique, skin, appearance and movements. Dance theorist Laurence Louppe discusses the dancer's body as 'corporeal architecture' forming and transforming the space.[v] I intend to discover whether this 'other' corporeal landscape can contend with the autonomy of the younger dancer and create its own emancipated environment in space and time. So, aesthetically, this is a test to exhibit through film documentation as described by dance scholar Nanako Nakajima, that 'dancing beauty can be old.'[vi]

This project is an experiment to challenge the ideal dancer's body, traditionally associated with beauty, youth, agility and athleticism. It is an opportunity to feature an older body, *up close and personal*, to reveal that ageing can be seen, and exuding assets not garnered so easily when young. Dance scholar Efva Lilja contends,

I can see beauty in the body on which time and life have set their stamp. I can see an expressiveness that is markedly different from that of the young person's body, since it has a different story to tell.[vii]

Such positive qualities emanate from an older dancer, reaped from the embodiment of technique, dance and life experience, which can only be attained through ageing and maturing, all enhancing their performativity. These assets form part of the importance of keeping older, experienced dancers visible and valued.

In Scotland, March 2017 I participated in a two-week interdisciplinary residency, with ten other national and international artists. We were fortunate to have the run of the magnificent stately home, Hospitalfield, where we were invited to make work in and around the confines of the house and grounds. Please refer to this link: http://hospitalfield.org.uk/residencies/residents/?y=2017&r=interdisciplinary-residency-march-2017

This artist residency provided me an opportunity to turn the lens, re-directing *the gaze* to observe an aesthetically different body, through film. As a dancer I am accustomed to time constraints and used this unique opportunity to make work in the first week of the residency and edit in the final. The approach to produce work was investigated through digital film documentation and photography to exhibit the corporeality of the mature dancing body and to collaborate with other artists if possible. Prior to leaving Australia I had secured permission to use the music of Icelandic composer Ólafur Arnalds and his publishing house to use the soundtrack Loftið Verður Skyndilega Kalt (The Air Suddenly Goes Cold) for the film.

A large printmakers studio doubled as my dance base, where over a three-day period from 6-am to am I explored filming myself, armed with 2 digital SLR cameras, a Nikon D500 and a Canon EOS 700D both mounted on tripods. I experimented shooting footage at dawn to capture the beautiful Scottish sunrise, filling the ecclesiastical styled studio with atmospheric light. Attempting to set up the two cameras and dance was at times perplexing trying to understand which camera angles captured the best footage.
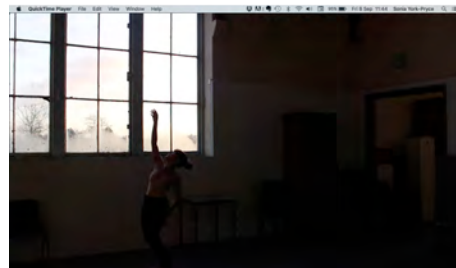

Fig.1 *Canon screenshot* Sonia York-Pryce 2017

All the while I had to be mindful of my responses to the eight dancers from the film *Interprète/Inappropriate Behaviour*, which at times proved difficult to visualise with the added concern of where I had positioned the cameras. March being part of the Northern Hemisphere winter, the timing for the film project was not perfect. The issue of the freezing cold temperatures in the studio were hard to support with many technical issues with the cameras plus trying to keep my body warm when not performing.
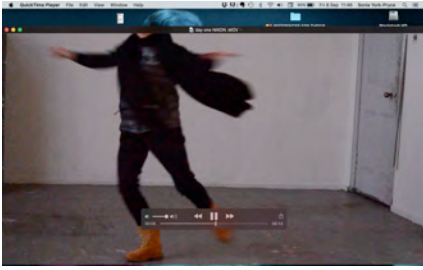
Fig.2 *Canon screenshot* **Sonia York-Pryce 2017**

The film recording uploaded each afternoon was transferred to iMovie to discover what had been captured. There were many occasions when neither camera captured relevant footage, instances where only half of my body appeared in the frame, or just an arm or leg, or blurry imagery, which was very frustrating. Over the three days, I experimented with many camera angles, moving the tripods around the studio, some proving successful, some not. The positive element was the vibrant light which never seemed to disappoint giving an atmospheric bend to the footage. On the fourth day, I collaborated with fellow residency artist, Fabiola Carranza, who filmed my movements using a mirrorless Canon EOS M3. Carranza stalked me with her camera, invading my space as I danced around the studio, capturing my corporeal difference, my body, skin, wrinkles, leaving nothing to the imagination. This was invasive, but necessary to the project to feature the older dancing body with all its flaws. Carranza's emotive footage supplied the in-depth, close-up imagery which was absent from my earlier attempts at filming. Her addition supplied a greater intimacy to the work and added the corporeal landscape I was searching for. This collaboration has added an incredibly poignant strength to the visuals for the project and the experiment would not have been so successful without her input.

For the editing in iMovie I used my Mac laptop, where the process took about three hours to piece together about four minutes of footage, whilst wrapped up in blankets in my bedroom at Hospitalfield to fend off the freezing cold. The film was screened during an informal critique session with the whole interdisciplinary group and the feedback was positive.

Please refer to this link: https://vimeo.com/233604194

Creative Works

this is my body = the constant, silent assertion of my lone presence. It implies a distance.[viii]

On my return to Australia in April 2017 preparations were made for the installation of the film work for the first exhibition later in July at the White Box gallery, South Bank Campus. I was going to revisit the concept of screening the film in large scale which I had successfully experimented with in 2015. By screening this new film, now titled *utterly*

(in)appropriate in a large-scale format the corporeality of the subject was blatantly accentuated and visible. On entering the gallery, the viewer is engaged firstly by the scale of the work, then it becomes a demonstration through film, where "the gaze focused on an image"[ix] is featuring an older dancing body. Here, the performer is me and I am bringing the spectator to gaze at this phenomenon. The witnessing and seeing here are two different things. As the performer in the film, I am directing my gaze outwards to the spectator, provoking some response; in turn I am expecting that the viewer will be challenged to respond to this vision of older woman dancing. Through this exhibition I am hoping to change or challenge perceptions of how we assimilate ageing in the dance arena.
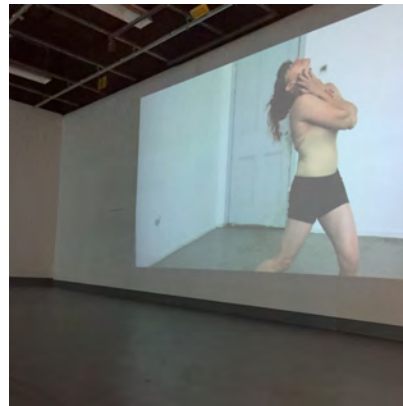

Fig. 3 *utterly (in)appropriate* **Sonia York-Pryce 2017**

Before the install started, I decided to edit some film footage in iMovie, to 'play' with changing the film format to black and white and producing two further short clips, one in close-up and the other like the original. I planned to screen these two black and white versions, known as *utterly (1) & (2)* side by side, on one wall, large scale for impact but also to create a dialogue. The scale of this new edited imagery is provocative and emotive and compliments the original film *utterly (in)appropriate.*

Please refer to these links:
utterly (1) https://vimeo.com/234962197
utterly (2) https://vimeo.com/234963742

Fig.4 *utterly (1) & (2)* **Sonia York-Pryce 2017**

Screening the three films without interruption simultaneously is visually uncluttered and direct, depicting an older dancing body screened large scale, leaving nothing to the imagination, as a celebration of the ageing dancer's body. The concept aims to accentuate a visceral response to the dancer's corporeality, the lived body experience, and lack of visibility.

utterly (in)appropriate has been screened at the Stockholm Dans Film Festival 2017 in Sweden, the Supercell Festival of Contemporary Dance 2018, Brisbane and *Method and Moment* Exhibition 2018 at the POP Gallery, Brisbane.

Research Aims

Years of knowledge and wisdom stored within these older bodies go to waste and audiences lose transformative experiences as we, as a society, revel in the virtuosity of youth and fail to see physical feats as merely one aspect of an artistic investigation.[x]

The aim of the practice-led research is to challenge concepts regarding ageism and corporeality within the Western dance world and to raise awareness that the physicality of the older, experienced dancer has a value and a place. There are assets embodied in these older dancers, and this can only be so because they are older, experienced dancers. We cannot expect as evidenced by dance critic Jillian Harris, that watching extreme virtuosity should not be what the viewer can always expect to see, these older dancers have other qualities that are only gained with maturity. The two works, *Interprète inappropriate behaviour* and *utterly (in)appropriate* aim to start a dialogue regarding the visibility and value of older dancers and how bereft the art form would be if they were to be removed. There is a need for ageing to be visible in dance to reflect society, and the audiences that patronize the arts need to see themselves represented.

Analysis

The online interface is essential to the promotion of digital technology and benefits the PhD practice-led research through the mediums of social media, e.g. Twitter,

Facebook, vimeo.com and Instagram. Each of these sites creates a unique platform to feature the older, experienced dancer. Other important podiums for discussion and screenings are dance conferences, festivals and dance film competitions which enable opportunities to screen the films giving credence to the cause.

Individual reflection

The estimation of documentation through computerized media is a fundamental asset for many dance artists today and shapes the creative element of this practice-led research. As I identify as an older, experienced dancer the film investigations become not only relevant and personal but fundamental to the PhD research. The opportunity to discuss the research and screen the films at dance conferences both nationally and internationally has been beneficial to introduce a dialogue regarding age discrimination within the Western dance culture. Film documentation offers an opportunity to give a voice to the dilemma of prejudice in dance, and through these created visuals a message is delivered, highlighting that the craft of the older, experienced dancer needs to be visible, valued and validated.

Conclusion

But of all the oppressions the one that hits dance hardest is ageism and it is the last to be explicitly addressed.[xi]

Digital technology is invaluable for my arts practice and for highlighting the physicality of the older, experienced dancer. It is an opportunity through galleries and social media to view older, experienced dancers although it can never replace a live performance. My aim to highlight the discrimination of the older, experienced dancer through film, giving credence to their craft. Through dance conferences, festivals and film competitions their visibility is gaining momentum and acknowledging that 'the dancing does not have to stop.'

Endnotes

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Using Search-Based Procedural Content Generation to Create First-Person Shooter Maps

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Abstract

Over the past three decades, video games have become one of the most popular forms of entertainment around the world. This increase in popularity comes with a demand from consumers for frequent and quality content such as maps, however, delivering content on this demand increases development time and costs. The aim of this research is to identify, develop and evaluate a method of procedurally generating maps for multiplayer first-person shooters using a search-based algorithm such as Genetic Algorithm (GA). Previous research in this field has not identified an evaluation technique based on first-person shooter (FPS) level design principals; the quality of generated content has not been verified via user testing and has allowed for little customization. This research evaluates the quality of generated maps based on the tension levels felt by an AI and their average fighting time in a simulated match, it also incorporates the maps overall size. Results indicated that the content generated via the designed algorithm creates maps to a similar standard as those designed by professionals. This algorithm is easily customizable, allowing designers to create levels of various shapes and sizes and allowing designers to use 3D asset packs for level construction. The algorithm has been designed in such a way that it can be integrated into any real-time game engine with ease.

Keywords

Video Games, First-Person Shooter, Multiplayer, Levels, Procedural Generation, Search-Based Procedural Generation, Genetic Algorithm

Introduction

Multiplayer first-person shooter (FPS) games are one of the most popular video game genres around the world (Entertainment Software Association, 2017). However, with this popularity comes a desire for consistent and quality content from players. Currently, this content is delivered through purchasable map packs. However, these maps are required to be created by professionals, costing companies time and money. One way of subsetting both financial and time costs is through the use of procedural content generation (PCG) algorithms. However, the quality of content generated via contemporary PCG technique varies greatly

from generation to generation. If a PCG technique could be created that ensures it creates maps to the same quality as professionally designed maps it would save developers both time and money.

To achieve the generation of quality FPS maps it is proposed that a new PCG system be utilized, this system is known as search-based procedural generation. This method evaluates the quality of generated content and gives it a score. The algorithm then mutates the highest scoring content in order to generate content of a higher quality than the last. However, little research has been done to identify what evaluation factors should be used in the generation of FPS maps. The previous research in this field has also not tested the generated content on players, therefore there is no evidence indicating if search-based procedural generation creates quality content. As such, this project will test generated content on players to determine if the content is of an acceptable quality.

Through the research and analysis of current techniques used for PCG in FPS games, this project has prototyped a search-based method to procedurally generate FPS maps. A map generated via the designed method has been tested by players and ranked against the design of a popular FPS map which is professionally designed.

Related Work

This chapter explores the current literature on search-based procedural generation in video games and how it can be used to generate content such as maps. These texts will be evaluated to identify possible gaps in the existing research and knowledge.

Search-Based Procedural Generation

Search-based procedural generation is an emerging form of content generation. Togelius et al. (2011, p. 3) states that search-based PCG has two main qualifications: the testing of content is not as simple as rejecting or accepting, it gives the content a 'fitness' score generated by a fitness function; secondly, the content being generated is contingent upon the fitness value of the content that was previously generated. The way that search-based PCG works is very similar to that of a genetic algorithm, which mutates information (genes) until it reaches a desired outcome. Search-based PCG has five main steps: content generation, evaluation (fitness function), checking if the content is acceptable, if not, selecting the fittest content, mutating the content and then looping back to generation. This process is outlined in Figure 1.

Cardamone et al. (2011) created a search-based PCG to generate and evaluate maps for FPS games. Cardamone et al. (2011) assume that the quality of a map is directly related

to the time that gunfights last within the map and this assumption is used as the basis of their fitness function that calculates the fighting time of two AI bots in a simulated map.
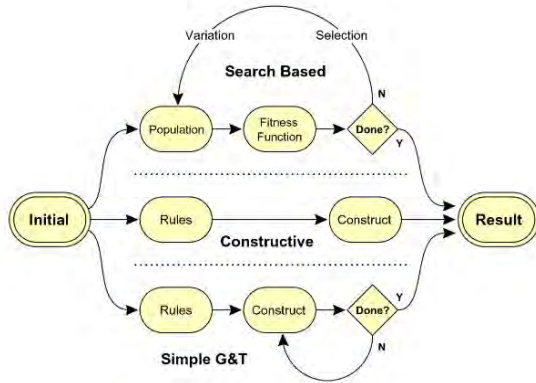

Figure 1 Flowchart of how Search Based, Constructive and Generate-and-test algorithms work (Togelius et al., 2011, p. 4).

$$f = \overline{T_f} + S$$

Figure 2 Fitness function used by Cardamone et al. (2011)

Figure 2 shows the fitness function used to evaluate the maps generated by Cardamone et al. (2011). $\overline{T_f}$ represents the average fighting time of all the bots from a simulated match of 10 minutes. A small $\overline{T_f}$ value means that a player gets killed very quickly after a fight starts while a larger value means that the fights last a considerable amount of time after a player first takes damage (Cardamone et al., 2011, p. 4). S is another factor used to calculate the fitness of the map and represents the amount of free space available on the map. Cardamone et al. (2011) admit that there are flaws in their fitness function as it relies heavily on the logic of the default bots in the Cube 2 engine and they also state that their fitness function has yet to be tested on players to verify if the maps created are of a high quality. Another criticism that can be raised about this paper is the fitness function. Cardamone et al. (2011) assume that measuring the fighting time in a match will allow them to generate good maps, however, they provide no resources to back up their assumption.

Lanzi et al. (2014) expand upon the research conducted by Cardamone et al. (2011) by changing the fitness function used. Instead of basing their fitness function on the fighting time of AI, Lanzi et al. (2014) base it on how balanced the score is between two players of different skill levels while using the all-black map encoding as outlined by Cardamone et al. (2011). Figure 3 shows the fitness function used by Lanzi et al. (2011) to evaluate their maps.

$$f = -\sum_{i=1}^{2} \frac{S_i}{S_1 + S_2} log_2 \left(\frac{S_i}{S_1 + S_2} \right)$$

Figure 3 Fitness function used by Lanzi et al. (2011).

In this function S_i refers to the score of $Player_i$ in the match, the score is calculated by subtracting the player's number of kills by the number of deaths. $\frac{S_i}{S_1 + S_2}$ represents the score ratio (SR_i) of $Player_i$, meaning how many points the player scored compared to the overall points of players in the match. A SR_i

of 0 means that the player did not score a single point in the match and a SR_i value of 0.5 means that all players scored the same and the match was perfectly balanced. The closer the total of each player's SR_i value is to 1 then the higher the fitness value will be (Lanzi et al., 2011, p. 3). Lanzi et al.'s (2011) algorithm searches for a fitness value that is greater than 0.92. This value allows the player with more skill to feel powerful while the player with less skill never dies more than double his amount of kills. This paper has similar flaws to that of Cardamone et al.'s (2011) paper: they rely heavily on the default AI from the *Cube 2* engine and the outcome is never tested on people to check if real-life matches would be balanced. The heavy reliance on the *Cube 2* AI makes this algorithm very difficult to reproduce and for the industry to use in projects. Like Cardamone et al. (2011), Lanzi et al. (2011) never test the generated content on people, meaning they have no proof if the generated maps actually allow for balanced gameplay or are fun to play. Lanzi et al. (2011) also fail to provide reasoning as to why evaluating maps based on fitness will create a map of high quality. The common trend of unjustified fitness functions and no user testing suggests that a gap in knowledge exists and further research is needed in this field.

First-Person Shooter Design Patterns
Previous research in the field of search-based PCG within FPS games indicates that research is needed in the development of a fitness function that is based on FPS level design research. Feil et al. (2005) discuss that pacing is an important part of any FPS game and that the rhythm of rising and falling tension contributes greatly to the overall flow of the level. Hullet and Whitehead (2010) break common FPS maps down into sniper locations, galleries, choke points, arenas, strongholds, turrets, vehicle selection, split-level, hidden areas and flanking routes. They mention that two of the most common design patterns are arenas and choke points, which is what our algorithm will be generating. Arenas are described by Hullet and Whitehead (2010) as wide open areas that allow for large-scale combat, stating that they are easily the most common design pattern. They explain that arenas have a fixed length, width and height and that they should have plenty of cover. Choke points are described by Hullet and Whitehead (2010) as being narrow areas that have no alternative routes, where the width and length of the choke point are very important. These two design patterns are present in Cardamone et al.'s (2011) paper and are incorporated in the all-black encoding method, which constructs levels out of arenas and corridors (choke points). Hullet and Whitehead (2010) indicate that these two areas of a map are the most tense for players.

The Gap
There is limited research on identifying evaluation methods used in search-based generation algorithms for FPS maps that are based on level design principals. The majority of existing algorithms use level size and average fight time as factors for evaluation. However, a strong link has been identified between good FPS maps and the tension felt while playing. It has also been the case that previous research has not tested generated maps on players to determine their quality. Therefore, this research aims to create a search-based procedural generation algorithm that uses tension as an evaluation factor. The generated maps will then be tested

on players to understand how the quality of the generated map compares to professionally designed maps.

Proposed Methods

Search-based procedural generation systems search through generated content to find the best based on a fitness value. In order to search through the content being generated, a genetic algorithm will be designed and created. Genetic algorithms have six main stages: Encoding, Fitness Function, Selection, Crossover, Mutation and the Generational Cycle. The purpose and details of each of these stages will be discussed in the following sub-chapters.

Generational Cycle

The generational cycle is the cycle that the proposed genetic algorithm will go through until it finds an acceptable solution. Figure 4 shows the generational cycle of the genetic algorithm. The cycle starts with the generation of entirely random maps. The maps are then evaluated using a fitness function. If a map receives the desired fitness value the algorithm is stopped, otherwise, survivors are then selected via tournament selection. The survivors are then crossed over with each other, mutated and then the maps are generated again with the mutated DNA. This cycle continues until an acceptable map is discovered.
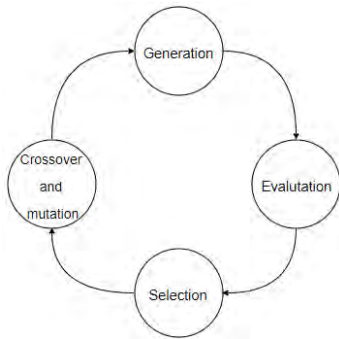

Figure 4 Genetic Cycle

Encoding

Data encoding is fundamental to the structure of any genetic algorithm, this is the process of representing your data in a way that can be mutated via the algorithm (Srinivas & Patnaik, 1994, p. 19). In our designed algorithm, data will be encoded into a 2D array of integers that will have the value of either 0 or 1. This 2D array will be the data representation of a map, an array index of 0 indicates that this section is a floor, while an array index of 1 indicates it is a wall. In order to identify which parts of the array are floor or wall segments, arenas and corridors are generated. Arenas are open areas that are represented by three variables: X and Y, which represent the location of the arena, and S, which represents the size of the arena. Corridors are open spaces with a fixed width and are represented by the three variables: X, Y and L. X and Y are the locations of the corridor while L represents the length; a positive L value aligns the corridor along the X-axis while a negative value aligns it along the Y. The genetic makeup (DNA) of a map is made up of lists of arenas and corridors. These lists are used to identify the location of open areas (floors) by manipulating the encoded data to equal 0 at their respective locations. Figure 5 shows an example of what the DNA structure may look like.
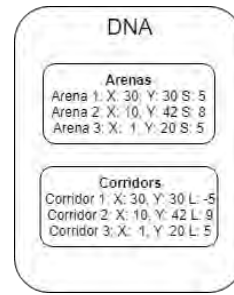

Figure 5 DNA structure example

Fitness Function

A fitness function will be used to evaluate the generated content and give it a fitness value (score) for how well the content meets the acceptance criteria. The acceptance criteria is a predefined fitness value that the generated content needs to achieve. However, this value cannot be determined until we have implemented the algorithm and seen the score attached to generated content. Our fitness function will have three different parameters: the tension an AI feels while playing the map, the size of the map and the average time a fight lasts. The whole fitness function is outlined and discussed below.

$$F = \begin{cases} if\ \bar{C} = 0\ => \ F = 0 \\ \bar{C}(\bar{T} + S) \\ if\ S = 0 => F = \bar{C}\bar{T} \end{cases}$$

Where $\bar{T}$ represents the average tension value felt by the AI

$\bar{C}$ is the average time combat lasts within the match

S is the total size of the level

In order to calculate the fitness value of the map the tension felt by the AI is added to the size of the map and this value is multiplied by the average combat time. However, there are some constraints to the algorithm and relationships between variables. Tension and combat time are related: if combat takes place then it is impossible for the tension value to equal 0. However, if combat does not take place it is possible for tension to be equal to or greater than 0. If no combat has taken place than the fitness value will equal 0. A fitness value of 0 indicates that a map has been generated in which combat was not possible and we do not want it to be selected for crossover and mutation. For this equation, it also required that the size of the level be greater than 0. The following three sections will discuss how each of the variables described will be calculated.

Measuring Tension

Tension will be calculated based on the following factors. It will increase when the AI is moving through a tight corridor, when they are being fired upon, and when the AI is under fire, more so if they are taking damage. Tension will also increase when the AI is on low health and when they have an enemy in their sights. How these factors will be used to add tension will be outlined in the pseudocode in Tables 1 through 3.

Table 1 shows how tension will be calculated when the AI is on low health. The AI is determined to be on low health when their current health is below 25% of their max health value. For every second that the AI is below this threshold tension will increase.

```
Let H represent the health of the AI; MH represent the max health of the
AI; T represent the Timer; deltaTime represent the time between frames; X
Represent the amount of tension to add

//Check On Low Health
IF H <= 25% of MH THEN
        T += deltaTime
        IF T >= 1 THEN
                Tension += X
ELSE
        T = 0
```
Table 1 Adding Tension When On Low Health Pseudocode

```
Let L1 represent a line trace; let L2 represent another line trace; let T
represent a timer; let X represent the amount of tension to add

//Check in Corridor
L1 3 meters to the right of AI
IF L1 hit a wall THEN
        L2 3 meters to the left
        IF L2 hit a wall THEN
                IF distance between L1 & L2 hit locations <
        3 THEN
                        T += deltaTime
                        IF T > 1 THEN
                                Tension += X
ELSE
        T = 0
```
Table 2 Check in Corridor Pseudocode

How the AI detects when it is in a corridor is outlined in Table 2. The AI does a line trace to the left and to the right. When there is a collision on both line traces the distance between the two hit locations is calculated. If this value is below three meters than the AI considers itself to be in a corridor. A timer is then started and for each second the AI is inside the corridor the tension value is increased.

Table 3 outlines how tension is calculated for when an enemy is in the AI's line of sight, when the AI takes damage and when it nearly takes damage. Tension increases for every second that an enemy is within the AI's line of sight. To calculate when an AI has taken damage we need to compare the AI's current health to the health it had the last frame. If the current health is lower then the health last frame then tension will be added. When an enemy's bullet nearly hits the AI, tension is also increased.

```
Let T represent a timer; let deltaTime represent the time between frames;
let OH represent the health of the AI last frame; let H represent the health
of the AI this frame; let X represent that amount of tension to add.

//Check Enemy In Sight
IF Enemy in line of sight THEN
        Timer += deltaTime
        IF Timer >= 1 THEN
                Tension += X
ELSE
        Timer = 0

//On Taking Damage
IF oldHealth < currentHealth THEN
        Tension += X
oldHealth = currentHealth

//On Near Miss
IF bullet nearly hits AI THEN
        Tension += x
```
Table 3 Check Enemy in Sight, On Taking Damage and On Near Miss Pseudocode

Fighting Time Evaluation

By measuring the average time a fight lasts within a match we will be able to promote the generation of maps that allow for longer fights. By encouraging the generation of maps that allow for larger fighting times, we should generate more intricate and detailed maps. This is because maps with a higher fighting time average should have more opportunities for players to escape an enemy's line of sight and prolong fights. The steps to implement these calculations are outlined in the pseudocode in Table 4.

```
Let H represent the current health of the AI; let MH represent the max
health of the AI; let CF represent the time of the current fight; let deltaTime
represent the time between frames; let fightTimes represent an array of
times.

//Measuring Fight Time
IF H < MH THEN
        CF += deltaTime
        IF health <= 0 THEN
                ADD CF to fightTimes array
                CF = 0
ELSE
        CF = 0

//Calculating Average Fight Time
totalFightTime = 0
averageFightTime = 0
IF amountOfFights > 0 THAN
        FOR x = 0 and x <= amountOfFights, x++
                totalFightTime += fightTimes[x]
        averageFight = totalFightTime/amountOfFights
RETURN averageFight
```
Table 4 Measuring Fight Time and Calculating Average Pseudocode

Table 4 explains how the length of fights are measured and how the average is calculated. In order to check if the AI is fighting, its current health is checked against the max health. If the current health is less than the max health, the AI is considered to be fighting. While the current health remains lower than the max health a timer increases. Once the AI has been killed or has returned to full health the timer stops and the time is added to a list of fight times.

Evaluating Level Size

Maps will also be evaluated based on their size. By measuring the total size of the level, we can promote the generation of larger maps with more areas for combat to take place. The process in which the size of the level is calculated is outlined in Table 5. We start by looping through the 2D map array on the Y value, we then do the same for the Y. Each time we come across the value of 0, indicating a floor, the level size variable is incremented.

```
let LS represent the size of the level; let mapX represent the size of
the map on the X-axis; let mapY represent the size of the map on the
Y-axis.

LS = 0
FOR x = 0 and x <= mapX, x++
        FOR y = 0 and y <= mapY, y++
                IF map[x,y] == 0 THEN
                        levelSize ++
RETURN levelSize
```
Table 5 Calculate Level Size Pseudocode

Selection

Selection is the processes of selecting which maps will be used for mutation, this is survival of the fittest: only the

highest scoring maps will be selected for mutation. Tournament selection will be used to determine which maps will survive and be used for mutation and crossover. This method of selection selects two maps and compares their fitness values, the map with the higher value will survive while the other will be discarded. Table 6 shows how this method will be implemented. If the fitness value of map 1 is greater than map 2 then map 1 is returned and vice versa.

```
Let M1 represent a generated map; let M2 represent another generated map;
let population represent a list of generated maps.


IF M1 fitness > M2 fitness THEN
        REMOVE M1 from population
        RETURN M1
ELSE
        REMOVE M2 from population
        RETURN M2
```

Table 6 Tournament Selection Pseudocode

Crossover and Mutation

Crossover and mutation is the next step of the proposed genetic algorithm, this is the process of selecting which parts of one map will be mixed with another. Maps are made up of DNA, which is comprised of a list of arenas and a list of corridors, crossover will be performed on both lists of data. The process of crossover and mutation is outlined in Table 7. Two maps will be selected at random for crossover, these are known as the parent maps. For each element in the DNA structure, a number is generated between 0.00 and 1.00, if this number is below the crossover probability rating then entirely new data will be generated instead of crossing over with another map. If crossover is selected then we must determine which parent to mutate from, we do this by generating a number between 0 and 1. If the generated number is 0 then parent 1 is used for mutation, if it is 1 than parent 2 is used. This process will repeat for each element within the map's DNA structure.

```
Let GenomeLength represent the amount of arenas and corridors; Let p1
represent a generated map, let p2 represent another generated map; let MR
represent the chance of crossover; let A represent a list of arenas; let C
represent a list of corridors; let newDNA represent the DNA being created


MC = random number between 0 and 1
FOR i = 0 and i < GenomeLength, i++
        IF MC <= MR THEN
                ADD new arena to A with random values
        ELSE
                Parent = random number between 1 and 2
                IF parent = 1 THEN
                        ADD p1 arenas[i] to A
                ELSE
                        ADD p2 arenas[i] to A
FOR j = 0 and j < GenomeLength, j++
        IF MC <= MR THEN
                ADD new corridor to C with random values
        ELSE
                Parent = random number between 1 and 2
                IF parent = 1 THEN
                        ADD p1 corridors[j] to C
                ELSE
                        ADD p2 corridors[j] to C
RETURN newDNA
```

Table 7 Crossover and Mutation Pseudocode

Prototyping and Evaluation

This chapter will focus on the prototyping and implementation of the proposed genetic algorithm discussed in Chapter 3.

The implementation of the algorithm will be conducted in Unreal Engine 4, however, it can easily be applied to other real-time engines, such as the Unity game engine.

Prototyping

This section will cover the practical design of the proposed genetic algorithm that was outlined. This step is critical as it demonstrates how to apply the methods in a real-time engine to make a working prototype for testing.
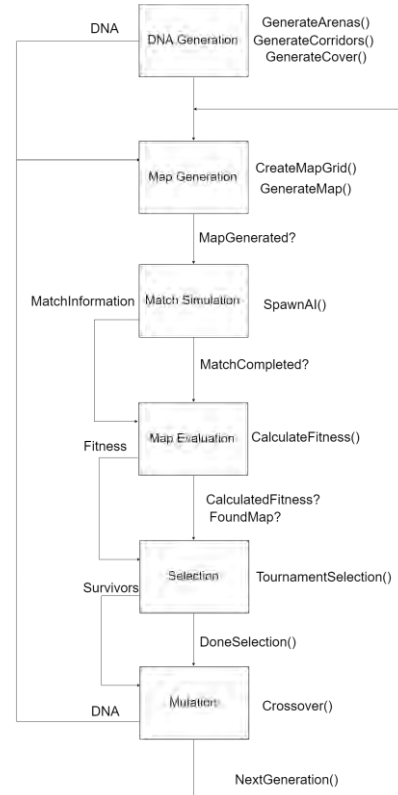

Figure 6 Structural Diagram

Figure 6 shows the structural diagram of the designed algorithm. The diagram showcases the order in which functions will be called and the data that will be transferred between them. The methods used by each of the main functions are visible to the right of the function that calls them. There are six main steps that take place during the algorithm: DNA Generation, Map Generation, Match Simulation, Map Evaluation, Selection and Mutation. Firstly, DNA Generation, calls the 'GenerateArenas' and 'GenerateCorridors' methods to randomly generate DNA that consists of new arenas and corridors. The DNA constructed from this step is then used in the second method, Map Generation. The 'CreateMapGrid' method uses the DNA to construct a 2D array of integers to represent the map, in this array walls are encoded as a 1 and floors as a 0. This 2D array is then used by the 'GenerateMap' method, which spawns 3D models into the world based on the value at each index in the array. When the map is completely generated the Match Simulation begins and AI are spawned. When the match is completed, evaluation can begin and the 'CalculateFitness' method is called. Once all the fitness values have been calculated we then check if any of the maps from this generation reached the desired fitness value. If not then the Selection function is called. This is where the highest ranked maps are selected

as survivors using the 'TournamentSelection' method. After the selection process, all the survivors are then used for mutation and crossover. Once Mutation has finished the process loops back to Map Generation to start again.

Implementation

The implementation of all the systems mentioned above creates a search-based PCG algorithm that generates FPS maps that are evaluated by an AI measuring tension, fighting time and map size. Each section of the algorithm is implemented in the order that they were discussed in the previous section.

The first part of the algorithm to be implemented is DNA Generation. For this, we need to create a class for arenas and corridors, these classes will define what arenas and corridors are. Arenas are a class that contains three integer values: an X position and a Y position along with a Size. Corridors are similar with an X and Y position and variable that controls the length. A DNA class is then created that contains two 2-dimensional (2D) vectors, each vector will contain arenas or corridors. The 'GenerateArenas' method is then used to create arenas with a random position and size to add to the arenas vector. The 'GenerateCorridors' method does a similar thing except for creating corridors.

Once the DNA of the initial population of maps has been created we move onto the Map Generation phase. In this phase, a 2D array of integers is created called 'MyGrid' and the size of the array is set to equal the size of the map with each index being set to 1. This grid is the digital representation of the map we are going to generate, an index value of 1 means that this position is a wall while an index value of 0 means that it is a floor. At this point the 'CreateMapGrid' method is called. This method loops through the arena and corridor vectors stored in the maps DNA, changing the value of the grid from 1 to 0 at the locations of arenas and corridors. After this process, the 'GenerateMap' function is called, this function loops through values in the grid. If the value is a 1 and the index directly next to or above/below is a 0, a wall model is spawned, if the value is 0 a floor model is spawned. Once this process has been completed the map generation phase is considered complete.

After the maps have been generated we enter the Match Simulation phase. This phase begins by spawning the AI in opposite corners of the map, and they move around the map at random until they gain sight of an enemy. When the enemies gain sight of each other they enter combat, each bit of damage taken increases their tension value, and the longer an enemy remains in sight tension increases further. Tension is also increased when the AI is nearly damaged and when the AI is in tight corridors. Each AI also measures the time each fight lasts, this information will be used to help calculate the fitness value of the map. Once the match has been played for a total of 10 minutes the match is considered to be completed.

At this point, the Map Evaluation stage begins and the fitness value of each map is calculated using the 'MatchInformation' stored in the AI. This 'MatchInformation' includes the total tension that each AI felt and the times of each fight. The average tension is then calculated by adding the tension values of all the AI together and dividing it by the amount of AI that played the level. The average fighting time is calculated in a similar way by adding together all the fighting

time values and dividing by the number of fights. The size of the level is then evaluated by counting all the values in the grid array with a value of 0. The more 0s, the larger the map. In order to calculate the total fitness value, we add the map size to the average tension and multiply it by the average fighting time. After all the fitness values have been calculated, the Map Evaluation stages is completed.

The next stage is selection, in this stage, the 'TournamentSelection' method is called. This method selects two random maps and compares them based on their fitness values. The map with the highest value is added to a list of survivors and removed from the population. This process is repeated until there are no more maps left in the population. However, if a map has a fitness value of 0 it is discarded.

Once all the survivors have been calculated, mutation can occur, this is the phase were two maps combine or entirely new maps are generated. At the beginning of this process, two maps are selected at random from the survivor's list, these maps are the parents. After this a mutation chance value is generated between 0.00 and 1.00, this value will be used to determine if new arenas/corridors are created or if they are taken from a parent. We then loop through the number of arenas that the map requires and do the following: if the mutation chance value is less than or equal to the mutation rate, which we set to 0.25, then an entirely new arena is generated and added to a new DNA. If not, then a random parent is selected and its arena is added to the new DNA, this process will also occur for the corridors. Once all the arenas and corridors have been generated or mutated the process loops back to the map generation step to evaluate the newly created maps. This process will continue until the program finds an appropriate map. Figure 7 shows the mutation of a map over a number of generations, in this example you can see the changes that the map goes through over time in order to achieve a higher fitness value. Based on observation of content being generated it was determined that a fitness value of over 250,000 generated content to the desired quality. However, the map generated ended up with a fitness value of 400,000. Figure 8 shows the layout of the map generated.

Figure 7 Original (Left), Mutation 1 (Middle) and Mutation 2 (Right)

Evaluation

This section will discuss the process in which the generated map was testing on participants and the results will be discussed and evaluated.

Participants

Twenty-seven participants were gathered and asked to play each map for ten minutes and provide their feedback via a survey. Participants were gathered from a game design course in hopes to get individuals who were familiar with video games and level design. These participants were asked a series of introductory questions to gain insight into

their experience with video games. On a scale from 1 to 7 participants were asked how often they played video games in which the mean result calculated to be 5.89, indicating that participants played video games 'very often'. A similar question was asked to gauge the participant's skill level with FPS games, the mean answer was 5.33, indicating that the skill level of participants was above that of a casual player. In the conducted survey, Map A refers to the map generated via the genetic algorithm and Map B refers to the control map.

Generated Maps

In order to evaluate the impact that our fitness function had on generating maps, we need to have a control map. The map Dust 2 from the video game *Counter-Strike: Global Offensive* was selected as the control map. This map is held to high critical acclaim and is commonly referred to by gamers as one of the most iconic and best-designed maps of all time, appearing in many top 10 lists (Green, 2018; Partridge, 2016; Stubbs, 2017; Valve, 2017; Verhoene, 2016). The control map was recreated in Unreal Engine and elevation and the cover were removed from the map, as these items do not exist in the generated maps. Figure 8 shows the generated map and the control map.
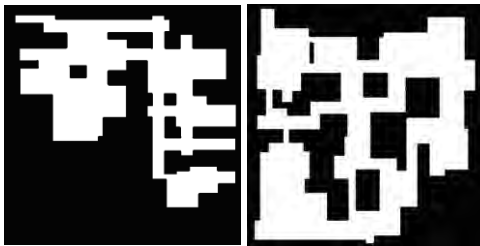
Figure 8 Generated Map (Map A, Left) and Control Map (Map B, Right)

Procedure

Participants were gathered in groups of four and placed in front of a computer. It was explained to participants that they would be playing against each other in teams of two on maps generated via a genetic algorithm and that communication and teamwork was encouraged. Each participant was then given a survey to fill out at after playing each map for a period of 10 minutes. Participants answered questions about the map on a Likert scale from 1 to 7, the results were collated, and a T-Test was performed. These results can be seen in Table 8.

Results

To evaluate the impact the proposed fitness function and algorithm had on the quality of the map, we must create a null hypothesis and an alternative hypothesis. The null and alternative hypothesis are as follows:

The null hypothesis: $H_0 = \mu_0 \geq \mu_1$

The alternative hypothesis: $H_a = \mu_0 < \mu_1$

In the above equations μ_0 refers to the mean score given to Map A for each individual question. μ_1 refers to the mean of each question for Map B, the control map.

In order to determine the differences between the quality of the generated map and the control map, the hypotheses are checked against each question. This will allow us to determine what aspects of the generated map are considered to be of equal or greater quality and which aspects are less than the quality of the control map. A T-Test

has been conducted on the results of the survey, using a significance level of 0.05. The results of each hypothesis can be seen in table 8.

Question 1 asks players how much they enjoyed the map on a scale from 1 through 7. The mean results for Map A were 4.78, while Map B had a mean of 5.44. By rounding these results to the nearest whole number both maps received the average ranking of 5, being 'slightly enjoyable'. The conducted T-Test resulted in giving these figures a P-Value of 0.10, this is above our significance value and the null hypothesis has failed to be rejected.

Question 2 has players rank how tense they felt while playing Map A and B on a scale from 1 through 7. The mean result from this question is very similar between to the two maps. Map A scored a mean value of 4.89 and Map B a 4.96. By rounding these numbers to their nearest whole both maps scored a 5, indicating that both maps are 'slightly tense'. The P-Value of these results was calculated to be 0.83, this is much higher than our significance value of 0.05, therefore the null hypothesis has failed to be rejected.

	Q1	Q2	Q3	Q4	Q6
Map A Mean	4.78	4.89	3.89	4.67	4.41
Map B Mean	5.44	4.96	5.00	5.22	5.22
T Stat	-1.67	-0.21	-2.64	-1.35	-2.31
P-Value (two-tail)	0.10	0.83	0.01	0.18	0.02
H_0	Failed to Reject	Failed to Reject	Rejected	Failed to Reject	Rejected
H_a	Rejected	Reject	Accepted	Rejected	Accepted

Table 8 Results

Question 3 then asked players if they believed the choke points to be well placed. These results received a P-Value of 0.01, allowing us to reject the null hypothesis and accept the alternative. This shows that there is a difference in quality in the two maps, this is evident in the mean value of the maps. Map A scored a mean value of 3.89, while Map B scored a mean value of 5. This indicates that choke points placed in Map A are not as well placed as the choke points in the control map.

Question 4 asks a similar question to the previous but with a focus on arenas instead of choke points, however, the results are very different. The mean result for Map A is 4.67, whereas the mean result for Map B is 5.22. The P-Value calculated for the results of this question is 0.18. This result indicates that we have failed to reject the null hypothesis and that the arenas in Map A are placed to a similar standard or greater.

Question 5 has been disregarded from the research as the question was badly written. The question asked players what they thought of the size of the maps on a scale from 1 through 7. However, neither 1 or 7 was considered to be good, the middle value was, this does not align with the other questions.

Question 6 asked players what they thought of the overall quality of the two maps. The mean result for Map A was 4.41 while Map B scored a mean value of 5.22. The T-Test

calculated the P-Value of these results to be 0.02. This value is lower than our significance value of 0.05, rejecting our null hypothesis and accepting our alternative. Meaning that there is a negative difference between the results.

Discussion

This section evaluates the results of each question. Question 1 failed to reject the null hypothesis of the generated map being of similar or greater quality than the control map. However, the mean values awarded to these results indicated that Map B was of a slightly higher quality, but not high enough to prove a statistical difference. Question 2 also failed to reject our null hypothesis, the P-Value of 0.83 suggests that the two maps are very similar in creating tension in players. These results indicate that our algorithm is creating tense maps, with players ranking both maps as 'slightly tense' and maps that are 'slightly enjoyable'.

Question 3 was the first question that rejected the null hypothesis, giving us grounds to accept the alternative. This suggests that our algorithm is not placing choke points around the map correctly, however, this could also indicate that we needed to search for a map with a higher fitness value. Although, it cannot be ignored that the results suggest a large statistical difference between the placement of choke points in the two maps, meaning the placement of choke points in the algorithm needs adjusting.

Similar to question 1 and 2, question 4 failed to reject the null hypothesis, indicating that our algorithm is placing arenas to a similar or greater standard than the control map. However, by looking at the mean values of the two maps we can see that on average Map B scored slightly higher, although, this difference is not considered to be statistically significant.

Question 6, like question 3, rejected our null hypothesis, giving us means to accept the alternative. This question refers to the overall quality of the map and the results indicate that the maps generated are of a lower quality than the control map. However, the mean values have a difference that is less than 1, this shows that there is not a vast difference in the quality of the two maps.

Overall, these results indicate that our algorithm is generating maps with a similar level of enjoyment and tension to the control, and that arenas are placed to a similar standard. Two questions have rejected the null hypothesis, suggesting that those areas are not to the same standard as designed maps. However, the results from 3 out of 5 questions have failed to reject our null hypothesis, indicating that our algorithm is a viable method of generating FPS maps. This suggests that our algorithm shows promise and that with future research could generate maps of a higher quality.

Conclusion

This research aims to investigate methods of procedurally generating maps for FPS games to a similar or greater standard than maps that are designed by professionals. Previous research identified a new method of procedural generation, search-based procedural generation that had been used to genetically generate maps for FPS games. However, the fitness function used in the previous research was not based on research in level design and generated maps were not tested on players. This research attempted to design and implement a fitness function based on research in design patterns in FPS games, testing the generated map

on players and examining how the generated maps compared to designed maps.

Main Findings

This research found that, overall, the designed algorithm does create a map of a similar quality to that of a professionally designed map. Players enjoyed the layout of both the generated map and control map equally. Both maps proved to create similar tension levels in players and arenas were placed to a similar standard. However, players believed that choke points were not as well placed and believed the overall quality of the map was slightly lower compared to the control map. It is also worth noting that the generated map scored slightly lower in all areas, even when the results indicated that the maps were similar. This could imply that a map with a higher fitness value needed to be searched for. Results also suggest that with future research, generated maps could surpass the quality of designed maps.

Future Work

In order to complete this research in a timely manner, certain aspects of level design were not considered in this research, these areas leave room for future research. Areas of future research could include: the placement of cover items, generating maps with varying degrees of elevation, the placement and construction of spawn locations and other design patterns identified by Hullett and Whitehead (2010) such as sniper locations, galleries and split levels. By adding these items as a factor in the designed algorithm it may be possible to generate maps of a higher quality to designed maps.

Acknowledgements

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A Framework For Virtual Reality Horror

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Abstract

Ludic fear has been ingrained into entertainment throughout history, evolving alongside the displays they exist within. With the rapid increase in virtual reality (VR) technology in recent years, and the explosion of commercial digital media available alongside it; horror is naturally there, terrifying players who dare enter this digital domain. Despite the significant presence of research in the area of horror in film and games, there is a limited research on identifying components of horror commonly used in designing horror games and how they may be affected by the introduction of VR. Therefore, this research aims to develop a framework for de-signing a virtual reality horror experience. This research also develops a prototype game to present the framework in a practical situation; and analyse the components through a test play and questionnaire to evaluate the components. This contribution to the knowledge of game design, horror design and VR design allows for digital media developers to understand many of the designing aspects required to develop their projects.

Keywords

Game design, Virtual Reality, Horror, Immersion, Obscurity

Introduction

Ludic horror has been part of digital entertainment for many years, immersing players into digital worlds of fright. Recently, successful commercialization of VR has allowed players to experience greater levels of immersion as they are thrust into the digital world at a greater level than typical videogames allow (Steuer, 1992).

There has been a lot of research into components of horror design in games and film and their impact on viewers and players (Demarque & Lima, 2013; Ekman & Kajastila, 2009; Perron, 2005, 2009). While virtual reality is much younger than typical games, the research behind the systems, and their effect on immersion and horror experiences, show the benefits of virtual reality in ludic horror design (Harrinanan, 2016; Lin, 2017; Slater, 2009). Although the research exists discussing the components of horror and virtual reality, there

is little existing knowledge covering their execution in the design and development stages of game development, and

their impact on gameplay. This research aims to develop a framework compiling components of horror and VR design. The resulting research provides a framework for developers to use in their design, a better understating of how components are implemented as well as their impact on the experience of fear in players. The research also provides opportunity for further re-search into the individual components as well as the overall framework.

Related Works

This chapter analyses work related to tension building in horror games, as well as the impact of virtual reality on player experiences in horror games. This chapter is divided into 4 sections to review work used in this research. The first section considers the presence of Virtual Reality in game design and how VR impacts the horror genre. The second section examines audio techniques and their impact on the experience of fear, looking at audio hallucination (AH) and audio localizations (AL) techniques. The third chapter considers the visual components of colour and lighting in the design pro-cess. The fourth chapter investigates other mechanics attributing to the design of horror games: the paradox of control; blind space; and forewarning.

Horror in Virtual Reality

As the main focus of this study, this section considers the immersion generated by virtual reality and how it impacts on the targeted emotions of fear in horror game design. Mel Slater (2009) discusses the sense of immersion that occurs when using VR systems, breaking the sense of immersion in the system into place illusion (PI), the sensation that you are actually in the virtual world; and plausibility illusion (PSI), the belief that what is taking place is actually happening; both of these taking place with the participant fully understanding that what they are seeing is entirely digital and non-existent. Place illusion (PI) occurs when movements of the player are reflected by the in-game avatar; Plausibility illusion (PSI) occurs with the illusion that what is taking place inworld is taking place. Slater identifies a key component of this as events that refer to the player while they have no direct control over them. His research identifies that the two illusions act to greatly improve the sense of immersion participants experience when using the system. Studies found presence and immersion are key components when eliciting realistic mediated frights within virtual reality (Parsons & Rizzo, 2008). Further studies have continued to present data that the use of VR causes in-creased levels of immersion and fear and components associated with PSI cause greater levels of fear than PI (Harrinanan, 2016; Lin, 2017).

In her 2017 article, Tammy Lin broke down elements from The Brookhaven Experiment, a 2016 VR horror demo game,

into elements associated with Slater's PI and PSI. While this was only one part of the research, with the focus being on coping reactions of the participants, elements associated with PSI were found to have greater impact than PI. While her study does not identify how these elements are created, nor does it define how each element achieves the desired results, Lin does identify that events where the player loses control of their weapon (PSI) and do not know where the enemies will come from (PI) caused the greatest levels of fear, suggesting that events where the player is left uncertain of events or unable to maintain control cause in-creased fear in participants. These are established practises used in horror production for games for creating tension (Perron, 2005). Despite the change in perspective that is provided from the shift to VR, implementation of these does not change. Instead the effectiveness of their use is increased due to the increased immersion associated with VR.

Akash Harrinanan (2016) compared levels of fear and immersion experienced in several games that have both VR and non-VR modes. The difference between modes was only in the perspective; gameplay and other mechanics were left unaltered. The re-search identified that the use of VR increases levels of fear and immersion experiences in players. While the players' previous experiences with horror games impacted these results, the conclusion remains the same.

These results can be considered as due to the ability of VR to place the player into the scene to make it seem real. Sound is also frequently used in game design to further the immersion and make the scene come to life. The next section examines audio techniques used in game design to create a sense of fear in players.

Audio

Sound is an important tool in game design, as it makes a scene seem more realis-tic, furthering the immersion of the game. Game engines use a system of audio spatialization, which allows for 3D audio to be utilized, allowing for sound to have an apparent source. The following section looks at how audio can be used in games to create a greater sense of fear in players. Audio hallucination (AH) looks at sound that does not have an apparent source, replicating symptoms associated with schizophrenia, and considers how they are used in games and the impact they have. Audio localization (AL) looks at sounds that have a source, and what directions are experienced with more fear.

Auditory Hallucination

Associated with psychotic disorders such as schizophrenia, auditory hallucination (AH) is the perception of audio that has no known source. The AH experienced by those suffering schizophrenia often involve voices that do not exist or hearing audio different to what would be expected from a source. Demarque and Lima (2013) analyse the psychological condition in relation to videogames and film, how AH is used in design, and the effectiveness of its use in videogames.

Case studies of four successful horror games were conducted, each of which was identified as using elements associated with the identified psychological AH condition. The design components of AH where formed from the games: Silent Hill; Fatal Frame; F.E.A.R; and Hotel 626. Through the study of these games a series of components are identified in relation to AH such as: screams and growls of unseen monsters; creaking wood and doors shutting; ghostly voices talking to the player; and unidentifiable noises. Using these components of AH, a game was developed to test the use and success of using the condition in a horror game.

Developed in Unity3D, AH symptoms were replicated by placing 3D sound emitters outside of the view of the player, with invisible triggers place in the scene to cause various sounds to play. This recreates the experiences associated with AH by having the player experience audio hallucinations as someone with the condition may. This test game presented the applicability of AH and through testing found its use successful in involving additional fear in a game.

Audio Localization

Ekman & Kajastila (2009) discuss the relationship between audio localization (AL) and its perceived scariness. They identify how audio in games differs from audio in film, where the latter is static and planned throughout, games require dynamic audio able to play from any direction. Ekman & Kajastila's tests aimed at differentiating be-tween the accuracy of the AL, placing the participant in a room with 24 speakers and playing sounds classified as 'scary' in different patterns Figure 1 shows how they were set up.
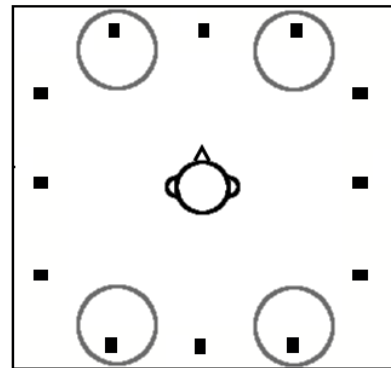

Figure 1 Example of speaker setup (Ekman & Kajastila, 2009)

Their findings show two things, firstly sound from behind has a higher scariness rating, and spread has a higher rating than point sound. Spread audio also resulted in stronger scariness than point audio regardless of the direction (Ekman & Kajastila, 2009). While Ekman & Kajastila's study successfully identifies how scariness is impacted by the localization of the sound source, their experiments take place in a room with physical speakers, as opposed to in an actual game environment. The same scenario can be created in a game environment through the use of 3D audio, something used in many game engines such as the Unreal Engine. Video games use 3D audio to add more believability to the game environment by creating realistic sound within the game world (Breinbjerg, 2005).

Visuals

Colour manipulation

The psychology of emotional manipulation through colour theory has been long studied. Valdez & Mehrabian (1994) evaluate the effects of saturation, brightness, and hue on emotional states using the PAD emotion model (Pleasure-Arousal-Dominance). Their findings indicate that the

emotional experiences associated with colours change significantly with when saturation is introduced into the colour. During Valdez & Mehrabian's testing, darker colours resulted in less pleasure with more arousal and dominance. Emotions associated with these colours are those akin to aggression or hostility. To target emotions akin to fear, a lower level of dominance can be targeted to simulate the feeling of lack of control or submissiveness, which their findings indicate can be done through lower levels of saturation in the colours.

Research presented by Kaya & Epps (2004) provides further evidence towards the use of darker colours to elicit negative emotions, which can be associated with fearful emotions. During their research on colour association, Kaya & Epps compared the same colours from the research conducted by Valdez & Mehrabian with a deeper definition of associated emotions.

While a general guide can be determined through these studies, they do not cover the colours use in videogames or other media such as advertisements and film. When used in video games other considerations need to be taken such as: the models the colours are presented in; the type of surface the texture is (e.g. metal or wood); lighting types and strengths; and UI interfaces.

Lighting

El-Nasr, et. al. (2006) discuss the lighting techniques used in videogames to project tension on to players; developing two prototypes presenting the techniques in use. Through the analysis of techniques, various patterns were identified regarding the use of brightness, saturation, and contrast in eliciting tension. The contrast of lighting proved to be a main focus of the paper, which aimed to create a dynamic lighting system for projecting tension. This contrast is seen as the difference between light and shadow in an image (or scene) and in the designed game is presented as areas lit up and those in shadow.

While this paper presents various techniques used in projecting tension on players, it does not discuss how the implementation of virtual reality impacts their use. The paper uses observation techniques to validate the results, providing opportunity to question its success. The research does not cover the impact of using the lighting patterns in combination with other design techniques.

Other mechanics

Paradox of control

The paradox of control is where the player experiences limited control of a situation without possessing complete control, allowing influence of an outcome but leaving the conclusion uncertain until the end (Perron, 2005; Salen & Zimmerman, 2004). Through his analysis of the critically acclaimed horror game Eternal Darkness: Sanity's Requiem, Perron (2005) demonstrates the use of mechanics to create this paradox. The game keeps track of the avatar's "sanity" where the value decreases every time the player encounters a monster. As the sanity levels get low, the game starts to act odd, affecting the game-world, screen and console, making control of game-play difficult (Perron, 2005). This mechanic plays to the horror troupe of not having control over the events taking place, video games are able to replicate this through means similar to these. Perron paints a picture of this mechanic in typical video games but does not discuss its use

in virtual reality and how the change in perception may cause restrictions on controlling the player.

Blind space

Building off what Pascal Bonitzer calls the "blind space" (1982, pg. 96), Perron (2005) illustrates that what is taking place off-screen can be just, if not more, important than what is taking place on screen. Perron (2005) assesses the off-screen approach used in some video games, identifying the use of aiming down the sights of a gun, which allows the player to aim but often drastically reduces what can be seen. The use of darkness is also brought up by Perron, where there is limited lighting to illuminate the area by the player (this also plays onto the fear of darkness many people have). Using Activision's Doom 3's light/gun mechanic, where the player has to choose between using a flashlight to better see the surroundings but leaves the player defenceless; or equipping a gun, which allows the player to fight back but allows for significant distance to see threats, Perron (2005) pairs the blind space principal strongly with the foreshadowing of threats.

Forewarning

In horror design, forewarning is used to elevate experiences of fear related to shock and tension. Shock, in terms of horror, is the sudden trigger of an event causing surprise in the experiencer. Tension, on the other hand, is the build-up of suspense leading to a fearful event, creating an increasing experience of fear over a longer period of time. Fear experienced from a combination of tension and shock yields stronger emotional responses than each individually and they are used together because of this. Bernard Perron (2004) analyses this technique as it appears in interactive media, considering how it is achieved and how it affects users, using various successful horror games/franchises as examples.

Perron (2004) concludes that the use of forewarning intensifies the emotional experiences of fear experienced within a horror game, and it is importance in the build-up of suspense and anticipation in the player. While including a significant shock event as a result of it is common, the tension created by forewarning can be sufficient on its own.

A Framework for Virtual Horror Reality

The Hardware

This section details how the prototype was executed in terms of the game engine, virtual reality hardware and controls. The game engine used for the prototype is the Unreal game engine (version 4.19.2) using the blueprints coding system. This has been chosen due to availability and familiarity with the game engine and its use in the industry. The virtual reality hardware chosen is the HTC Vive and steamvr controllers. The Unreal engine also has plugins that help with using the HTC Vive for controllers and movement.

The locomotion method used is a standing scale room, using the controller to move the standing space. The speed for this movement is limited to reflect a slow walking pace. This restriction relates to the paradox of control mechanic, where the players maintain some control without having full control over their movement. Players are still able to walk around the space (indicated by a circle in the centre of the digital room). The movement is controlled by the thumb pads using one steamvr controller. The steamvr controller is used in the prototype to allow for movement in the scene, and to control a flashlight, providing a player controlled light source. The

hardware used allows for the accurate reflection of physical movement in the virtual world, reflecting Mel Slater's virtual reality immersion place illusion. The next chapter looks at how the visuals are implemented into the prototype game.

Visuals

Colour manipulation

While the models and textures for the prototype were gathered from outside sources, the Unreal game engine allows for modification of how models and textures appear through the use of blueprints to add a colour parameter onto the base texture. This allows for each instance of the texture to be darkened, and saturation can be lowered. Figure 2 shows the difference between a material before and after the darker colour is applied.
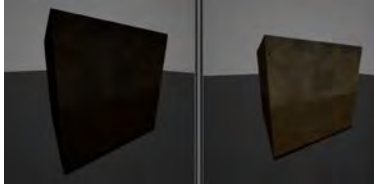
Figure 2 Left= darkened texture. Right = original texture

Using this colouration method, the same saturation can be applied throughout the scene. By lowering the saturation and darkening the colours, the contrast of light and dark also increases and with the implementation of lighting, the darker areas show much darker than those influenced by the light. Unnatural colours can also be introduced into the scene through the use of lighting. The prototype uses 2 instances of this coloured lighting. Both are used to draw attention to a specific location and interaction, these can be seen in the Figure 3.

Figure 3 Examples of colour being applied through lighting

Lighting

This section discusses the use of lighting, and how it is implemented in the prototype, covering the use of ambient lighting, focused lighting and player-controlled lighting. The Unreal engine has a powerful lighting system to aid in the lighting of the scene, this allows for easy manipulation of the three types of lighting.

The ambient lighting in Unreal is controlled by the skylight component. At the start, the ambient lighting is low, complimenting the low saturation colours of the scene. As you continue through the prototype the ambient lighting lowers to show no lighting other than the focused and player-controlled light. The ambient lighting allows for some environment to be seen outside of the lighting provided by

the focused lighting without providing a clear view, creating visual obscurity.

The main source of light implemented in the game is focused lighting using the spotlight component available in the Unreal engine. The settings of the spotlight allow for customization of how the light acts and appears in the scene. Figure 4 shows how an inner and outer light cone can be used to control the falloff of light to aid in creating a sharp contrast between light and darkness.
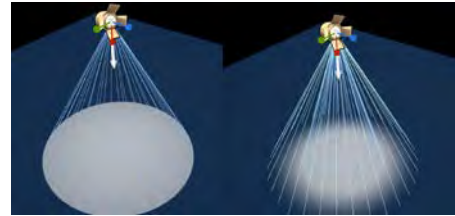

Figure 4 Examples of the lighting customization in unreal.

The lights in the hallway use these cones to create a sharp falloff to compliment contrast, while still having the light simulate naturally fading. Figure 5 shows how the lighting appears in-game. Each source of light in the hallway is spaced out enough to have some darkness between the areas lit up.
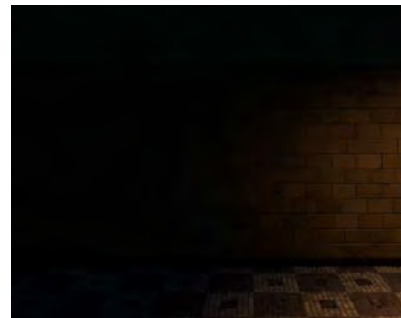

Figure 5 Example of the lighting in-game.

As the player continues through the scene, these focused lights become less com-mon and will flicker and die, providing less light and helping to add to place illusion by creating more life to the scene. This is also achieved by the torch acting as the player-controlled light in the scene.

The torch is the player's main interaction in the environment besides movement. A hand is replaced by the torch during gameplay and uses a texture light profile to shine light, similar how a torch does in the real world, Figure 6 shows how this appears in-game.

Figure 6 The player-controlled lighting provided by the torch.

During the gameplay, the torch gives the player a way to control what they can see while still limiting the light available

from it. During the gameplay, the flash light will flicker and die, reflecting again on the paradox of control.

These lighting systems are used in the game design for several reasons, to allow the player to see the world, to guide them through the world and to hide the world.

Audio

Audio Hallucination

The Unreal engine has a built-in sound system, which allows for audio to be played all throughout the level evenly without coming from a location. This replicates the way that those who experience audio hallucinations will hear sounds without a source. The prototype has 3 stages of sound. Each stage uses a mix of audio looping randomly, selecting which track to play. Stage 1 consists of ambient sound; stage 2 consists mainly of ambient sound, with incoherent speech in the mix; stage 3 consists largely of coherent speech with some incoherent speech in the mix.

This 3-stage method creates a build-up in the audio; as the player continues through the audio increases in intensity. Starting with random sounds, moving to incoherent speech and finishing with clear voices playing without any noticeable source.

Auditory hallucination in this prototype is used for sound without a source in the scene, this prototype also uses localized audio in its design.

Audio Localization

The prototype utilizes audio localization in two ways. The first way is to draw attention to a specific event (e.g. the door opening or shutting). The second way is to give the sound an unclear source location. The Unreal engine sound system can support these using audio spatialization, which replicates how we perceive sound in the real world within a 3D virtual space.

The first use of audio localization is to draw attention or realistically reflect an event. When first entering the gym, the door slowly opens with a creaking sound playing. This works towards PI, in that the world acts realistically, and when the door slams shut, the corresponding sudden sound is played. When the torch fizzles and dies, the appropriate sound again plays. The second use of audio localization uses multiple sources of audio for its effect.

In the research, audio localization was found to have scarier results when the location was blurred. To replicate this in the prototype, sound was given multiple sources, separated and played with a very slight delay. This resulted in both the source of the sound being blurred and the source having a general direction. Figure 7 shows how the set up was done in the game engine, with the speakers placed behind the player.

Figure 7 The set up for sound audio localization.

These methods of audio localization are able to mix with those of audio hallucination. For example, after the player has approached the lamp, a sound effect is played to draw the player's attention to the door that has just opened. It does not use a normal sound of a door opening, reflecting on how auditory hallucination can also include when the incorrect sound is heard to what would be expected. The second use of audio localization mainly uses disembodied demonic voice sound effects, which are also strongly associated with audio hallucinations.

Most of the audio used in the prototype is directed at creating the belief that some-thing exists that cannot be identified through obscurity.

Other Mechanics

Obscurity

To create obscurity in this prototype, visuals and audio are used to hide much of the space in darkness, while having sound play from unseen sources.

The contrast between light and dark creates awareness that something exists in the darkness, despite it being difficult or impossible to see. The sound from unidentifiable sources also adds to the sense that something exists that cannot be identified.

By reducing the light available in areas that have already been seen, opportunity for players to question what was there arises. This is further manipulated by moving objects in areas when the player returns. After leaving the gym, the original corridor is changed, lengthened and darkened. The two rooms the player originally passed also move further down the hallway and are opened with a white light and mist seeping out. Figure 8 shows how this is seen by the player.

Figure 8 Darkened corridor with smoke and shadow obscuring view.

Paradox of control

This section looks at the implementation of taking control away from the player. The prototype uses this in three ways. Firstly, upon entering the gym, the player's torch dies, removing the player-controlled lighting. Secondly, towards the end players are thrown down a hallway. Thirdly, at the end players are unable to move in any direction other than towards the statue.

During the first half of the game play the player has a working torch, acting as the player-controlled lighting, allowing for a limited controlled illumination of the environment. When the player first enters the gym, the torch dies, removing this form of control for the player. Towards the end, the second loss of control happens when the player is moving down a corridor, at one stage the player is thrown down the corridor towards

the final point of the game. This event leads to the final stage where the player is placed before a statue. No matter what direction the player tried to move, they are forced to continue towards the statue, this is the final loss of control the player experiences in the game.

Forewarning

For the prototype, the effect of forewarning is created primarily using audio. Although the prototype does not contain any actual threats, build-ups are used during events. Sounds are used to direct the player's attention, using the premise of forewarning to create a build-up before a larger event. The gym door opening the first time uses a slow creaking sound before slamming shut after the player passes through. As the player progresses through the final corridor the lit-up door and smoke (see Figure 8) retreats into the door as it slams shut. An audio build-up is played as it does so. This process is repeated for the second door; however, the build-up continues into a booming sound as the player is thrown down the hallway.

 Another use of audio forewarning and build-up is played throughout the scene. As discussed in the audio section, the prototype uses 3 stages of ambient audio, each one increasing in intensity. This build-up of audio acts similar to the more specific event-directed audio but plays throughout the scene until the final stage of game-play where the tension is created from complete silence for a short period.

Results

Participants were gathered from the South Bank TAFE campus in Brisbane, where the research evaluation took place. After being given a breakdown of the re-search in the form of a plain language statement, and an opportunity to ask questions, participants then signed a consent form indicating their agreement to take part and understanding of what is involved. Once these procedures were done, participants were able to begin their test playing.

The prototype developed during the execution phase was used to for test playing during evaluation. The players begin in a tutorial section that is completely lit with instructions on how to play the game. When ready, the players continued through the passageway to start the main game.

The main game takes place in an abandoned school, starting in a dimly light corridor. As the player makes their way down the corridor ambient sound plays with no direct source, representing AH. As they continue through the game, the sound in-creases in intensity and the audio changes from scraping wood and slamming doors, to monstrous growls and demonic voices whispering at the player.

About halfway through the gameplay the lighting in the scene drastically drops, leaving the player in near darkness. The player is left only being able to see small areas for guidance with completely black areas between. During the final segment of the game, the only light is from unnatural sources and very limited.

Players move through the scene by using the thumb pad on their steamvr controller. The controller also functions as the torch available during gameplay, which provides a player controlled light source. Players movement and light source are both taken away at points during gameplay to increase the sense of losing control.

The scene is set up to loop back to where the player started. As they make their way through the corridor a blockage prevents their movement, but a door opens to guide players into the gymnasium. While in there, light is reduced to nothing and ambient noise increases. When they exist the gymnasium, the blockage is gone, and they continue back the way they came down the corridor. As players approach where they began, they are thrown down the corridor towards a statue, at which point their movement is stopped and all sounds become silent. The game finishes with the statue crumbling to dust in front of the player.

When ready, the VR equipment was fitted securely to the participants before they were placed into a short tutorial segment to allow for adjustment to virtual reality. During the tutorial segment, any questions about the game are answered, with the exception of revealing information that may impact the results. Checks of the equipment are done during this time to make sure the experiences during the proto-type functioned as intended.

Once the play through was completed, participants were provided a digital questionnaire, using survey monkey, to provide feedback on their experiences with the various components of horror. The questionnaire used a 7-point Likert scale, asking participants to rate their experience of fear regarding a component (1 being no experience, and 7 being very high experience).

The questions asked in the survey were designed to evaluate the effectiveness of the developed components on eliciting fear during gameplay. A total of 7 questions were used to achieve this;

1.   *How fearful did you feel of the ambient sound playing throughout the game-play?*

2.   *How fearful did you find the disembodied voices speaking?*

3.   *How fearful did you find the sudden burst of sound?*

4.   *How fearful did you find the longer, less sudden burst of sound?*

5.   *How fearful did you find the loss of lighting available during gameplay?*

6.   *How fearful did you find the loss of control?*

7.   *How fearful did you find being unable to see everything around you?*

Participants filled out their responses to these questions using Survey Monkey, which kept track of all individual responses and provided overall breakdowns of answers. Table 1 below presents the results of the questionnaire, which are dis-cussed in the next section.

		Min	Max	μ	M	SD
Q1	Ambient Sound	3	7	5.21	5	1
Q2	Disembodied Voices	2	7	4.68	4.5	1.28
Q3	Sudden burst of Sound	1	7	4.95	5	1.43
Q4	Longer Build-up of sound	1	7	4.63	5	1.22
Q5	Loss of Lighting	2	7	4.63	5	1.38
Q6	Loss of Control	1	7	4.76	5	1.53
Q7	Unable to see everything	3	7	5.03	5	1.27

Table 1 Results from testing.

Discussion

This section discusses the results from the questionnaire and play through, as well as providing justification based on the related component, discussing why some results were higher than others.

The two highest scoring were Q1 and Q7. Q1 related primarily towards audio hallucination and Q7 to obscurity. As covered in the related works, AH relates to real world mental condition of hearing sounds that do not exist; while obscurity relates to being unable to see things but having the belief that something exists unseen. The higher scores can be considered a result of both of these components complementing each other as they both create unseen presence and unease in those playing. They are both also present throughout the gameplay, gradually increasing over time.

The third highest score came from the sudden burst of sound. This related to the audio localization component and was used largely to draw attention to certain events. The score can be considered due to the sudden contrast between quiet sound to a sudden loud audio event as opposed to the event that related to the sound.

Q6 relates to the paradox of control, where the player's control during gameplay is reduced. This component was the most difficult to develop due to the VR system's limitation regarding motion sickness. Results from this component had the potential to be higher because of the opportunity to cause negative effects on the player, but the implementation in the prototype may have caused a lower score than other components.

Q2 relates to both audio hallucinations and audio localization. The score can be considered due to the amount of time the player is exposed to the sounds. They in-crease in intensity towards the end, only becoming strongly apparent for a short time before stopping.

Q4 and Q5 both had the lowest score, this can be attributed to a smaller, less obvious presence than the other components. They both slowly build-up throughout the gameplay, as opposed to being apparent at any one time.

Although the results from the questionnaire varied, they all resulted in an increased experience of fear during gameplay. The standard deviations range from 1-1.53 showing that overall results follow a similar trend, with the highest and lowest means having a difference of less than one.

Conclusion

This research successfully investigated components that make up horror design and how they can be implemented into virtual reality game design. This research contributes to the body of knowledge by providing a framework for the development of a virtual reality horror game. The components of the framework have also been implemented and tested to provide further contribution to the body of knowledge.

This research found numerous components of horror design, covering: the VR hardware; the visual components of colour and light; design of audio hallucinations and localization; and other mechanics including obscurity, paradox of control, and forewarning. The finds present data showing that each component showed some level of improvement to the experience of fear in participants, however the combination of components caused greater experiences of fear.

The framework combines hardware, visual, audio, and obscurity techniques to create a VR horror game. The hardware encompasses how the hardware required for VR impacts the design of the game controls. Focusing on locomotion styles for player movement throughout the scene and the motion tracked controllers use for interaction. The visuals components cover how colour and light can be utilized to elicit fearful emotions. The audio component of the framework breaks down using sound to elicit fear through audio hallucinations and audio localization. These two techniques involve using sound without specific sources in different ways. Finally, the framework uses obscurity, a horror design technique that encompasses the other components of the framework to create a sense of unknown around the player. Making it appear that things are lurking just out of sight.

The designed framework is implemented by creating a prototype VR horror game. Using the Unreal engine and HTC Vive, the components of the framework were successfully developed in the prototype. The tools provided by the Unreal engine allowed for the implementation of all the components.

The designed framework was evaluated by having participants play test the developed prototype, then answer a questionnaire to determine the effectiveness of the components. The questionnaire used a 1-7 Likert scale rating system for participants to rate their experience of fear from certain condition. These conditions related to various components of the framework so that each component could be tested. The results of the evaluation show that all the components of the framework successfully elicit fear in participants.

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Creating Digitally-Enhanced Acoustic Performance Spaces for Pipe Organ and Choir

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Abstract

This research is a preliminary examination of how real-time digital processing can enhance the performance of pipe organ and choral music in acoustic performance spaces. It considers the issue of matching repertoire to appropriate acoustic environments in addition to creating new spaces through digital processing It investigates two techniques to digitally enhance acoustic spaces and discuss the tools, aesthetics and issues faced when using these two instruments. These issues are explored in two live music performance events where the aims of this study are realized, providing performers with a variable acoustic space and the audience with an enhanced listening experience. The innovation of this work lies in the treatment of the particular instruments and the control of their blend to create a new, definable acoustic space.

Keywords

Spacialisation, sampled sound, convolution reverberation, acoustics

Introduction

The performance of pipe organ and choral music relies heavily on the acoustic response within a performance space. Some music compositions may be composed without thought given to the performance location of the works – it is up to the conductor/director to consider the performers and the venue and "make it work". In contrast, numerous musical works (particularly commissioned compositions) are written for specific music ensembles or venues. As Parry discusses, the acoustics of the venue can have a dramatic effect on the actual performance of the piece, particularly for choral music [9]. With this in mind, the acoustics of a performance space are a controlling (and sometimes limiting) factor for both performer and audience.

In the context of music, the effective performance of a work may transport the audience (in their minds) to another time, location or world. The experience takes them out of the performance venue into another place. While this can be achieved musically (particularly through the use of lyrics, musical style, etc.) it is also achieved through the acoustic environment such as the sound of a 16th century French

cathedral. This effect of spacialisation is an audio effect used in performance art for placing the listener into a space different from the one in which the music was produced. Digitally enhanced spacialisation has become achievable through recent improvements in digital audio processing [11]. It may be produces by mimicking sound arriving directly at the listener's ear through the use of ambisonics. However such techniques are difficult to achieve for live performance in a large space [10]. Another approach to spacialisation includes composing for a particular space (such as acousmatic music) where the emphasis is on the playback of electronically processed music [13].

A further approach exploits the fact that an audience derives pleasure from features of a space such as reverberation [13]. In this work the focus is on this latter feature of spaces, exploring the use of reverberation to create a sense of space, or "*to create impressions of artificial or imaginary soundscapes that are enhanced by the listening space*" [13]. Rather than adjusting sound to suit the performance space, we are interested in creating a sound that evokes a different space with different acoustic properties. There are two important and frequently used digital processing techniques that can assist with this process: reverberation (particularly through convolution) and digitally sampled sounds. As the choice of instruments used in performance will influence the choice of spatialisation technique, for this work we investigate spatialisation using pipe organ and choir as instruments. By treating each of these instruments separately, but combining them together in an acoustic performance spaces, we are able to explore the possibilities and practical considerations of transporting the audience from their physical location to quite different spaces acoustically.

The Pipe Organ

The modern pipe organ includes a number of ranks where each rank consists of individual pipes, each of which can produce only one pitch [3] (p 264). Each rank has a unique timbre, and is designed to reproduce that timbre, so alternate timbres must be supplied by additional ranks of pipes. We adopt the definition of timbre provided by the American National Standards Institute as follows:

"Timbre is that attribute of auditory sensation in terms of which a listener can judge two sound similarly presented and having the same loudness, pitch and duration as being dissimilar." [2]

Consequently the pipe organ requires a large number of pipes. As an example, a pipe designed to reproduce middle C is often designated as 8', meaning 8 feet in length [3]

(p269). Because of the resulting size of these instruments, a pipe organ is almost always custom built for the space in which it will be installed and played. Some organs will be designed for hymns and other liturgical use, while some organs are designed for concert repertoire. This includes a careful consideration of the aesthetic and acoustic qualities of the space which heavily influences the mechanical design of the pipes in order to blend appropriately with that space.

The advent of electronics enabled the first pipe-less organs in the 1930s [5]. These organs were built using additive synthesis, but sampled sounds took over as computer memory became cheaper and enabled storage of the greater amounts of data required for this approach. Some pipe organs are fitted with electric solenoids to open and close airways. These can more easily be modified to allow control from MIDI sources. However, the cost of modifying an existing organ to be MIDI controlled can be prohibitive.

The Choir

The choir is composed of a mixture of voices with different register, and the timbre of the sound produced varies greatly with the individual singer. In addition, certain vowels provide problems for male or female voices. Consequently there is no guarantee of consistency of tonal quality over the pitch range [3] (p307). It almost goes without saying that a choir cannot be made compatible with MIDI, and so the sound of a choir produced during a live performance cannot be modified by digital techniques as a MIDI equipped pipe organ can. However, since the availability of microphones and electronics amplification, it is possible to apply effects to alter the sound produced by an individual voice or choir [3] (p320). More recently, the availability of digital computers fast enough to perform real-time audio processing has opened many opportunities to the artist to experiment with almost any conceivable audio effect. Unlike the organ, the choir is not restricted to a physical location, and may be more versatile in relation to the sounds and timbres that can be produced.

Pipe Organ and Choir Combination

Pipe organ and choir is a popular choice for concert performance for a number of reasons. These two instruments carry a rich tradition of liturgical use, which provides a diverse choice of repertoire. Additionally, due to the very different nature of sound reproduction and the different relationship to space, these instruments provide an ideal experimental platform for spatialisation techniques. The differences between the mechanical sound realization used by these instruments provides a useful case study in balancing the various aesthetic and practical considerations of such performance, as it relates to creating spaces.

Sampled Sound

An instrument may be digitally sampled in order to reproduce its unique sound electronically in situations where the original instrument is not available. This allows another instrument to playback those sounds in response to the musician, instead of its own sounds. This requires the reproducing instrument to be equipped with MIDI output capability. This poses a problem for some concert spaces, as the pipe organs available at those spaces may or may not be equipped with MIDI out, necessitating the use of a MIDI keyboard. As far the choir goes, a sound may be produced from a synthesizer like that of a vocal choir, but this cannot match the versatility

of the human voice. In addition, as audience expecting to hear organ and choir may be disappointed to realize that a choir sound is reproduced sampled sound, rather than being produced by human singers in their presence. The possibility of blending a human choir with sampled sounds is possible, but is not explored in this work.

When presented with a requirement of reproducing the sound of a French cathedral, complete with two organs and a choir (as was the case in one of the performances), it raises additional issues of tuning a sampled sound with a second organ and choir, as well as matching the timbre of the different instruments.

Convolution Reverberation

Reverberation influences the emotional characteristics of musical instrument sounds, and so is commonly applied to recorded music in order to add depth. Being more precise, one would describe this as a specialization effect, placing the listener into a space different from the one in which the music was produced. Artificial reverberation techniques have been in use for at least 50 years [14]

Convolution Reverberation (CR) represents a further refinement of this technique. It is an audio processing technique that allows a sound arising in a "flat" acoustic space to be transformed to sound as though it is occurring in a space with more desirable acoustic properties. CR can be achieved using digital techniques provided by several commercially available software products, including *Apple Space Designer* (within *Logic Pro X*) and *Ableton Live*.

Convolution is a mathematical technique that involves multiplying a set of numbers that represent the response of a desired space with numbers that represent the sound derived from a "flat" space. Convolution performs this multiplication repeatedly, each time shifting the desired response relative to the flat sound. Such a mathematical operation, repeated many times, is ideal for software implementation, with the requirement that the audio signal, and the desired response are represented as a digital signal.

If the dry audio signal is digitized and represented by a function *f(t)*, and an impulse signal representing the reverberation characteristics of the space to be recreated is represented by a function *g(t)*, then the convolution of these two signals is given by:

$$(f * g)(t) = \sum_{\tau=1}^{T} f(t)g(t - \tau)$$

where *t* is the time step, and τ is the time step to shift the impulse by, which is bounded by the number of samples *T* contained in the signal. The process is illustrated in Figure 1.

Such techniques represent new tools to provide artists with aesthetic choices for specialization. Indeed, the concept of CR has progressed to the point where it is possible to carry out such techniques, and to adjust the parameters, in real time. This allows musicians to "play through each other's sound" [4].

Although CR can reproduce the sound of an instrument and can also reproduce the sound of a space, it has the

disadvantage of not reproducing the eccentricities of each individual note. As far as the organ is concerned, different pipes have different characteristic sounds. In addition, a pipe organ may produce a high note at a given volume, when the available air from the pump is directed to that pipe only. However, when other notes are played at the same time, some of the air is diverted to those pipes and therefore less air is available for the high note. This will change the sound of the higher note. This effect can be produced by more sophisticated MIDI implementations of organ sound, but not with CR.
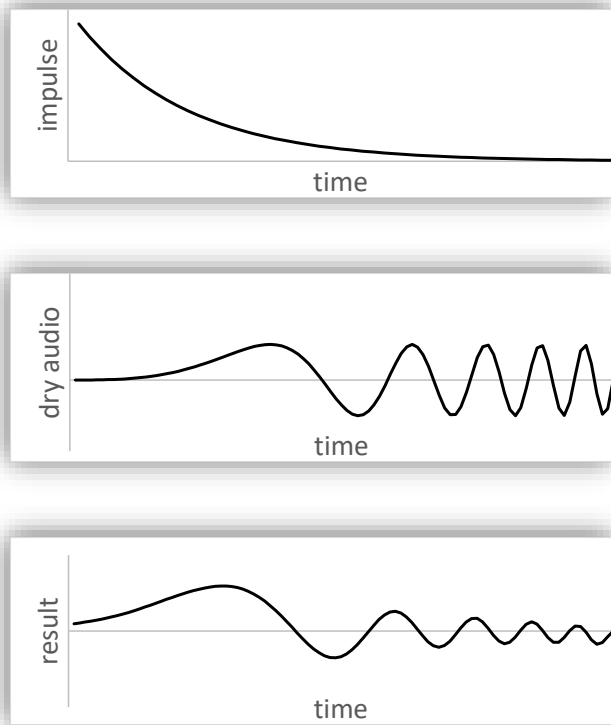
Figure 1. A simplified illustration of the effect of convolution. Impulse signal (top) is combined with audio signal (middle) to produce result (bottom).

Concerning the choir, there are very few recent studies reported in which CR has been applied to choir during live recording, for the purpose of recreating another space. To underline the sparse literature in this area, we highlight this with a search on Google Scholar for the terms "convolution reverberation" and "choir" for the years 2008 to 2018 inclusive. This search returned only 27 results, of which 2 were relevant to this work.

In the first of these, the authors asked domain experts to comment on the difference between a recording made in the chapel of Trinity College Dublin, Ireland and a recording of a dry sound, with spatialisation reconstructed using CR [7]. Impulses for the convolution were collected from

microphones using the Time Stretched Pulse (TSP) method. Results suggested that experts could tell the difference between recording and reconstructed sound.

In the second of these, more directly relevant to the work reported in this paper, the authors describe an attempt to reproduce the acoustics of Hagia Sophia, Istanbul, Turkey, in the Bing Concert Hall of Stanford University, USA [1]. Impulse signals were generated from a single balloon pop (transient method). Authors report that "*listeners and performers … felt overwhelmed by the power of the experience*". However, neither of these report on work involving a reproduction of both choir and organ.

Given the large existing repertoire for choir and organ, it is surprising that little work has been reported on the use of digital processing to create alternative acoustic spaces during live performance of these two instruments. Furthermore, the application of different acoustic reverberation characteristics applied to various instruments within the same room is under-documented.

Realization

The reproduction of the pipe organs used *Hauptwerk*, a software application from Milan Digital Audio, which features a large library of sampled sound, as well as detailed and comprehensive modelling of the organ operation [8]. This program allows the MIDI data from the keyboard of the organs to be used to generate sound using digitals samples. Controls such as stops are represented on a touch screen interface, which provides as intuitive user interface. This software is also capable of modelling physical extraneous noise such as key and stop operation, and motor and blower noises.
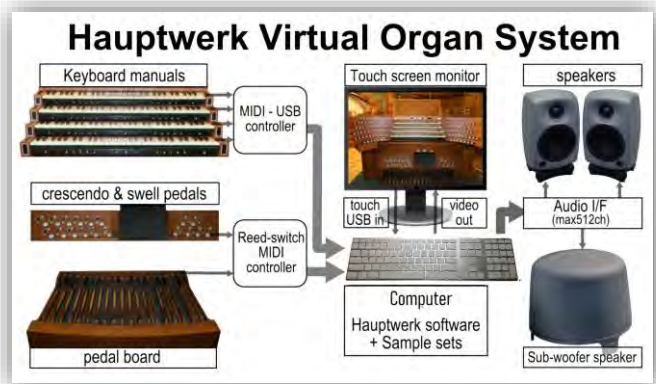

Figure 2. Hauptwerk Virtual Pipe Organ (schematic). Used with permission.[1]

Microphones were placed to pick up the sound of the choir, Loud speakers were directed up towards the ceiling to avoid

directing sound at the audience, as this detracted from the creation of a larger, resonant space.

During performances, a person sitting in the audience would hear sound directly from the choir and organ, sound with the reverberation of the hall where the performance was held, and sound from loudspeakers producing the digitally enhanced sounds of choir and organ. The resulting impression was a blend of all three, achieved by balancing amplifier gains to avoid feedback.

Live Performance Events

Two live performance events were held to demonstrate the creation of alternate auditory spaces. The first performance set out to reproduce the sound of a French Cathedral organ in the Harold Lobb Concert Hall located at Newcastle Conservatorium, Australia. This hall is equipped with a pipe organ, but it was not used in this work, due to the fact that it is a neo-classical instrument with acoustic properties far removed from the sounds of a French cathedral. In contrast, a typical French cathedral has two pipe organs, a completely different resonant space, and pipes specifically designed for that space. The instrument and location chosen for this acoustic recreation was the pipe organ of the Abbey of Saint-Étienne, France. The main organ in this abbey was built by Aristide Cavaille-Coll in 1885 [12].

The first performance was held May 13th, 2017 in Newcastle Conservatorium of Music, and featured the choir Echology (the University of Newcastle Chamber Choir) and Newcastle Christ Church Cathedral Choir. The floor plan of this space is shown in Figure 3, along with the position of instruments and loud speakers.
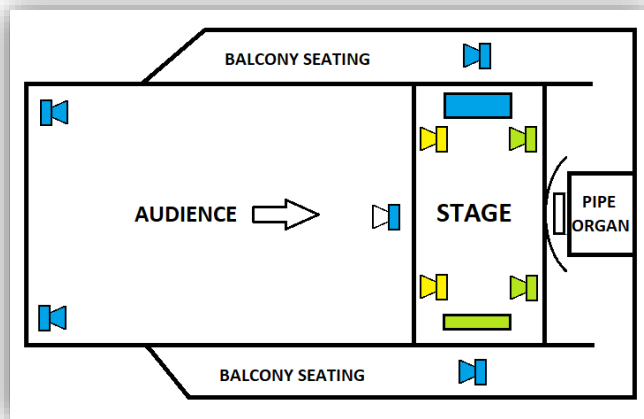

Figure 3. Simplified floor plan of concert hall, Newcastle Conservatorium, showing positions of instruments and loud speakers.

The pipe organ was realized using two instruments: a three-manual MIDI equipped organ (blue rectangle) and a MIDI keyboard (green rectangle). The MIDI from the organ was fed into the first computer to apply the sampled sound from the Abbey of Saint-Étienne, then through the mixer and amplifier to speakers (blue symbols in Figure 3) at back of hall and on the balcony, with a sub-woofer positioned in centre in front of the stage (blue / white symbol). The MIDI from the keyboard was fed into the second computer to apply additonal sampled sound from the Abbey of Saint-Étienne, then through the mixer and amplifier to speakers (green symbols in Figure 3) at back of the stage. Audio from the choir was picked up using microphones and processed using convolution reverberation before being conveyed to the loud speakers (yellow symbols at sides of stage). A diagram showing the realization of digital effects is provided in Figure 4. This uses the same color code as Figure 3 to identify the three instruments used: blue for the organ console, green for the MIDI keyboard, and yellow for the choir. The program featured music by Langlais, Duruflé, Fauré, Messiaen, Poulenc, Franck and Couperin [6].
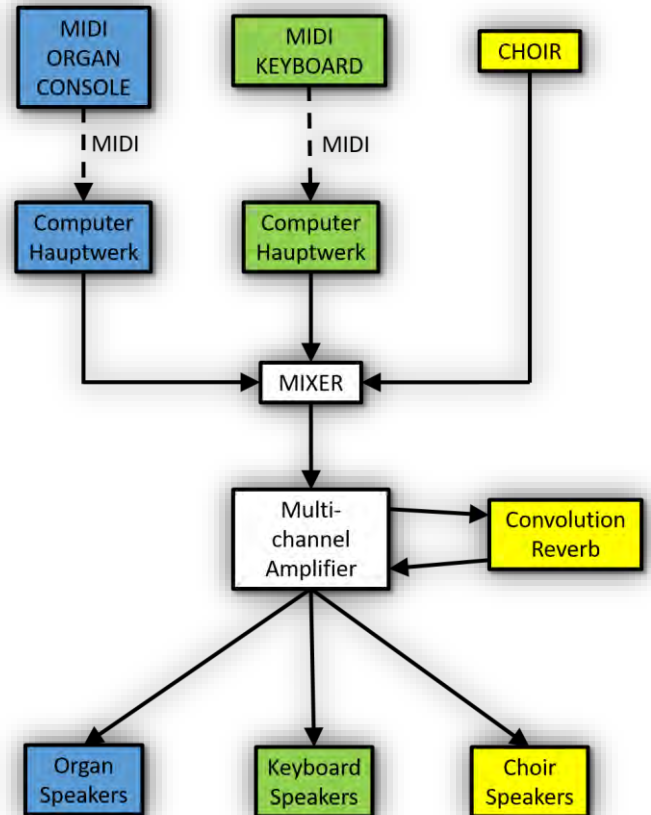

Figure 4. Arrangement of instruments and digital effects as used in the first performance.

The second event was held at the Great Hall, Sydney University, on the 22nd October 2017, and featured the choir Echology with soloists. This event was designed to reproduce the sound of the organ of Christ Church Cathedral in Newcastle. The Great Hall is constructed in a Tudor Gothic style and features the von Beckerath pipe organ, built in 1972, with over 4000 pipes. The Great Hall organ is installed across the back wall of the hall, shown at the right in Figure 5, with the organ manual installed in a gallery at the top of the diagram.

From Figure 5 it may be seen that for this performance the usual orientation of the audience was changed so that the audience faced the back of the hall, where the organ is

installed, in order to enhance the creation of an alternate acoustic performance space.
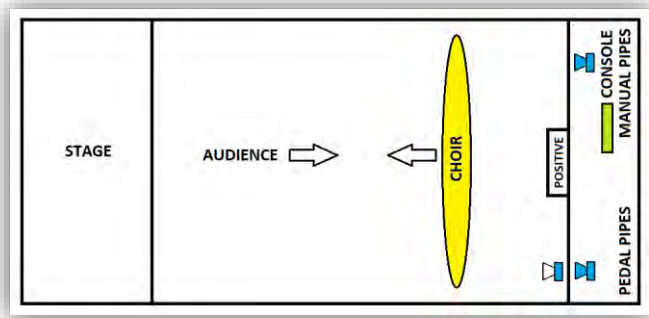

Figure 5. Simplified floor plan of the Great Hall, the University of Sydney.

The organ has three manuals (keyboards), with principal pipes from the Great division (middle keyboard) shown at the top of the diagram, behind the console. Above these pipes are pipes for the Swell division, operated by the top keyboard. At the middle of the organ gallery is the Positive set of pipes, operated by the bottom keyboard. The Pedal pipes are shown at the bottom of Figure 5.
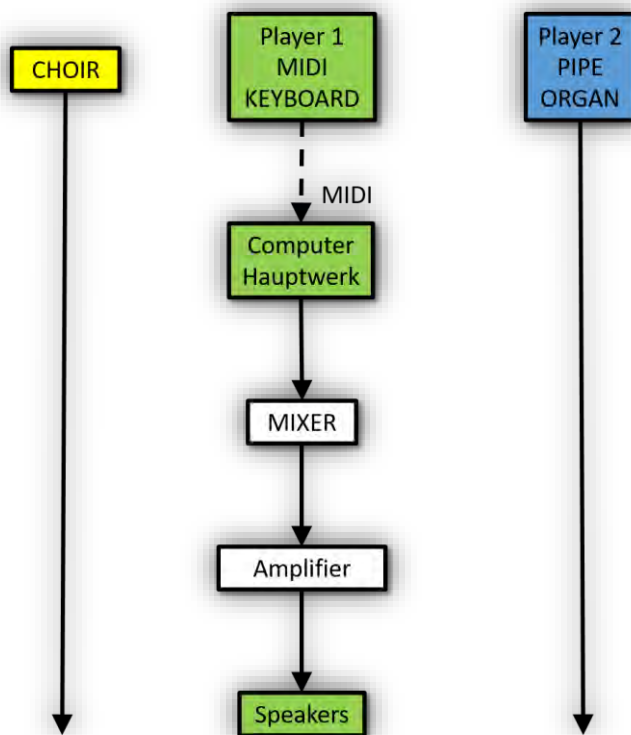

Figure 6. Arrangement of instruments and digital effects as used in the second concert.

The sound of the organ of Christ Church Cathedral, Newcastle is of particular interest because one of the pieces forming part of this event was a prelude on Ein feste Burg, written especially for that instrument and space. However the organ of the Great Hall, Sydney, is unable to fully realize this piece since it does not include particular sounds that Christ Church Cathedral does. So in this event, a different approach was required as shown in Figure 6. Here it was possible to make use of the organ as is, but with the addition of the sounds of 32' reed and flue tones, Zimbelstern and Vox humana. In other words, the existing instrument was enhanced by the addition of these sounds.

The choir stood across the stage facing the audience. Microphones were positioned in front of the stage and at the organ manual loft for soloists. The sound of the choir was not enhanced.

Results

Although this work is in a preliminary stage, it is obvious from the performances that the aim of creating new spaces through digital processing is not only possible, but is able to be used in live public performances featuring pipe organ and choir. Audiences attended both the events mentioned here and provided very positive informal feedback. In addition, the opinion of an expert was received, with Peter Guy, the Organist and Master of the Choristers at Christ Church Cathedral, Newcastle saying "*I would never have imagined being part of a concert like this (using the French organ colors and acoustics) in the Con Concert Hall. It worked!"* [Guy, personal communication].

Conclusion

This work investigated the use of digital processing to create alternate spaces using reverberation techniques based on sampled sound and on convolution reverberation. This approach represents a new application of these techniques to two compatible but different instruments: the pipe organ and the choir. Given the popularity and extensive repertoire of this combination of instruments, these techniques have the potential to open a new door on enhanced performances.

In future work, we plan to continue the live performance series with other concerts and to refine the techniques

Acknowledgements

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A Framework for Player Trait Scenarios

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Abstract

There have been an increasing number of studies on player behaviours in video games over time, which has led to researchers grouping these behaviours together in the form of player types. Since the creation of Bartle's taxonomy of player types various researchers have attempted to identify and categorise player behaviours. However, research into player type models have proven to be inefficient due to ambiguous psychological foundations and a heavy focus on specific game genres. This has paved the way for player trait models instead. Research into player traits is quite recent and so far, has been limited to subjective questionnaires. This research expands the field of trait models by creating a framework that explore various behaviours which players exhibit in scenarios related to their player traits. Three artificial agents are created to display these behaviours in a video game setting. This aims to provide an understanding into how a player's trait orientation can inform their actions in each scenario. The scenarios created for the agent to interact in will be informed by the subjective survey questions designed in previous research to identify player traits. It is expected that the knowledge from this project can be used to predict player behaviours based on the scenarios that developers have created. This leaves the potential to personalise a game for multiple player traits or cater towards a specific one.

Keywords

Typology, Traits, Player, Game, Behaviour, Model, Agent, Scenario

Introduction

As popularity in games increases developers have needed to factor in how consumers play games to tailor a more personal experience for them. Many researchers have aimed to define players by categorising them into varying types of play based on their behaviours. However, some issues have been brought up concerning player types. It is generally assumed that each type is mutually exclusive, which has been proven not to be the case (Bateman, Lowenhaupt, & Nacke, 2015). This has led to suggestions of a satisfaction model based on trait theory instead, which views personality as a combination of multiple characteristics. A recent player trait model that is extensively focused on in this research describes three unique player traits: Action orientation, which is associated with challenge; Esthetic Orientation, which is associated with exploration and socialisation; and Goal orientation, which is associated with mastery and achievement. While recent, there has been a lack of research into how a trait model for player satisfaction could be used, and an absence of a framework to assist developers in appealing to player traits.

Through research and analysis of previously designed player satisfaction models and psychological behaviours, this research will create three agents that exhibit three separate defined player traits. Each agent will engage in a virtual environment simultaneously to explore the behaviours that they display both individually and as a group. Throughout this process, the project will maintain a constructivist viewpoint by collecting information without bias while interpreting the behaviours and scenarios required to create the agent.

As discussed previously, there has been a lack of structure when it comes to utilizing trait models in game development. Therefore, the contribution that this project aims to provide to the body of knowledge is a framework that defines behaviours that players could exhibit in a variety of game scenarios.

Related Work

Player Typologies and Trait Models

Kahn et al. (2015) explore player motivations across both culture and genre using the Trojan player typology, which consisted of six distinct types of player motivations. A survey was posted online with assistance of Riot Games' Mobile Online Battle Arena(MOBA) League of Legends(LoL) from North America, and the Chinese Massively Multiplayer Online(MMO) Game Chevalier's Romance 3 from KingSoft. Additionally, the player motivational types were validated by server-side behavioural data. The authors also propose a new motivational type, smarty-pants, which describes playing games as a method of improving intelligence. Although it is still a type model, trait theory has been shown to translate across typologies as explained by Bateman, Lowenhaupt, & Nacke (2015), who analysed previously developed typology models for player satisfaction in video games. However, most of these models are based off psychometric typologies that have been adapted to video games. On top of this, it is explained that the criticisms these type theories have received leads credence towards developing a trait model for player satisfaction instead. It was discovered that a player typology could still be created while using a trait theory approach. The paper follows the development of various type theories and their transition towards a trait theory of play. The theoretical creation of the surveys and the instruments used to carry out their implementations are also explored. This provides support for the need of trait models, as they can have a higher level of accuracy than the widely used type models.

BrainHex provides a typology of player preferences in video games by combining previous knowledge in player research and understandings in neurobiology (Nacke, Bateman, & Mandryk, 2014). The intention of this model was to guide researchers to develop a reliable trait model further down the line. The model was created by defining seven specific archetypes of player experiences and describing how they relate to prior research concerning player archetypes. The seven archetypes are seeker, survivor, daredevil, mastermind, conqueror, socialiser, and achiever. Using the BrainHex model to conduct a survey of 50,000 players, demographic data was gathered to compare each of the archetypes. This study is significant because it informs future research into trait models for players. Fortes Tondello et al. (2018) aimed to further the research performed by the BrainHex model by condensing the seven archetypes into three traits; action orientation, esthetic orientation, and goal orientation. Using the BrainHex scale, they analysed a dataset of over 50,000 respondents to refine this trait model. Additionally, the study gathered the respondents' favourite video games to understand the factors that affect playing preferences. It was discovered that gender and story do influence the intensity of a player's trait orientation. This leads to the possibility of creating a fourth trait, immersion orientation, in their future research which could lead to a more definitive player trait model. Type models have been covered extensively in research, usually by adapting personality models and surveys to fit into player types or extending on previous type model research. This trait model is very recent which gives many opportunities to expand the knowledge of this topic. The fourteen questions in this player survey are also the scenarios that this research is utilizing to create a real-time environment. Although it isn't a definitive trait model yet, the process used to identify the behaviours in-game can be expanded to fit an improved version in the future.

Player Arousal
Instead of excitement, this research will use the term arousal as it is more extensively used in other studies. Arousal is one of the six dominant reasons for video game use according to a survey conducted by Sherry, Greenberg, Lucas, & Lachlan (2006), and various studies have identified how arousal affects players in video games. Research by van Den Hoogen et al. (2014) reveals that arousal increases when avoiding undesirable outcomes. Arousal has also been seen to increase when the risk of being defeated and probability of success are higher (Larche, Musielak, & Dixon, 2017). This means that players could feel more excited when the outcome of a match is uncertain. This is corroborated by Grodal (2000, p. 204), who states that a game provides a higher level of immersion for a player if it can satisfy their optimal mental and motor capacity.

Arousal also increases when the chance of rewards are higher (Johnson et al., 2018). As tasks become more challenging in games, there are better rewards to go with completing them. Further research has also been done on people using the pleasure-arousal-dominance(PAD) model, a trait model on personality. These tests involve exploring the effects of colour on emotion (Valdez & Mehrabian, 1994) and identifying predictive factors of behaviour (Mehraei & Akcay, 2017), however they don't target game players specifically. They establish that emotions including admiration, distress, anger, and anxiety are emotions of high arousal while boredom, disdain, and relaxation are low arousal states.

Fraser et al. (2014) describes a methodological approach to identifying and quantifying difficulty factors in a video game. They argue that without a method of measuring when the player is bored or frustrated, the game's commercial value could be affected as a result. To achieve this, they designed an experimental testbed based on the well-known game Pac-man due to how easy it is to learn and the simplistic graphics. Additionally, there are a small number of game factors to work with that will not affect the player's level of engagement due to the varied behaviour of their opponents.

The results of this methodology demonstrate a variety of game factors that can be applied to many situations, and a small number of factors that can be applied to specific player types.

Identified Gap in the Literature
The literature review identifies gaps around player trait models and underlying motives behind player arousal. The majority of existing research is informed by either type theory or traits of existing personality models. However, there is a lack of design methods that guide developers of how to implement trait-oriented scenarios in video games. Therefore, the most efficient way of solving this gap is to create a framework that contains various methods of how to design trait-oriented scenarios in games. This framework aims to serve as a guideline for developers looking to cater to either a specific player trait orientation, or all of them.

A Framework for Player Trait Scenarios
Previous research has established that the three predominant trait behaviours in player personality are action, esthetic, and goal orientation. This framework provides design methods for how to implement game scenarios based on the three defined traits.

Taking on a Strong Opponent in a Versus Match
For a developer to implement this scenario, an optional area or game mode dedicated to Player VS Player (PVP) events should be created. To ensure that a player understands if their opponent could be considered "strong", a ranking system should also be created that is displayed to the challenger. Regarding this project, a strong opponent is synonymous to a skilled or experienced opponent. Klimmt & Hartmann (2005) explain that "Playing task-based or competitive games is fun only as long as the resolution of the given tasks is uncertain". As a skilled opponent would create a more uncertain outcome than an unskilled opponent it can be assumed that a player would consider a strong opponent as somebody who has a skill level roughly equal to or higher than their own. Additionally, this system has been used in competitive games before.

Feeling excited
As discussed in previous literature, arousal is an important factor for players in video games. Each player feels excited in different situations which makes this scenario hard to implement. However, there are some factors to consider. Avoiding undesirable outcomes is one. Although an undesirable outcome could be subjective to each person, it can be regarded as a state that places the player in a

disadvantageous position. This could be something as common as taking damage or being placed in check in a game of chess. The chance of succeeding and risk of losing is also a factor to account for. A potential method to use can be to identify and quantify the game's difficulty factors. This could be used to determine what the player finds difficult and tailor it to give them a challenging experience. Finally, player arousal increases when the chance of a reward is higher. This can be used with enemy types where harder enemies give better rewards and exploration, where secret rooms or alternate paths are created to reward players. It can also appeal to goal-oriented players by providing prizes to players who reach certain milestones.

Being in control at high speed

Previously identified research established that players feel more immersed when a game matches their mental and motor capacity. Therefore, it can be assumed that a player who enjoys being in control at high speed would be more inclined to favour high speed situations. Creating events in which the player can deliberately places themselves in these situations would go towards this scenario. 'High speed' in this instance could be defined as an event that is considered faster than the default state of the event. For example, movement speed is a constant state, but evading is a short burst of increased speed in movement, thus making it a high-speed situation.

Completing a punishing challenge after failing many times

As mentioned earlier, arousal is increased with the risk of defeat and chance of success. Almost succeeding is also known as a near-miss situation. This is because the player believes that they have a higher chance of succeeding if they reattempt the challenge. It is quite difficult to gauge what the player believes to be a challenge, however measures such as identifying factors that the player finds difficult can be implemented to understand what they find challenging.

Talking to NPCs

Non-player characters (NPCs) in games serve many purposes such as supplying various functions, acting as an adversary or friend, or providing information and loot to the player (Warpefelt, 2016). It is explained that NPC types are identified based on their surroundings and location, actions taken, attributes, and visual presentation. In the case of this behaviour, talking to non-player characters could be applied to any type of NPC.

Exploring to see what you can find

Exploring an area in games generally means veering off the path of the primary goal. Many game developers create rewards that incentivise players to explore their surroundings in open-world(Green, 2017), and non-open world(Walker, 2018) games alike. Creating optional paths for players to traverse can be achieved in most games that involve a method of travel.

Co-operating with strangers

There are a variety of games that contain cooperative aspects which allow you to work with acquaintances and strangers alike. Using a matchmaking system to pair players together is a good method to foster cooperation between strangers.

The second stage to this scenario is to create an event that requires or has the potential for cooperation between players. Games can be designed with the purpose of cooperating with others or it can be offered as a choice, allowing players to compete instead. In either case, producing a game that contains cooperative elements will appeal to people who enjoy this scenario.

Wondering what's behind a locked door

Locked doors are a common mechanic in games ('The Locked Door (Concept)', 2018) which can generally be unlocked by reaching a certain level of progress, completing a specific challenge or using a consumable item such as a key. This scenario ties well into exploration as it creates more optional paths to navigate throughout a level.

Talking to other players

The two most common approaches for talking with other players in games are text chat and voice chat, which have often been compared to each other to determine which is a better communication method (Wadley, Carter, & Gibbs, 2015). Although voice chat is a great way to free restrictions on players and deliver messages in a short time, it can diminish aspects of role-playing if player's voices do not match their in-game avatars. Additionally, text chat doesn't suffer the same way voice chat does when it comes to clutter and congestion.

Using either or both methods of communication comes down to the type of game being created, which is a highly subjective process. Games that are fast-paced and require instant communication benefit more from voice chat. Text chat can benefit games that contain slower, more social events (see Figure 1).

Figure 1. Gamepedia. (2017). Chat system in NeverWinter

Running away from a dangerous foe

As established previously, a ranking system can be used to identify the skill level of enemies, including other players and NPCs. This can be used to inform the player that the current foe is going to be challenging or impossible to defeat. Another approach to this scenario is to remove the player's means of attack, forcing them to retreat. As making a game is a subjective process, these approaches can be used in a variety of ways. This includes restricting the locations a player can go, forcing the player into another area, or increasing the tension a player feels in specific situations.

Picking up every single collectable in an area

Collectables are items such as coins (see Figure 2), keys, or rings that are placed throughout the environment for the player to gather. They are generally used to complete levels, provide additional rewards, or encourage exploration. These rewards can range from an increase in the player's health to narrative devices that expands the story of the world or characters. Collectables can be based off the themes of the game or determined by the developers.

Figure 2. Nintendo. (2012). Mario collecting coins.

Cracking a challenging puzzle

While some games tend to use combat or platforming as obstacles for players to surpass many others use puzzles instead. This suits goal-oriented players highly as it appeals to their sense of mastery and achievement. Testing can be done beforehand, or data can be gathered from players to measure the number of attempts or time it took to complete a puzzle. This method can be used to ensure that the puzzles made in a game are challenging enough for players.

Feeling relief when you escape to a safe area

Relief is defined as a feeling of relaxation following release from distress or anxiety. As explained in previous research, distress and anxiety are considered high arousal states. Creating safe areas for players to relax in can been done in a variety of ways. One method that can be applied is by using towns as a safe area, restricting combat encounters to areas outside of it. Even if the developer doesn't directly create a safe place, players themselves can build them if given the right tools.

Working out what to do on your own

This scenario ties in well with the puzzle scenario, as the challenge from some puzzles can be figuring out what to do. One method to achieve this is by feeding the player limited information which incentivises them to explore and put the pieces together over time. This can also apply to navigation, action and combat situations as well. The similarities between these situations is that the player is made aware of the goal state, but not the path to get there. Although the situation is dependent on the game as long as the player is aware of the goal they need to reach, they can attempt to work it out on their own.

Prototyping and Evaluation

The next step in the research was to implement the framework into a virtual environment and evaluate its effectiveness. For this research, there will be three virtual agents developed that contain a weighting towards each specific trait: action, esthetic, and goal orientation. The action-oriented agent is shown as a red box, the esthetic-oriented agent as a blue box, and the goal-oriented agent as a green box. The current environment developed to implement these scenarios is a dungeon-crawling shooter game. This environment was chosen to develop because it allows for multiple types of game scenarios based on challenge, exploration, or mastery; each related to the three traits. Each scenario listed in the framework is added to this environment to provide an example of how they can be used and how a trait-oriented agent could react to them.

Taking on a Strong Opponent in a Versus Match

Although the agents in this research exhibit different behaviours, there is no difference in their combat mechanics or decision making during combat, so it can be assumed that all agents are at an equal skill level with each other. After clearing out a room of enemies, the action-oriented agent will challenge another agent if they are in the same room. There is a twenty-five percent chance that the other agent will accept this challenge, which will result in both agents seeing each other as enemies. After one agent defeats the other or if an agent declines the challenge, they will both resume their original tasks until clearing another room of enemies.

The action-oriented agent would successfully challenge any other agent that was in the room with it after all enemies have been defeated, after which they would attack each other if the challenge was accepted. Unfortunately, the frequency of accepting this challenge was determined subjectively as no research could be located on how often players accept duels, or how trait orientations influence this. However, it proves to be a successful experience for players who choose games with this scenario advertised, as with a lot of competitive multiplayer games.

Feeling excited

Based off the studies mentioned previously in the methodology section, the agents contain a level of excitement that increases due to the events listed:

As arousal increases when avoiding undesirable outcomes, the agent's level of excitement will increase if it manages to dodge a shot from an enemy. This bullet has to be within a certain range of the agent for it to influence their excitement. If the bullet hits the agent, their excitement will fail to increase.

The agent's level of excitement will also increase with the risk of being defeated and probability of success. In this research it means that an agent will become more excited if they are close to winning but are also low on health during combat. This increases the amount of excitement that is gained by dodging enemy shots.

Finally, the agent's level of excitement will increase if the enemies are more challenging, as they are more rewarding to defeat. Each enemy has a difficulty level that goes towards the rooms overall difficulty level. The enemy's difficulty level was determined by the amount of shots, rate

of shots, and type of shot that they fire. This difficulty level will influence the agent's excitement.

As listed in the framework, the agent's excitement increased due to a small set of factors: avoiding damage, risk of defeat, chance of success, and chance of rewards. This implementation was successful as excitement did rise, however further research is required to identify how player arousal decreases, and how behaviour is influenced by a high level of arousal.

Being in control at high speed
In this project, the only high-speed event defined is evasion. Although every agent can evade shots, the action-oriented agent has an ability to briefly move faster when dodging enemy bullets.

This implementation was achieved as the agent does frequently dodge bullets fired by enemies. Future steps for this process would be to include more examples of high-speed events for this agent to perform as it moves through the environment.

Completing a punishing challenge after failing many times
A punishing challenge could be considered to occur when an agent fails to overcome a challenge that it has attempted multiple times. If the challenge provides a valuable reward and the agent almost wins then it will be more likely to retry. In this instance the challenge for the action-oriented agent is to defeat all enemies in a room. When the agent's health is reduced to zero, it gets sent back to a previous room and must retry.

This scenario was implemented in the project as the agent occasionally fails and reattempts to defeat a room of enemies. There could have been more potential obstacles for the agent to face however, as it retries the same room because there is a limited amount of rooms for the agent to move through.

Talking to NPCs
The scenario for this project involves a non-player character placed in a room with an option to talk to. Their purpose is to provide information about either themselves or the world around them. While NPCs can be used to give items or tasks to a player, this instance specifically involves using them as a narrative device.

This scenario is successfully implemented into the designed environment as the agent talks to an NPC in any room it finds. Further research into player motivations behind why they converse with NPCs may be required. This could improve the framework by giving more options to the NPC, such as bartering or dialogue.

Exploring to see what you can find
The scenario developed for this project is a set of rooms in a grid-like pattern. The agent is given information about the current room they are in and the direction of the boss room, as well as the exit points in the area. In this project the esthetic-oriented agent will attempt to navigate through every room before entering the boss(final) room. This is opposed to an action-oriented agent, as their purpose is to move directly to the boss room which is theoretically the toughest challenge to overcome. Additionally, there is one locked room which the agent must locate a key to, as seen in Figure 5. They will remember the location of this door

and travel back to it after they locate a key placed in another room.

The agent was effective in exploring every room, even going back to the locked room after discovering the key(see figure 4). Exploring in this instance was only limited to instances of each room, however there could be a possibility of creating a method of exploration for open-world environments in the future. As previously mentioned, it is also important to gather more research regarding player motivations to explore and adding more items to reward thorough exploration.
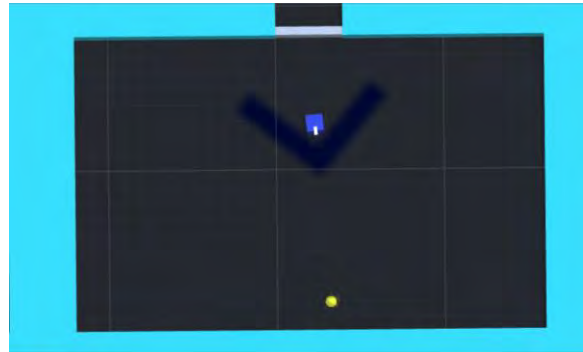

Figure 3. Esthetic agent(Blue) finds key(Yellow) through exploring.

Co-operating with strangers
In this project, three agents will be playing through the game simultaneously. Each agent has a different trait orientation that would go towards affecting this behaviour. A factor of cooperation that can be measured in this scenario is if the agents are in the same room and fighting the same enemies. Another behaviour is the communication between the agents when attempting to solve puzzles or telling other agents about the location of collectables, NPCs, or room difficulties.

Cooperation was implemented and demonstrated through the agents firing at enemies in the same room (See Figure 4). There is an additional element with an enemy who is hard to damage from the front. This allows the agents to work together as one draws the enemy's attention and the other fires at its back. Unfortunately, these methods of cooperation occur due to circumstance, and there is no explicit action that one agent takes to help another besides the action-oriented agent moving to difficult rooms. Further research could explore motivations behind player cooperation, and how player traits could influence these motivations between both friends and strangers. Additionally, more methods of cooperation should be created and tested for this scenario to be supported further.

Figure 4. Action (Red box), Esthetic (Blue box), and Goal (Green box) oriented agents fighting in a room with enemies.

Wondering what's behind a locked door

In the scenario created, an optional locked door is placed in the environment. The method to open this door is with a key located in another room, which is likely to be found by the esthetic-oriented agent as it explores the level. If the agent comes across the key first, it will continue exploring until it finds the locked door. However, if it finds the key after learning the position of the locked door it will move towards there immediately.

In the current implementation there was no method to make an agent "wonder" what is behind a locked door. Therefore, this agent decides to find a method of unlocking the door instead. As described earlier, the agent finds a key while exploring and moves back to the locked door afterwards. Some further improvements to this scenario could be locating research that asks what a player believes to be behind a locked door. Additionally, more scenarios involving puzzles or enemies to unlock doors could be used to showcase more variety in this scenario's implementation.

Talking to other players

For this prototype the agents do not need to be sending actual text to communicate with each other. Therefore, it will be limited to sharing information of their position, difficulty of enemies in a room, locations of collectables, and Non-Player characters. As this is a behaviour weighted towards an esthetic-oriented agent, they will be the one to communicate this information. The goal-oriented and action-oriented agents will respond to the information that benefits them, such as collectable locations and difficult enemies. As the agents didn't communicate with each other in the manner regular human players would, this scenario does differ in some respects. However, the events mentioned such as enemy amount, NPCs, or collectable locations can all be communicated by both agents and humans alike. This can be seen when the action-oriented agent changes its path after being informed of a large group of enemies, or the goal-oriented agent moving towards a collectable another agent discovered. Further information should be explored including what critical information players communicate in a game, and how players could potentially react in a group versus being alone.

Running away from a dangerous foe

As this project involves blocking off exits to the room until all enemies are defeated, the goal-oriented has an ability to escape if its level of excitement gets too high. As any foe could be potentially dangerous based on the agent's health, difficulty does not factor into the agent's decision to run.

The goal-oriented agent did successfully run away from a foe when its excitement level increased too much. However, the agent would attempt to fight the same enemies almost immediately afterwards due to the linear nature of the game and simplified behaviour of the agents. As running away was calculated by excitement level and not agent health or enemy difficulty, it is also hard to determine if the foe was indeed dangerous. Additional improvements to this field could include creating additional paths for the agent to take, as well as communicating for assistance to other agents to combat the dangerous foe.

Picking up every single collectable in an area

The scenario developed in this environment adds collectable items in the form of small red orbs. These orbs only hold value as items that the agent can find and don't provide any additional benefit in the way of gameplay advantages. The agent shown in this implementation chooses to pick up every collectable it finds. It also moves to an unlocked room with a collectable after being informed by another agent. Unfortunately, the collectables did not hold much significance for the agent outside of narrative use. Further research should attempt to show more uses for collectables to assist in the validity of this framework.

Cracking a challenging puzzle

In this research, the goal-oriented agent will go through a process of identifying a random number. The agent is given the values that the correct number is between and is given a set number of guesses to correctly learn it. As the agent guesses a number it will be informed if it is correct or not. The agent will eliminate that number from its next guess and move on. The agent will fail the puzzle if it runs out of guesses or chooses to give up while attempting.

The implementation of this scenario succeeds as the agent attempts to complete the puzzle. Additionally, there is a chance for the agent to fail the puzzle by running out of attempts. While this is a functional example of the scenario listed in the framework, there was no reward or punishment for completing or failing the puzzle respectively. Moreover, there was little strategy on the agent's part to determine the correct solution. Future scenarios could improve on this by providing extra scenarios that make use of puzzles, as well as improve upon how the agent approaches them.

Feeling relief when you escape to a safe area

The scenario developed for this research as mentioned earlier is unlocking doors after all enemies have been defeated. Therefore, the goal-oriented agent has been given the ability to escape to the last room it was in. This gives the option for the goal-oriented agent to escape if they feel like they are in danger or continue fighting, which is determined by the agent's state of arousal. The higher the level of arousal, the more likely a goal-oriented agent would attempt to escape. After escaping, the agent will feel relief in the form of their level of arousal decreasing.

This scenario does achieve its goal by having the agent escape and decrease in arousal. Unfortunately, the limited area of the environment led to the agent retrying areas it had just escaped from, sometimes creating a loop of running and fighting if it couldn't succeed. An improvement on this scenario would be to identify areas of danger and

determine if the agent should feel distressed or anxious enough to be relieved afterwards.

Working out what to do on your own
For this scenario the agent will be asked at the beginning if they want to see the location of the boss room. The agent also has limited information regarding the correct solution to the puzzle, which it needs to make multiple guesses to succeed. Unfortunately, the only current method implemented for the agent to work out what to do on its own is the puzzle scenario. As the agent is given no hints as to what the correct number is, it is required to solve the issue by itself. To expand on this scenario's implementation, more choices should be given to the agent to refuse, such as puzzle hints or enemy weaknesses

Conclusions

Research Contributions
As identified in this research, trait models of player satisfaction have currently only been used in surveys to measure the response of participants in theoretical scenarios. This study has created a framework that provides guidelines of how to implement these scenarios into a virtual environment. This contributes to the field of research by providing developers with a potential insight into how players act and which scenarios to implement into their products to appeal to consumers. Specifically, this framework has been developed for potential use in commercial products.

Main Findings
The agents were able to exhibit behaviours based on data from human players including player arousal, challenge, socialisation, and mastery. As these agents were able to successfully complete their tasks and perform in the designed scenarios mentioned, this could hold true for a human player as well.

However, it was discovered that many of the implemented scenarios had problems, mainly due to lack of research into player motivations or rigid implementation. Exploring and solving these issues will assist in making the framework more defined.

Answers to Research Questions
After designing, implementing, and evaluating the framework, the research questions can finally be addressed.

Which elements make up a framework that can be used to accommodate players of differing trait orientations?
In total, there were fourteen elements that corresponded to different scenarios in the framework. Each element had a primary weighting towards three defined traits: Action, esthetic, and goal orientation.

Action orientation involved elements related to challenge and excitement. These included taking on a strong opponent in a versus match, feeling excited, being in control at high speed, and completing a punishing challenge after failing many times. Esthetic orientation involved elements related to socialising and exploring. These included talking to NPCs, exploring to see what you can find, co-operating with strangers, wondering what's behind a locked door, and talking to other players. Goal orientation contained elements related to achievement and mastery. These included running away from a dangerous foe, picking up every single collectable in an area, cracking

a challenging puzzle, feeling relief when you escape to a safe area, and working out what to do on your own.

How can a framework that is used to accommodate players of differing trait orientations be designed?
Throughout the course of this research, the Design Science Research Method (DSRM) was utilized. This assisted in the design process as the framework was being developed. Data from existing trait model research was used and expanded on to determine the required elements for the framework.

How can a framework that is used to accommodate players of differing trait orientations be effectively implemented and evaluated?
The implementation used in this research involved three artificial intelligence agents that exhibited different behaviours based on their trait orientations. This implementation was used to play through the elements defined in the framework. The evaluation of this framework came in the form of critically analysing the scenarios and behaviours of agents in the implemented environment.

Future Work
As this framework has been tested using agents that are modelled off human behaviours, the next step would be to test on human players to identify that they perform in a similar manner. Testing with humans would require methods of measuring player behaviours and potential motivations in games, but this was outside the scope of the current project. Additionally, while each agent held a single trait orientation, human players contain all three traits with different weightings which means that an agent would need to have weighted values in all three traits in future research.

Acknowledgements

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Stochastic weather modelling to generate rain, snowfall and wind

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Abstract
Within the past decade development and quality of weather phenomena in virtual environments has rapidly increased. However, there is a lack of documented framework to create a dynamic and optimized weather system suitable for real-time environment. This research is a critical inquiry of current research and the implementation required to create such a weather system in real-time. In this research a dynamic weather model was created using different weather component generation techniques such as Particle emission, Markov chains, Cellular Automata, Tri-Planar projection and Depth mapping. The weather model was designed and tested through the design science research methodology to ensure functionality. This framework can be easily integrated into existing real-time engines.

Keywords
Weather Simulation, Immersion, Virtual environment, Rain, Snow, Dynamic weather, Design Research Science, Cellular automata, Markov chain.

Introduction
The advancements made in real-time graphics and computer processing power has caused an explosion of visual standards within digital entertainment. This can be seen in the newest games as they strive for an ever-higher level of photorealism. However, as characters and environments within these games continue to increase in its level of realism it is becoming apparent that the development of weather simulation within these environments is falling behind. Often being unchanged as developers focus on parts of the game that will have more apparent impact on its quality.

Weather is one of the most powerful realism building mechanisms for environments in open world games. Weather is an astoundingly complex natural phenomena that currently cannot be completely mimicked [5]. As such it requires a variety of skills, knowledge and understanding to create a model that not only looks real but feels real. Realistically depicting weather events such as thunderstorms, wind, moving clouds and their intensities would help support the idea of the game world being a living, breathing, dynamic space [5]. A convincingly realistic weather simulation requires a variety of weather types with the ability to transition between weather types. These dynamic changes must be able to transition both naturally

and through inputs from the developers to allow for a single model's usage in both the open world and cinematic cutscenes. The time and cost of developing not only the weather model but alternative textures of all objects in the game world essentially doubles both the scope and production cost of any game. This scope and expense are further exacerbated by companies desire to keep their developments secret, leading to a requirement for each individual company to invest into research and development. However, this lack of common knowledge limits development to companies that can afford the cost or time, meaning smaller less well funded companies generally create less developed models that contain only a few or one component of weather. Through research and analysis of weather model techniques and case studies of contemporary video games, this project plans to prototype a model capable of simulating spatial weather events within a virtual environment in real-time.

Related work
Realistic physically based rendering of rain is expensive to compute, and the more common use of particle effects can look unrealistic [11]. A new method intended for a real time environment was proposed by Rousseau et al. [11] in 'Realistic real-time rain rendering'. This new method proposes a hybrid of the two rendering methods, which provides realistic reflections and refractions by generating a refraction texture based on what the player's camera is rendering. Rousseau et al.'s method is less expensive than current physically based rendering systems and gives a highly realistic visual result. However, the findings are currently rather limited as the method was built for a specific rendering system and is acknowledged to have no collision and a unified speed [11]. These reflective and refractive methods can be translated to a more generalised particle system that has already resolved these issues and is usable with an accurate collision system. Merging this rendering method with White's research may allow for a more visually realistic particle system while retaining the accuracy of a physically based particle system.

The next factor that greatly affects the realism of rain is how it moves within the environment. 'Stochastic motion - motion under the influence of wind presents a wind simulation model based on a stochastic process and physically based modelling' [17]. This model uses a cascade system of three components: Wind model, dynamic model and deformation model. The most important part of this paper is the wind model which uses formulas to produce spatio-temporal wind velocity fields using the power spectrum and autocorrelation of wind [17]. Although not every engine currently supports

such algorithms to generate dynamic 3d vector fields, the formula can be interpreted for generating static 2d directional vector fields instead. Static vector fields are more commonly used as generating, simulating and updating a dynamic vector velocity field is greatly more expensive for a similar effect.

Within Shinya & Fournier's paper the authors note that wind influences all objects, but that this is not constant and instead increases and decreases in intensity over time. The authors suggest that this can be mimicked with a harmonic oscillator in which the strength of the wind influence oscillates over time. Along with this oscillation, how much the wind influences each object is based on that object's weight and flexibility, so different characteristics should be created or some form of weighting system implemented to allow for a more realistic visual result.

In total Shinya & Fournier's paper [17] considers almost every relevant characteristic of wind simulation that should be considered for my model and includes algorithms and formulas that solve any possible problems at the time. It is important for this research to continuously return to this paper to ensure all components of realistic wind simulation and its influence on rain and snow is considered before continuing.

Particle collisions are likely the most expensive component of any particle system, calculating the position and collision data of thousands of objects every frame can quickly become costly. The second issue with particle collision detection is that most engines e.g. Unity and Unreal cull collision detection for objects that cannot be seen in order to increase performance. This can cause particles that seem to 'phase' through roofs into obviously covered areas.

A solution for this can be found in 'Distance fields for rapid collision detection in physically based [6]. A distance field is a mathematical function which gives, for each point X of a given space, the distance between X and the object being rendered. Distance fields can be used in a variety of ways ranging from improved image rendering approximation methods to AI navigation. The usage of distance fields in collision detection was highly accurate but inefficient to use in large environments due to the distance field being rebuilt as objects move around. Distance fields for rapid collision detection in physically based modelling [6] proposes the usage of Signed distance fields and the generation of mesh specialised for these distance fields, allowing for an accurate and efficient method in the simulation of physically based models.

Signed distance functions by themselves would eventually become taxing if not for the papers proposed method of baking the equations into a form of distance field mesh at the launch of the engine. By baking the equations into a mesh, the engine is no longer required to recalculate constantly allowing for accurate simulation without the normal rendering cost. By only calculating the particle collisions against one large mesh instead of many complicated smaller collision mesh, computation requirements are lessened, and the engine has the ability to simulate collision with objects outside of the cameras rendering view, solving the issue of particles 'phasing' through walls.

Although accurate motion and collision detection is important for realistic weather, rain and snow loses all realism once it encounters and does not interact with a surface. Rainfall at a distance can and will be immersive but sight is only one sense, if the rain does not make a noise it will not feel solid, similarly, if the rain does not affect surfaces in the way we assume it would (puddles and splashes for example) then the rain loses the feeling of touch, if we cannot see it make contact then we will not believe it can. Unlike other components of weather simulation, this cannot be solved with a singular process and instead requires a large array of primary and secondary effects to ensure a realistic environment that both looks and feels alive.

The complex stormy environment "Toyshop" [4] created by ATI to showcase the rendering power of graphics cards is the perfect example of possible phenomena a rainstorm can create as it soaks the environment. Along with this visual demo a presentation was conducted outlining all the features and actions required to reach this level of visual fidelity. Natalya Tatarchuk's 'Advanced Real-Time Rendering in 3D Graphics and Games' [15] focusing around rain and surface effects; she presented why the methods and design decisions chosen were best to suit the stormy urban environment.

Natalya presents a list of atmospheric physical phenomenon required to create a highly realistic wet environment, the primary ones of interest for this paper being; strong rainfall, raindrop splashes, reflections in surface materials, water streaming off objects and puddles with water ripples on the streets [15]. These effects can occur in almost any environment in the real world and are the next steps to fully realistic weather in a real-time environment.

A very interesting component used in "Toyshop" is water streak generation on glass windows. 'Animation of water droplets moving down a surface' The source provided by the "Toyshop" paper proposes a method of procedurally generating a water streak texture using a set of rules to influence the direction it moves in. e.g. gravity, object movement, wind and if any area is already wet. This method uses a lattice of cells, if a cell has a water droplet in it then it can move one of eight directions depending on the rules it must follow.

The ability to procedurally generate water streak textures gives the virtual environment a unique appearance every time and lessens any obvious repetition that often ruins immersion for many people. This paper has a unique streak generation method that is similar to Cellular automata which could be used instead with the information given from this paper to create a more efficient streak generation method. Cellular automaton or CA for short is a grid of finite state cells that change their states depending on the states of their neighbours according to a set of rules. All cells change their state at the same time using the same update rule. Through a series of very simple rules, highly complex images and events can be created.

Tri-planar projection is useful for repeating patterns and environmental effects such as rain splatter and streaks on static objects. This repetition of water splatter on the ground often goes unnoticed due to the visual noise of rainfall and

other moving objects. This repetitiveness is more noticeable on walls or moving objects as walls are less affected by perspective angles and water that is not affected by motion is very noticeable as its movement does not match that of its environment. Due to this, a layering of the static tri-planar method with a more dynamic water streak method for high detail objects or objects in motion is suggested.

Tri-planar mapping or projection mapping is a method of 'projecting' a texture or image onto a surface from three orthogonal planes: X, Y and Z. The textures are oriented using world space position and the objects normal direction. This method is often used for large scale environments that are too large to accurately unwrap and texture in the normal method. 'Procedural terrain' [3] uses triplanar mapping to address this exact issue. This research procedurally generates a never-ending environment with marching cubes. Generation of geometry through this makes it impossible to unwrap. Within this paper is a detailed pseudocode example of the process they used to implement the texture projection, along with examples of how slopes can affect how the textures are rendered. Through Triplanar projection textures are projected into the environment from a specified angle and is not locked to the position of objects in the environment. Textures through this method are projected at the correct angles but does not check what surface it is being projected on.

Projected textures must be able to decide what surfaces they are projected onto. This is because a surface undercover should not become wet if it is physically impossible for water to realistically reach that surface. Cover textures are generated through a method of top down shadow generation "Perspective shadow maps: care and feeding" [8] suggests a process of real-time dynamic shadow generation. This book suggests a multitude of ways in which to generate real time shadows. The method of interest is called a light camera. The first process is a depth camera viewing from the same position of the normal camera. This camera renders everything as black and white and projects this onto a texture. This black and white texture is projected into the environment as a type of shadow texture. A similar method to this could be recreated from the surface of objects up.

This literature review identifies a situation in which many of the components of real-time weather are researched and tested in depth as separate entities. However, these components are yet to be developed as a complete framework. Therefore, this research will develop a framework to design and implement a dynamic simulation system that combines different components of real-time weather such as sunshine, rain and snow in a 3d real-time environment. Therefore this research will incorporate the following techniques. Particle effects, Stochastic vector velocity processes, surface raindrop generation, 2d matrixes and surface raindrop generation. Through the combination of these systems, this research will provide a framework of dynamic weather simulation in real-time for 3d real-time environments.

Prototyping and Evaluation

In this section we will be covering the practical design of the components covered in Chapter3. The design process first started with a comprehensive review of the literature surrounding the relevant fields of research. This was done to find specific gaps and most importantly, proposed solutions if any. This investigation was essential in generating the foundation of this research and continued to play an important role in the direction of the creation process. This step is crucial as it demonstrates how the methods and techniques from the previous chapter are implemented into a real-time engine to make a working prototype and through this, allow us to test the designed framework.

Figure 1 Three weather states with all components implemented

As can be seen above in figure 1, all components from the previous chapter were implemented along the guidelines of the original framework design. This figure showcases the desired environment result of the completed framework. The methods and techniques used are all shown within these three weather states. All three weather states are selected using the markov chain state selection algorithm. Sunshine (left most) is a default dry environment which is the most common in real-time environments, this environment does not contain any visual components of the framework. Rainfall (centre) showcases rain particle emission which is part of the particle emission component. Rain particles can be difficult to see, Figure 2 showcases the same image with the particles highlighted in red. The rainfall state also showcases water accumulation and puddle placement which are utilise tri-planar projection and is part of the surface effects component. Finally, this image showcases cover detection which is part of the cover mapping component, this component is highlighted in figure 2 in blue. The final state, Snowfall (Right most image) showcases highly visible snow particles which clearly showcases the signed distance collision component.
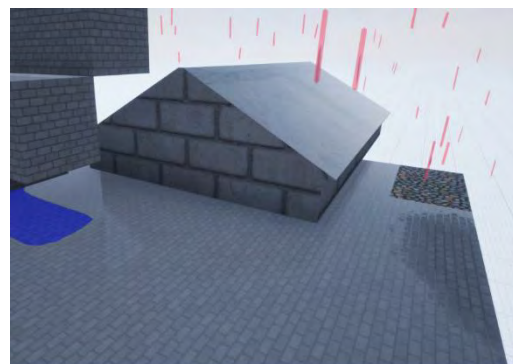

Figure 2 Rain particles highlighted in red and cover detection in blue

Markov Chain

The possible weather states are put into an array and ordered by descending probability. A random number is rolled, the resulting number is compared to the probabilities, picking the

state that matches this number. Probabilities of each state is affected by what state is active, any manual overrides chosen by the designer to allow for location-based weather. Finally, a probability decay is set for the currently active weather state. This decay is applied each time the random number is rolled and reset when a weather state different to the current one is chosen. This primarily to ensure a weather state is not chosen too many times without a different weather state being chosen. This weather probability decay is useful while the model has only a few weather states, as the amount of possible weather states increases this will be used less and less but its functionality will not negatively affect the model overall.

Below is the pseudocode example of the Markov weather selection function. The weather is selected with a random number between 0%-100%. For example if there is two weather states and one has a probability of 40% then the other has a probability of 60%. If the random number is less than 60% then state two is picked or if it is above state one is chosen. Since probability is not in descending order the first function required is a sorting function to sort the weather states. Descending order means the largest number is first, this ordering was chosen to make it easier for users to debug any possible issues.

Table 1 Markov array sorting algorithm

Let; S represent the current state; O represent the original array; N represent the new sorted array; M represents the transition matrix currently in use; T represents the number to add to the new array

Procedure SortArray(S, M)

If S ∈ M **Then**

    O ← transition probabilities associated with S

    For each O in S **do** //where O represents the amo of probabilities in the original array

        T = **max** O //find the largest probability in

        N(i) = T

        i++

        remove **max** O //remove the largest probability from the original array and loop

        If O > 1 **continue** //loops until original array is empty

        Break

Return N

Table 2 Markov algorithm

Let; S represent the current state; N represents the next state; M represents the transition matrix currently in use; T represents the current and previous probabilities added together

Procedure MarkovChain(S)

If S ∈ M **then**

    R ← transition probabilities associated with S

    P ← randomly generated float between 0-1 inclusive

    For each R in S **do** //where R represents the amount of probabilities

        T = T + R(i)

        If P ≤ T **then**

        N = S(i)

Return N

Wind

Wind direction is dictated as a 360-degree angle input. This angle is then converted into a X, Y directional output to dictate the direction particles should go. In this case 0 and 360 both point towards north, and every 90 degrees is a cardinal axis east, south, west respectively. The degrees are converted to a radian number. This allows the original number to be used as a x, y vector velocity input that is required for particle motion directions. The degrees to radians is a simple algorithm.

$$X° \, x \, \pi \div 180° = Y2\,\pi\,rad \ = \ Y\,rad$$

The radian result must be converted into a x and y strength or direction. For example, 0 y and 1 x moves upwards and a 0y -1x moves down. This is done through a Sin conversion for the X axis and Cos for the Y Axis. This conversion gives each axis a range from -1 to 1 or two units. The strength of the wind is a float intensity that multiplies the velocity range results. The algorithm is as follows:

Let X represent the X axis; Y represent the Y axis; D represent degrees; R represent the radian result; I represent intensity

Procedure WindDirection(D)

    D ← inclusive float input between 0-360

    R = D * π/180

    X = Sin(R Rad) X I

    Y = Cos(R Rad) x I

    Return X, Y

//Radians to directional input multiplied by intensity

The strength of the wind is chosen at the first initialisation of the current weather and is changed each time the weather state is updated. The intensity of wind should fluctuate constantly, and more intense weather generally coincides with stronger winds. To simulate the random fluctuations of wind a superposition of three sine waves is used. Three waves is the minimum amount needed to generate a semi-random appearance wind. The amplitude of the sine wave is increased by a quarter of the wind intensity to simulate the increase of fluctuation that occurs with stronger winds. The formula is as follows

$$y(t) = (A \times (I \div 4)) \sin Pt$$

Where A is the amplitude, I is the Intensity and P is the period in time. Finally each of the sinewaves are added together to have them function at the same time. The three Sinewaves used are as follows.

F(x) = 1.2 sin 3.3x, G(x) = 1.7 sin 1x, H(x) = 2 sin -1.8x

Particle Emission

Figure 3 Rain in motion (Left) Rain without motion (Right)

Rain and snowfall are simulated through particle emission. Due to the low cost to use, these particles are spawned through a large emitter located within the scene. The appearance of rain is difficult to replicate accurately as rain in real life appears to be streaks. The rain particles without motion are rendered as transparent spheres that refract light around the edges at a refraction rate of 1.33 at the edge and 1 at the centre. As can be seen in figure 8 and 9 particles are then stretched in relation to their speed to simulate the visible stretching effect. Snow however, moves at a slower speed

and has a solid colour, it is easier to create realistic looking snow particles.

Table 4 Particle scaling algorithm

Let H represent the particles vertical scale; V represent Velocity in m/s; O represent Original scale; M represent maximum vertical scale

Procedure VelocityStretch

    If V > 0 **and** V < M **Then**

    H = O * V

    Return H

Particle Collision

Particle collision utilises an in engine signed distance field mesh generation algorithm. This algorithm calculates the position of every surface within the environment and stores this information within engine. The in-engine process generates the signed distance mesh at the same time as baking static lighting.

Puddle placement

Puddles are generated through a reflective material shader function, with a liquid level variable that works in tandem with the world wetness variable that dictates the overall wetness of the world. Puddles are placed using a tiled noise map texture that is set to world position allowing for rapid seamless puddle placement. The generated puddles are further modified through a deformation texture that is unique to each texture type. This deformation texture dictates cracks, gaps and low areas that water is more likely to form in instead of sitting uniformly despite the rendered height of an object.

Window Water streaks

Water streaks on a window is more visually apparent than on non-transparent surfaces as such they are required to be of a higher quality to general water streak textures on non-transparent surfaces. This is a common issue found in other real-time games in which low quality water effects damage the environment immersion quality. It is not computationally efficient to generate a new texture every frame render as this would cause drastic bottlenecking that would result in constant freezes. These textures are generated beforehand through a separate program and stored as an array of textures within the engine to be selected for rendering during rain events.

Table 5 Cellular automata algorithm

Let G represent the Image grid size; X represent the pixel X size; Y represent the pixel Y size; S represent random placement seed; F represent the pixel fill percentage; NMap represent the newly generated map

Procedure CellularAutomataWindowPlacement (G)

    S ← Random hash code number seed 1000 in length

    X = G

    Y = G

    For i < X

    For i < Y

      If S.next < F //.next is next int in hashcode

        Map(X,Y) = 1 //Map (X,Y) is the pixel location on the image

        Else

        Map(X,Y) = 0

Return Map //Returns the populated image where 1 is white and 0 is black

Procedure IterateTexture(Map, G, X, Y, NMap)

    For i < X

    For i < Y

      If Map(X,Y) = 1

        If Map(X − 1, Y − 1) = 0 **and** Map(X,Y -1) = 1 **and** Map(X + 1, Y -1) = 0

        Rule1()

        If Map(X, Y − 1) = 1 //same as above and statements

        Rule2()

        If Map(X + 1, Y − 1) = 1 //same and statements for others (= 0)

        Rule 3()

        Else

        Rule1()

    If i = Y // at the end of the loop apply changes to original texture

    Map = NMap

The three rules used for this algorithm follow a weighted probability based on the location of the previous cell above. As can be seen in the algorithm above active cells check one cell above themselves and to the left and right of the above cell. Depending on which cell is active, one of three rules are chosen. If there are no filled cells above then rule one is chosen instead. The rules are simple, Rule one means there are no cells above or the previous cell is directly above, this rule gives a heightened probability to continue going directly downwards and a equal chance of going left or right. Rule 2 is used if the above cell is to the left, this indicates that the water is drifting to the right, this rule gives a higher probability to continue this rightward drift and slight chance to go straight down. Rule 3 is the inverse of rule 2 as it drifts leftward instead.

Cover map generation

Cover detection maps are currently generated through an in-engine process called 'DistanceToNearestSurface' which is an automated version of Z-depth testing. This process was chosen as it is more efficient to use a pre-made engine specialised process instead of creating a whole new process from scratch.

The non-engine specific process for this which is likely to function similarly is either a depth test shader which is essentially the same process. The second process that will work similarly is a depth camera texture which is generated from above, if the object is not at the same height as the texture height then the water effect is not rendered, which is essentially the same process. Although this is a simple effect, once compiled with tri-planar projection and cellular automata it becomes visually complex.

Evaluation

The experimental environment in the following screenshots contains just over one hundred objects of primitive shapes and a large high detail terrain. This environment maintained a constant 59.9 frames per second (fps) while limited to a maximum of 60. Draw calls maintained an average of 1.99 ms without ever going above 2.1, with no correlation between the active weather and cost to rendering. This shows that this weather model has a low cost to environments. Sixty frames was chosen as the limit as it is currently considered the standard frame rate for most real-time games.

Figure 5 shows a section of the test environment while the

Figure 5 Dry environment

weather state is sunny. The environment includes: A default reflective wall which is premade within the engine, a sloped surface which includes a slight overhang and a large floor area for water to accumulate on.

Figure 4 Wet environment

Figure 4 shows the same section as the previous figure but during an active wet weather state. Water splash effects can be seen on the sloped surface and puddles are visible on the floor. The puddles are formed semi randomly and are affected by cracks and elevation on the surface. Finally, rain

particles are seen falling from the sky. The water splash effect colour has been changed to a more obvious colour for visibility for this image.

Figure 6 Puddle formation on plain surface

Figure 6 shows the puddle formation on a flat plain white surface, without deformation. All puddles follow the same base generation method meaning any connecting objects with different textures will have the same overall shape of the puddle. The puddle is then offset by any deformations and heights within the model.

The results are visible from the implementation of the various components in the previous section. This is also illustrated by the figures shown in this chapter. This project was successful in the implementation of the simulation model and its respective components into the Unreal engine completely. Furthermore, this project was successful in the implementation of the 'detachable component' design method, meaning that although each component shares variables they can and will function independently. This allows for the addition of new components without affecting the functionality of the original model. Each component was successfully created albeit with some minor changes to ensure efficiency. By documenting and analysing the implementation and function of each component, we were able to demonstrate its functionality.

Performance comparison

The purpose of this comparison is to discover if this proposed simulation model is functional and just as efficient to previous models. This model is considered to have succeeded if it performs similar to or better than reviewed research models in more than one category.

This this weather simulation model consistently stays within a range of 59 – 60 frames per second (fps). It is important to note that this frame-rate test was performed with two tests and limited to a maximum of 60 fps, the first test was an isolated environment with a single flat surface for the surface effects. This is to measure how much processing power was required for the weather model without other objects being rendered. The second test was in the populated environment in which an environment was constructed with various simple and complex objects to test shader intensity and particle collision accuracy. 60 fps was chosen as the limit as it is currently the most dominant frame rate for console systems and the chosen limit for most PC games.

When these tests were conducted again without a limit on the framerate, the framerate constantly stayed within the 190-210 range averaging at around 198-205. This was tested on a computer with a NVIDIA GeForce GTX 1070 and 16 GB of ram. There was no noticeable framerate changes during any of the weather states or the intensity of said states. This likely shows that particle count in this model does not have a high

computation cost while below 80,000 particles. Within the figure below the average cost and framerate is shown within the unreal engine. The framerate of this model compared to other models is lower but as more particles are spawned this model's framerate remains stable and close to the original framework before the addition of more particles. Other models such as the one created by Rousseau et al. [12] lowers by 17 frames with the introduction of 10,000 more particles. Stability, even at a lower framerate can be considered better than an unstable model.

Below is table 6 which is a framerate comparison between this research's model and three other models. This research's model most closely resembles Anna Puig's model in particle count and research intent of efficiency and Rousseau's in framerate. As can be seen within the table this model is outperformed by all others in framerate at their intended particle count amount, when every model is using the same particle amount of 100,000 this models framerate lowers by an average of 6 while Anna Puig's lowers by 50 and Rousseau's by 17. This indicates a model that is more stable in comparison to other models but requires more optimisation to reach the higher framerate of other models.

Table 6 Comparison of framerate performance

Model	Rousseau et al. (2006)	Sarah Tariq (2007)	Anna Puig (2009)	This model
Number of particles	90,000	150,000	50,000	50,000
Frames per second (FPS)	219	290	457	201
Frames per second at 100,000 particles	202	333	359	195

The completely unique feature of this model is the weather selection and probability method through a markov chain. Of the other papers reviewed they either lacked a selection method or the method was simply on or off. Furthermore this is likely unique of games as the most common method appears to be randomised chance with static probability such as Skyrim or Fallout [13].

The particle count is one of the most compared components of weather models. This is because particles are generally the most expensive to compute aspects. This model has a maximum of 50,000 particles putting it in the middle range of reviewed models.

This model has accurate particle collision through a signed distance mesh that is generated at the same time as lighting. The stored static mesh is a very low-cost collision mesh that appears unique in comparison to the reviewed models.

Dynamic oscillating wind that is implemented in this model is unique in that its intensity oscillates and direction is variable. In comparison most, papers reviewed had static wind

direction and intensity or in the case of Rain [14] a global intensity slider.

In overview this comparison has shown that this model has many unique features and improvements to previous models that can be quickly implemented into future models or real-time environments. These improvements have many possible future improvement paths available and due to the component structure of this model they can be implemented quickly and easily.

Conclusion

This research has found a unique weather selection method using a markov chain that functions with statically accurate, randomised and manual inputs. Along with the selection method a framework for wet weather and dynamic wind simulation has been created. During this creation process, it was found that these components compliment themselves well and improve efficiency as many variables can overlap. Due to these overlapping variables it has been found that expansion in the way of more weather types or function of most variables.

This research has opened further areas of development including but not limited to: more advanced rain simulation techniques, Secondary snow effects such as dynamic accumulation and window frosting or various other weather type effects, more advanced weather probability algorithms that can more accurately simulate real life weather probability, Dynamic wind simulation that takes obstacles into account.

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Inside the Spark: Pondering Sudden Insight and Songwriting, Yesterday and Today

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Abstract

Songwriting is typically an art form resulting in three or four minutes of sonic, structured – sometimes poetic - time. Songs typically take hours, days or even years to compose. Paul McCartney's *Yesterday* – at least its melody – was conceived in a dream, fully formed. It seemed to have spontaneously appeared from the ether in a state of relative completeness.

This practice-based, self-study explores the creation of a new song - *Nothing Is Everything* - composed in real-time in just three and a half minutes. It explores theories of creativity and the nature of insight regarding songs and evaluates fast, compared to slow-form creations. The use of everyday technology to capture the spark of creativity is also discussed and the original artefact compared to the refined master is considered.

Keywords

songwriting

song

creativity

insight

Yesterday

Introduction

> It was the only song I ever dreamed.

Paul McCartney's *Yesterday* is the most recorded song in history. It is particularly famous for its origin story - a song created in a dream.

Some songs that sound like they were penned in just five minutes actually were. The Beastie Boys' *(You Gotta) Fight For Your Right (To Party)* is such a song [1]. But *Yesterday*'s melody is inspired in its structure. Its chords are sophisticated in its harmonic twists and turns and its lyrics are sad but not saccharine. McCartney has described *Yesterday* as the "most complete song I have ever written".

Yet, according to McCartney, he awoke with a fully-formed melody in his head. "I have no idea how I wrote that. I just woke up one morning and it was in my head. I didn't believe it for about two weeks" [1].

The melody is remarkable in its structure.

Figure 1 – Yesterday's melody is constructed of just two melodic cells.

A simple downward tone supports the opening lyric *Yes-ter-day* – cell A. Then a rising major scale supports the lyric, *All my trou-bles seemed so*… but with a yearning minor 6th alteration on the *so* – cell B. A simple downward melodic cell returns on *far a-way* which resembles cell A, but is transposed up a 6th and in rhythmic augmentation – cell A^1. Next, the upward scale of the second melodic cell is inverted into a mirrored descending variation *Now it looks as though they're*… - *cell B^1*. The first motif then returns in another variation on *here to stay* – *cell A^2*. Then two small variations of the downward tone idea occur for *Oh I be-lieve*, A^3 followed by a return to the initial *Ye-ster-day*, but this time rising in inversion – $A^{4.}$ J.S. Bach would have been proud.

While this elegantly structured melody arrived in a dream, the harmony and lyrics did not; the original title was *Scrambled Eggs* and the finished song was not recorded for a year and a half after its melodic inception. Still, it seems miraculous that such a melody could appear out of nowhere. Yet, *Yesterday*'s composition conforms to a number of well-established theories of creativity.

Rational Miracles

A groundbreaking theory of creativity ascribed to British social psychologist, Graham Wallas [2] proposed four specific stages of the creative process:

- *preparation*, the acquisition of both skills and knowledge;

- *incubation*, a period of conscious and unconscious processing;

- *illumination*, the unforced *lightbulb moment* of inspiration, (which cannot occur without preparation and incubation); and

- *verification*, a conscious stage of testing for validity and acceptance

Yesterday subscribes perfectly to Wallas's four stages.

McCartney's father was a working musician and the young Paul grew up in a world of jazz standards and Broadway show tunes. By the time he penned *Yesterday* McCartney had been a professional musician himself for many years. He possessed both the requisite skills and knowledge to write the song, and a lifetime to ponder, both consciously and unconsciously, the intricacies of pitch and form that make great song melodies. And so, unwittingly, McCartney had completed phase one and two of Wallas's stages of creativity – *preparation* and *incubation*.

The *illumination* – the dreamed melody and the frantic waking moments to capture its fleeting form - have been well accounted by McCartney himself, as well as the *verification* phase.

> So first of all I checked this melody out, and people said to me, 'No, it's lovely, and I'm sure it's all yours.' It took me a little while to allow myself to claim it, but then like a prospector I finally staked my claim; stuck a little sign on it and said, 'Okay, it's mine!' It had no words. I used to call it 'Scrambled Eggs' [3]

Yesterday also ascribes to Mihaly Csikszentmihalyi's *systems model of creativity*. And so, despite "'Yesterday's promotion as a Romantic piece of creative activity, perpetuating the myth of the mystically inspired freely expressive artist, the creation of 'Yesterday' can be seen as a more considered and rational process than otherwise mythologised" [4]

The *systems model of creativity* advocates a different approach to Wallas's. Instead of exploring and defining it from the individual point of view – exploring the *what* of creativity - Csikszentmihalyi suggests the exploration of the *where*. He espouses the consideration of the dynamic interaction of "a system composed of three elements: a culture that contains symbolic rules, a person who brings novelty into the domain, and a field of experts who recognize and validate the innovation" [5].

Viewing *Yesterday* as an interaction between *individual, domain* – place, people and time – and the *field* of study, again the creation of the song seems more rational and somewhat less remarkable. From the Csikszentmihalyi perspective, *Yesterday* is as much about the culture and society of the early 1960s, McCartney's own songwriting peer group and a society willing to accept his work, as it is about McCartney himself – his mental processes and psychology.

Nothing Is Everything
On December 8, 2017, Paul McCartney played Brisbane. I had been an ardent Beatles fan since childhood; playing Beatles songs on the guitar and piano since the age of twelve and songwriting since thirteen. My career is based on composition, songwriting and recording and The Beatles were the catalyst.

I awoke miserable. Why had I not purchased tickets to this once in a lifetime event? I called my sister and we lamented this dreadful oversight. After hanging up I went straight to

the piano, routinely turned on the smartphone's record function, and played. In 3 minutes and twenty five seconds the essence of a new song was captured in its entirety: melody, lyrics and harmony - **Version 1 .**

By the 12th of December the lyrics had been disseminated into their final version and the song was recorded as **Demo 1.** This demo contrasted the verse sung in first person with second person, but this idea was discarded in favour of a simple repetition of the lyrics. A further demo was recorded the following day. **Demo 2**

Nothing Is Everything
Nowhere. No time is more than who I am
Right now. Right here. Right here. Right now
Nobody makes me, completes me
I am a whole thing. I am my everything
All alone. I'm all alone in this world. In this universe
There is nothing there. There is no one but me
There is nothing greener. There is nothing better
There is no place I'm meant to be
There is no one who's made for me
But me but me

It was only once listening to the improvised lyrics that I realised they were reactions to a sound installation I had produced six months earlier for a series of paintings entitled *Everything is Everything* by Chris Worfold.

Figure 2 – The invitation to the *Everything is Everything* exhibition by Chris Worfold [6]

At the time, the creation of a fast song felt supernatural, but in retrospect rationality takes hold. In terms of the interconnections between the proposed stages of both Wallas and Csikszentmihalyi, *Nothing Is Everything* - like *Yesterday* - is explainable.

In terms of Wallas's preparation stage, the skills and knowledge - the music theory and songcraft required to

write such a song - were well practiced and ingrained at the time of the song's creation. In terms of incubation, the ideas inherent in the song had been unconsciously simmering for six months. I remember pondering Buddhist concepts during and for some time after the exhibition. The cultural domain had an effect also, both in terms of the novelty and appeal of the Buddhist temple in which the exhibition took place, and the meditative state its structure and its spaces for meditation induced. Even the title of the exhibition, *Everything is Everything*, gently persuaded deep meditation.

If *Everything is Everything then Nothing Is Everything and Everything is Nothing. Etcetera.*

Through the stresses and throwaway meaninglessness of life in a modern capitalist society the contemplation of nothingness has great appeal. And so, from Csikszentmihalyi's systems view of creativity, this new song also held sway.
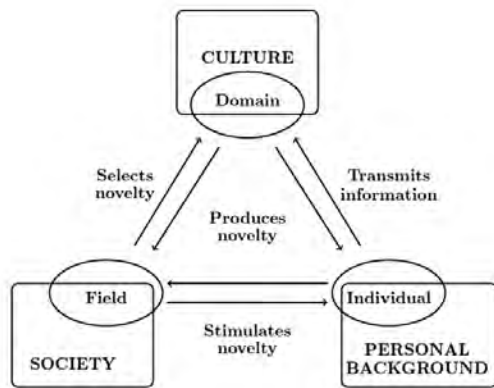

Figure 3 – A systems view of creativity [6]

Sudden Insight

Even so, in terms of Wallas's stages, the moment of illumination - of *sudden insight* - remains profound and inexplicable. Sudden insight is defined "as a new idea or perspective that is novel to the person and pops into awareness suddenly" [7]

Nothing Is Everything was totally improvised – chords, words, melody - not unlike a jazz solo. Jazz can be seen as an art form consisting of constant streams of insight. All the knowledge and training of many years comes together in a series of fluid moments of exquisite illumination.

Yet the links between these illuminations and the preceding period of preparation and incubation are aligned, with recent studies involving electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), which explain these as a "culmination of a series of brain states and processes operating at different time scales" [7].

Distraction and Sleep

It has been demonstrated that change of brain states, in particular, taking breaks, improves performance in problem solving tasks [8] [9] The Segal study also suggests the duration of the break is less significant than the break itself,

with problem solving participants improving as well with 4 minutes as a 12-minute break.

The idea of changing the brain state, particularly through taking breaks, showers, walking or resting is common practice when problem solving and creating. There is even the suggestion that the brain itself takes a short break – a *brain blink* - before a moment of epiphany [7].

The common suggestion to *sleep on a problem* - is validated by evidence that sleep produces sudden insights with regards to problem solving tasks. Sleep aids with the formation of new combinations from disparate associations [10] with REM sleep promoting "neocortical structures to reorganize associative hierarchies, in which information from the hippocampus would be reinterpreted in relation to previous semantic representations or nodes" [11].

Sleep was at the heart of the creation of *Yesterday*. McCartney awoke and dashed immediately to the piano to capture the fleeting notes of the melody [12]. *Nothing Is Everything, on the other hand,* was produced not through a state of dreaming, but through a state of melancholia.

Melancholy and Creativity

Aristotle first propounded a link between creativity and melancholia; "that all men who have attained excellence in philosophy, in poetry, in art and in politics, even Socrates and Plato, had a melancholic *habitus*; indeed some suffered even from melancholic disease." [13]. By the Romantic era the miserable artist was *de riguers*.

While positive moods have been consistently demonstrated enhancing creativity [14] negative affects have also been shown to instill the creative state [15]. In particular, some recent studies have demonstrated interesting correlations between melancholy and creativity. Negative moods inspired by miserable weather have been shown to improve focus and memory accuracy [16].

Likewise, the initial version of *Nothing Is Everything*, recorded in the melancholic moment of its creation, reflects an intensity of focus and a conjuring of subconscious six-month-old memories and thoughts.

Another study [17] explored the effect of negativity on persuasive messages and social influence strategies. Results demonstrated that participants in a negative mood were more effective at conveying persuasive messages and social influence than positive counterparts.

The lyrics of *Nothing Is Everything* convey a persuasive message effectively. The lyrics are sparse, devoid of conventional songlike structures, yet haiku-like in their concise meaning. Despite their poetry they are easily understood.

The nature of melancholy – its sweet sadness – is both positive and simultaneously negative. Unlike depression, which is debilitating, the melancholy state suits the meditative, silent focus required of creativity. Personally, I find melancholia the ultimate creative state. I associate with the argument that melancholia is its own aesthetic *emotion* [18]. Melancholia is my muse and I am not alone.

> Besides my other numerous circle of acquaintances I have one more intimate confidant - my melancholy. In the midst of my joy, in the midst of my work, she waves

to me, calls me to one side, even though physically I stay put. My melancholy is the most faithful mistress I have known, what wonder then, that I love her in return. (Kierkegaard) [18]

The Original Artifact

It took a year and a half for McCartney's *Yesterday* to mature from a dreamed-up melody into a fully produced recording replete with string quartet. But technology nowadays allows songwriters not only to record the moments of a song's birth with the convenience of smart phone technology, to refine it ad nauseum using the editing ease of the Digital Audio Workstation (DAW) and create a professionally produced master recording on a laptop in just days. Fast songwriting and rapid production bring the original artifact and the completed master closer together, so that the final *Nothing Is Everything* remains satisfyingly authentic to its source. The Beatles Anthology 2 recordings (1996) include Take 1 of McCartney's *Yesterday,* which although similar to the final released version – even without the string quartet – is different; "remarkable for [its] jarring stylistic divergences from the final versions" [19]. Perhaps this divergence is closer or truer to the original instances of the song.

The final version of *Nothing Is Everything* is different but not necessarily better than the original. The immediacy and rawness of the original artifact has value. It is perhaps more precious than the refined and edited final version. It is not uncommon nowadays for songwriters to blog their songwriting, allowing fans to follow the journey of a song from conception to inception through to maturity. Music fans of the present are blessed. What would we give to hear the moment McCartney - straight from dreaming - first struck out the notes of *Yesterday* on the piano at Jane Asher's house in Wimpole Street, London, November 1963?

I am finally pleased to say that on a wet December evening, 2017, a happy songwriter and his sister did indeed weep tears of joy – not melancholy - at that Brisbane McCartney concert.

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Painting's Facture and its Digital Translation

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Abstract

Analogue painting is a form of chirographic picture making which is indexical to the artist's gesture. Photo imaging technologies are commonly used to reproduce paintings, representing them as digital images. However, this reproduction process results in the loss of painting's material facture. In this sense digital images are not reproductions of analogue paintings rather they are tokens for them. Increasingly audiences are experiencing paintings indirectly via token digital images, where the uniqueness of the sensory encounter with a painting's facture; its mark making, materials and scale, is removed. This paper investigates the discourse surrounding the digitisation of analogue painting and identifies attempts to digitally translate painting's material facture.

Keywords

Art, analogue, painting, facture, process, material, digital, imaging, sensory, index, translation.

Introduction

> It would be folly to try to say in just what, exactly, the enduring fascination of painting resides. I will offer only one suggestion. Paintings quasi-miraculous mode of existence is produced, I believe, by its mode of facture. (Hennessy, 1979, p. 23)

Analogue painting - implies that a painting is physical, that it is manually produced, and that it refers pictorially in some way to something else, e.g. an object, a scene, an emotional state, etc. This understanding of analogue painting is congruent with analogue being defined as, "a physical object… used to measure or represent another quantity" ("Analogue," n.d.). At the heart of this understanding are the terms physical and manual, which underpin the concept of facture. "Facture refers to the way a thing is made… an artist's handling of medium, the brushstroke, how materials are worked descriptively and expressively" (Zurier, 2009, p. 29). Facture is intrinsic to the aesthetic experience of art as a manual act of production, in that it fuses gesture with image and allows for our attention to shift between artistic process and pictorial representation. Although facture can be identified

as the definitive characteristic of analogue painting, it has often been overlooked in Art historical discourse. (Freedburg & Gallese 2007, p. 198-199).

David Rosand protests this historical neglect, asking, "Must we dissociate the mimetic impulse of the stroke from its self-expression? Or can we in fact legitimately claim meaning for the brushwork itself?" (1981, p.94-95). Freedburg & Gallese, answer in the affirmative and validate the legitimacy of facture. They adopt neuroscientific research addressing empathic sensorimotor activity and its connection to emotion to conclude that the visible traces of artistic gesture in painting, "forms a substantial part of the experience of the artwork" (2007, p. 199).

Maurice Merleau-Ponty (2005), is one of the few 20th century philosophers who advocates for an emotive embodied state in the consideration paintings. In his discussion of Cezanne's work he pays close attention to the aesthetic consequences of physical involvement with the paintings and articulates that bodily felt imitation is implied by paintings' facture. Barry Gazzard also affirms this position, offering that, "surface materiality not only changes the way a painter works but also has a profound influence on the reception of the work" (1999, p.5). He suggests that paintings surface conveys a haptic quality which merges vision with tactility and allows us to attend to it both as an image and as an object (1999, p.5).

This quality of facture has been integral to the progression of modern art, with David Joeslitz asserting that, "painting from Impressionism onward represents a spirited investigation into how marks, or gestures, occupy the space between subjects and objects, or between persons and things" (2016, p. 169). He posits that the task of modern painting, both historically and philosophically, has been to reconsider the relationship between our objective perception and its subjective expression.

Chirographic > Technographic

Göran Sonesson expands on this, offering that in general, there are two ways to create a picture: the first, *chirographic*, made with a hand held tool that places a physical mark on a physical surface and the second being *technographic*, e.g. photography, film, computer graphics etc. (1999, p. 7). Employing Charles Sanders Peirce's semiotic concepts of index: a trace left behind by the referent itself (1999, p. 8), he attends that with a chirographic picture the physical marks are always indexical of the maker's gesture, and with analogue photography and film the photographic negative is considered to have an indexical relationship with the scene photographed or filmed. However, with computer graphics he notes, there is no clear index, no raw or direct source, rather computer graphics are digital constructions or reconstructions which form an image rather than a picture. He acknowledges that tools like digital stylises and image manipulation programs make chirographic techniques available in digital media (1999, p. 7), though as all media converge into digital platforms then all reliable indexes are displaced. Anne-

Marie Willis has also described this when she said, "with digitised photo-imagery… the index will be erased as the photo becomes pure iconicity… digitisation reverses the history of imaging technologies and takes photography back to the ontology of the infinitely manipulable medium of painting" (1990, p. 201-2).

Without index and therefore without facture, which is materially evident only in chirographic media, the concept of a picture as a fixed image/object may become redundant leaving us only with images per se. Gregory Currie conveys that the removal of facture is intrinsic to technographic media, "with photography there is a lack of interest in the relation between surface marks… and the things depicted… There is nothing noteworthy or aesthetically informative about this because it is achieved automatically" (2016, 30:03). Additionally he offers, in the case of film images, "when things move we attend to what moves, namely people and other moving objects. Static images impose less of a cognitive load on us… movement of objects makes that distribution of attention harder" (2016, 34:15). Thus he proposes that our attention to facture in film and even in hand drawn animation is diminished when compared to static pictures.

Certainly current digital media platforms, "strive for seamless, transparent representation of the real" (Bolter, 2006, p. 110). The goal of transparency being, "to efface the technologies and techniques of representation and to place the viewer in an apparently unmediated relationship to the objects or events represented" (Bolter, 2006, p. 110). However, in digital media there can be no "real", nor any real pictures, if we consider a picture to be an image/object, instead we have devices that offer the endless repetition, variety and iteration of images.

In Alaena Turner's review of Tate curator, Alan Godfrey's exhibition, *Painting After Technology* (2015), she suggests that, "if we are to follow Godfrey's assertion that… paintings are significant… we must take into account the specific scale, the sensory encounter with material, and the layering of mark-making, responding to the uniqueness of visual experience that is on offer" (2015, para. 11). In contrast a significant proportion of our contemporary lives are spent looking at digital devices which scale, flatten and homogenise visual experience onto screens. This poses the potential risk that our cultural and sensory acuity to facture will become diminished. (2015, para. 12)

Digital Immateriality
The non-transference of index and material facture to convergent digital media platforms is of key concern to painters today. Jason Hoelscher (2014) suggests that similar to the computer's evolution from mainframe to cloud, "painting today is undergoing an ontological drift from one mode of existence to another - from… canvas to networked, painterly immateriality" (p. 1). He warns that, "painting today risks obsolescence unless it addresses its position relative to virtualization within complex adaptive networks" (p. 1).

Walter Benjamin in his seminal essay, *The Work of Art in the Age of Mechanical Reproduction*, introduces "aura" as the unique, authentic and specific qualities of an artwork. Aura is based on the work's individual historical production and direct transmission which he proposes evokes an attitude of reverence in the viewer. He suggests that

artefacts that can be reproduced automatically and arbitrarily forfeit any sense of aura (2010, p. 3). Thus unlike traditional painting and sculpture - photography, film, digital imaging and even 3D printing, "do not inspire such feelings of reverence and remoteness, because they are technologies that reproduce their objects of representation 'automatically' " (Bolter, MacIntyre, Gandy, & Schweitzer, 2006, p. 25). Benjamin ultimately equates this loss of aura with a loss of culture (2010, p. 3). However this influential equation is now being contested in the 21st century. Martens, Mark, & Cheng (2006) explain,

There is grit, irregularity, imperfect construction, the imprint of the human hand, those elements that give a place character. Yet, (p. 372)… the bridge between digital and physical or analog modelling is a continual transformative act… where distinctions are at best fuzzy, and boundaries are often transgressed (p. 373)… We intermingle analog with digital to enrich not only the final artifact but to enrich the act of making. (p. 376)

As an advocate for expanded painting, David Joesiltz suggests that Benjamin's assumption that mechanical reproduction represents an absolute loss is outdated. "One could say… contra Benjamin, that it is saturation through mass circulation - the status of being everywhere at once rather than belonging to a single place - that now produces value for and through images… In place of aura, there is buzz" (2013, p. 18-19). However, he acknowledges that when a painting is translated into a networked digital image it is subject to inherent dislocation and probable degradation and fragmentation (2009, p. 134).

"In this age, material and digital experience are in an unprecedented state of coexistence, our understanding of the physical is being endlessly reshaped… Consequently, the very meaning of physicality and its apparent importance to us has become subject to questioning" (Knight, 2012, para.2). This questioning of the physical and the normalising of digitally hybridised experience has direct implications for analogue painting practice. Emma Bee Bernstein advises that, "the successful art of this… age will reflect on its own practice in relation to the past… Such reflection must involve an acknowledgement of the medium specific practices that are being replaced or combined" (n.d.). With Michael Stubbs further questioning whether we could, "re-define painting as sliding across and through the interstitial space of computer representation? Is there a relationship between this interstitial space and the fleshiness of the body and painting's materiality?" (2003, p.63).

Digital Translations
Over a hundred years ago, Vincent van Gogh, influenced by Uykio'e prints, addressed seriality in painting, making multiple repetitions of his own, [Sunflowers](1888-89), paintings. Van Gogh, the quintessential artist is of relevance because of his unique painting facture, his process of producing variations (repetitions) of his own work and his interpretations (copies) of the works of others. In the 1960's Warhol took these process further producing his infamous silk-screened flower "paintings" based on a "found" photographic image. He continued this critique with his, [Do It Yourself (Flowers)](1962), paintings based on amateur colour-by-number exercises. Warhol questioned notions of authorship, originality, reproduction, context, and temporality. His peer, Roy Lichtenstein, also extended this

critique to encompass the authenticity of the indexical painterly gesture itself in his, *Brushstrokes* (1965), paintings. This modernist questioning of painting, its indexicality and its technological translation has since been continued by many contemporary artists.

Internationally renowned painter David Hockney, has been questioning painting and experimenting with optical, photographic and digital imaging technologies throughout his career. Like van Gogh, in his practice he often produces iterative variations of paintings around a particular motif, habitually pursuing photographic reconstructions and digital variations of the same motif. Hockney's entire oeuvre can be framed as a practice led inquiry into the influence and interconnection between painting and technology (Sullivan, 2002).

However, beyond artists of Hockney's stature there are also numerous contemporary artists that can offer specific insight into the confluence of the analogue painting and its digital translation. Artie Vierkant's appropriately titled, *Image Objects* (2011 - present), are a series of works which begin as "painted" and manipulated digital images which are then printed onto dibond to form planar sculptures and which are then converted back into digital images in a potentially endless iterative cycle. In, *Sunflowers* (2013), Rob and Nick Carter, successfully translated the form and facture of Vincent van Gogh's famous painting, *Sunflowers* (1888), into a virtual 3D model which they then 3D printed, and ultimately cast in a traditional foundry processes iterating the work as a 1:1 bronze sculpture. In doing this they paved the way for artists to start conceiving of their work as transferable image/object data that can be represented in different media forms. In, *Starry Night for Mom* (2014), Gretchen Andrew, a former Google Glass employee, documented her process of painting a version of Vincent van Gogh's, *Starry Night* (1889). She used Google Glasses to record her point of view, whilst also being documented by collaborator Kyle Trainor. The resulting video draws attention to the differences in production, context and reception of drawing, painting, digital photography and video.

Del Kathryn Barton collaborated with director Brandon Fletcher to translate her paintings into an animated short film, in, *Oscar Wilde's The Nightingale and the Rose* (2015). Using both traditional stop motion and 3D digital animation processes Barton's paintings were deconstructed and remediated to form a new work derived directly from her paintings. And in a similar cycle of iterative technological expansion, Vick Wang remediated and animated, Italian Jesuit missionary, Giuseppe Castiglione's paintings in, *A Tour of the Imperial Garden* (2016). In this instance the animation is slow and atmospheric, emerging in dissolves from the background, creating a hypnotic and immersive experience rather than constructing a restricted viewing duration. Finally, in, *Dreams of Dalí* (2016) Salvador Dali's original work, *Archaeological Reminiscence of Millet's "Angelus"* (1933-35), was reimagined for the Dali Museum as a total navigable virtual reality (VR) environment. These works all highlight the influence of digital documentation, production and publication on painting and they point to the general trend of remediating painting practice as iterative digital design often with the extrapolation of 3D content based on textural 2D representation and surface.

There are also current practitioners exploring painting's combination with augmented reality (AR) technologies. Re+Public (Seiler, J. & Biermann, B.C.) have worked on a number of street art projects employing AR. Their collaboration with muralist MOMO, *Moto Wall: St. Louis* (2013), allowed viewers on location to walk around, in, and through the digital variations of this large scale painted mural in 3D space using a mobile augmented reality application (MARA). The mural was pre-planned and the colours and forms were all digitally 3D modelled and then painted in situ. In contrast to this process, painter Heather Day recently collaborated with Facebook Camera (2017), to photograph and video her paint facture and pouring techniques. This content was then collaged, animated and overlayed onto the architecture of Facebook's head office using AR, which formed an integral part of the brand's new product launch. Nancy Baker Cahill's, *4TH WALL AR APP* (2017), avoids animated content and employs panoramic photogrammetry allowing viewers to virtually walk through her LA studio in 360 AR environment in 1:1 scale from wherever they are. This overlay of virtual architectural space in AR as opposed to images, objects or animations is a different experience in kind and would seem to have significant potential for future applications.

Although van Gogh made painted repetitions and copies he rejected the use of technographic media (Rathbone, Elizabeth, Robinson, & Steele, 2013). When combined with the above review of contemporary artists this contradiction in van Gogh's practice provokes a key insight into the digital translation of analogue painting: principally that a painting's content needs to be artistically reinterpreted and expanded rather than simply digitally reproduced to generate aesthetically engaging content. This understanding seems to be tacitly acknowledged in many of the previously mentioned works including the works Rob and Nick Carter and Gretchen Andrew, which are explicitly referential to van Gogh.

Analogue/Digital practice

I was conscious of van Gogh's legacy in conducting my own practice led research into painting's facture and its digital translation. Embracing the clichéd genre of flower painting, I used a flowering weed as a motif in a series of works to investigate reciprocity between digital imaging and analogue painting. The paintings were executed as a series of collaged layers that increasingly emphasised the facture of the paint. Initially I produced a range of analogue drawings and digital photographs of the motif. However these were abandoned and instead I purposely chose a creative commons digital image (photograph), which was then manipulated and hybridized with a sourced image of a van Gogh painting in Photoshop. It was then printed on paper, manually redrawn on paper, digitally photographed and overlayed using the SketchAR MARA and re-redrawn onto a used packing crate, which was then overpainted and re-redrawn again. This process was repeated on a second packing crate, though in this instance, instead of being painted it was collaged with the colour palette used for the first painting. Various painterly gestures were then splayed across the surface unifying the two paintings into a diptych. The diptych was then digitally photographed, retouched and manipulated and posted in various 'versions' on Instagram.

The resultant diptych and the accompanying drawings were exhibited in the Art Capital exhibition, in Paris at the Grand

Palais, February 14 - 18, 2018. The exhibition of this experimental, digitally self-reflexive work in this prestigious historical venue seemed ironic and a number of Instagram viewers questioned whether the work was actually being exhibited at the Grand Palais or whether it had been "Photoshopped" there.

Figure 1. Asper - Oil, acrylic and ink on board - 2 Panels each 71 x 57cm - 2017

Conclusions

In my production process I noted that personal analogue drawings felt the most "authentic". However digital imaging brought many conveniences, including immediate mimesis, duration and conventional social acceptance. This in turn raised a number of questions. Can images from secondary sources, even when manipulated and stylistically rendered be considered "authentic"? Has painting always been a form of post-production? Deleuze posited that, "painting is invaded and besieged by photographs and clichés that are already lodged on the canvas before the painter even begins to work" (Deleuze & Bacon, 2003, p.11). And Nicolas Bourriaud also posits that, "notions of originality (being at the origin of) and even of creation (making something from nothing) are slowly blurred in this new cultural landscape" (Bourriaud, Schneider, & Herman, 2002, p.12). If cultural "sharing" and postproduction in our image saturated culture is a given, then are analogue paintings now made primarily for reproduction? And if so what does this mean for the material processes involved in analogue painting? Where does paintings' facture sit?

These questions remain open areas of investigation. However through this research it became clear the personal digital technologies easily enable: "photographic" conversion of physical scenes / pictures / objects to digital images or 3D data files, open access to an abundance of digital images, manipulation of digital images, augmented overlay of digital images onto physical planes (eg canvas), and open publication / display of digital images. Manovich suggests this redefines images, "as a provisional composite of both content elements and various modification operations that are conceptually separate from these elements." (Manovich, 2013, p.142-3) With Tinnell proposing that, "layers of multimedia are primed for post-desktop circulation… As such, the modular logic of visual layering… will likely become transcoded as a preeminent cultural form" (2014, p.79).

My final conclusions are that: the ease, functionality, accessibility and acceptance of digital imaging all have impact on the creation, dissemination and consumption of analogue paintings; that current digital technology can represent but not embody painting's facture; and that digital technology may influence the layering of analogue painting and its facture. And finally it may become apparent that technographic digital media, do in fact have a new type of "immaterial" facture which remains transparent in practice and only emergent in research.

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