‘MAKING’ A STATEMENT

EXPLORATION OF 3D PRINTING
TECHNOLOGIES AS A FORM OF
CUSTOMISATION AND OWNERSHIP
IN URBAN SPACES

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ABSTRACT

Ownership of urban space has been heavily contested in recent years by prominent artists, policy-makers and citizens alike. From Shephard Fairey and his condemnation of corporate culture in public space, to Banksy and his use of imagery as a form of political activism, the presence of 2D media in urban environments has become increasingly relevant. This research summarises recent advances in our thinking about space and place, and seeks the potential opportunities for customisation and taking ownership of these spaces to create a socially engaging, collaborative environment for the creative city (Florida, 2003). By using street art and graffiti culture as a model for creative inclusivity, this research explores the effects of new forms of data collection and configuration and the design opportunities they present. In doing so, this research hopes to promote discussion and debate into how we may use new media such as 3D printing and computer-generated imagery to make provocative statements and elicit responses.

To explore 3D printing as a means of customising and taking ownership of space, this research identifies recurring themes in traditional 2D media, as well as manifestations of 3D and 4D media in urban spaces. This background research is documented in a taxonomy of precedents combined with a technology review and observational research in the field. This background research provides a context for researching through design in the form of iterative physical experimentation and reflection. Beginning with abstract experimentation, the first stage of testing digital making technologies identifies opportunities provided by different software, materials, scanning and 3D printing itself, at all different scales and resolutions. This active process of making also tests the visual languages and aesthetics afforded by the technologies, particularly parametric modelling techniques as well as low resolution models with new visual qualities. By applying the knowledge gained from the abstract experimentation and observational research, different issues surrounding the urban context are identified and responded to using 3D technologies. These responses are carefully articulated to ensure that they are not only 'of the street' but also 'of the technology' and thereby serve as examples of 'making meaning' through 3D media in an urban context.

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TABLE OF CONTENTS

Abstract	5
Acknowledgements	7
Introduction	11
Thesis Overview	13
Chapter 1: Background Research	15
Literature Review	16
Taxonomy of Precedents	24
Chapter 2: Methodology	35
Chapter 3: Abstract Experiments	39
Introduction	41
Design Process	42
Findings	62
Chapter 4: Making with Meaning	65
Introduction	69
Scenario 1: What have we lost?	68
Scenario 2: Public Endangerment	76
Scenario 3: Confrontational Begging	82
Scenario 4: Play	94

Conclusion	103
Conclusion	104
Further Research	105
Works Cited	109
List of Figures	112
Appendix	114

INTRODUCTION

There is something intriguing in changing the way people think about somewhere or something, in a way that is either relatable or engaging. By creating shock, awe, curiosity and concern through discovery, we are able to give passers-by cause to stop and think about an issue that they may not otherwise register or be subjected to. Traditionally, this has been achieved using 2-dimensional forms of imagery, information, and sometimes a combination of the two. This research draws on my interest in the cultures of both graffiti and street art as a form of provocation through customisation, most notably in an urban context. Using the city of Wellington and its built environment as an example, this potential has been realised by creating location-specific 3D printed objects that serve as forms of expression or points of debate.

THESIS OVERVIEW

What new design opportunities does 3D printing offer as a way of customising and taking ownership of urban space?

Chapter 1 - Background Research. This section will be dedicated to providing an extensive overview of where the different fields of this research are situated as well as specific examples of these via a taxonomy of precedents and literature review

Chapter 2 – Methodology. This section details the methods of enquiry for this thesis and the theoretical grounding behind them.

Chapter 3 – Abstract Experiments. This section comprises of mostly discussion and analysis of initial experiments with 3D printing/scanning technology.

Chapter 4 – Making with Meaning. This section discusses the speculative scenarios developed that showcase the potential for 3D printed media in an urban environment.

1

BACKGROUND RESEARCH

LITERATURE REVIEW

Introduction

The purpose of this literature review is to develop a comprehensive understanding of the issues surrounding the customisation and taking ownership of urban space. In doing so, this research will investigate the practice of both graffiti and street art in a variety of contexts, to establish a firm knowledge on the difference between the two and how they influence the ways in which we interact and gather information from space. Following the same thread, this inquiry will discuss the difference between space and place, how humans may possibly lay claim to space to create a place and how social engagement with the urban environment can be encouraged by the notion of the creative city. This research will examine historical and existing public policies relating to artistic interventions in a number of settings across the world, predominantly focusing on New Zealand local governments, in an attempt to establish a potential framework for encouraging expression and identity within the city landscape. This investigation will continue by exploring the opportunities citizens may have to create their own brand and/or following through the strategic use of practices similar to advertising and other commercial initiatives in conjunction with the ethics and/or values portrayed by graffiti and street art culture. Finally, this research will examine the potential for 3D technologies to present information and create interventions that effect the way we interpret and communicate in public spaces. By also looking at the opportunities provided by 3D printing and its accompanying technologies relevant to this study, this investigation aims to provide a scope for scenario development in creating objects that are highly customised and encourage active engagement with the urban environment beyond the existing traditional 2D media in graffiti and street art.

Graffiti and Street Art: Origins and Differences

The origins of graffiti culture are attributed to 1970's New York, USA, as a means of creating a shared and inclusive space for visual expression (Dickinson, 2008). This 'cultural practice' aimed to "disrupt the existing image of white-collar New York by tagging subway trains" in an attempt to broadcast their message or identity to different locations all over the city (p.34). Though Dickinson (2008) discusses the effects of the developing graffiti epidemic in correlation with ethnic and social divides as part of a reconstruction of a 'neoliberal capital', he does touch on some key factors relating to the practice. Dickinson (2008) describes graffiti as a response to the "privatisation of the public sphere in the service of capital accumulation" (p.28). At this point in time, graffiti was establishing itself as a form of political protest, laying claim to space that the constituents believed was rightfully theirs to re-appropriate. Youths were showcasing their presence with tags sprawled over subway trains, which, either inadvertently or intentionally, struck at the image of a New York that pandered to the wants and needs of white-collar professionals (Dickinson, 2008). Banet-Weiser (2012) continues this by saying "historical manifestations critiqued local, state and federal policies to advocate for public space liberated from profit-driven commerce" (p.98). As a result of the process of critiquing these

policies for a number of years, Jeff Ferrell (1995) states that contemporary graffiti writing at the time was transformed and fuelled by the isolation and control of social spaces. Graffiti would eventually find itself defining alternatives to these arrangements, constructing systems of social status and identity through artists' writings.

Street art, though driven by similar values or ethics, has established itself as a successor of modern graffiti birthed 30 years prior. Graffiti and street art are both facilitated by a struggle to understand the meaning of public space 'and the role of creative production within the tangle of commerce, economics and racial identity' (Banet-Weiser, 2012, p.102). Also driven by a protest against the legitimisation of advertising in public spaces, street art aims to act as a vehicle where artistic expression of emotions or ideas can be achieved in the face of oppression, no matter how it manifests (Alpaslan, 2012). An example of this can be found in the work of Shephard Fairey and his 'OBEY' campaign. With its humble beginnings in 1989 by a series of stickers, Fairey's objective was founded on the premise of encouraging civilians to be more aware of their surroundings and how they are being put to use. "OBEY is about variety and experience, thinking about your surroundings and questioning the purpose. The medium is the message" (Obey, n.d.).

"People have always felt the need to share and express themselves in a public way, sometimes by telling a story or posing a question, many times by presenting a political ideology" (Visconti, Sherry, Borghini, Anderson, 2010). Another prolific artist, Banksy, is recognised for his stencilled style, but most notably his political commentary (Banet-Weiser, 2012). Banksy's mission has been to shed light on a variety of contemporary global issues from homophobia to war and violence. To achieve this, a lot of his work depends on the environment that the artwork is situated in to be a driving factor. For example: one of Banksy's most famous works are nine images painted on the Palestinian side of the wall surrounding the West Bank, one of which is an image of a young girl being lifted into the air by a collection of balloons, as if she was about to fly over the wall. This example leads to the defining aspect of street art; that its meaning is severely compromised once it is removed from its original setting (Riggle, 2010). Riggle (2010) continues by claiming that there is a material requirement for street art, that it must use the 'street' as an artistic resource, and that this use must be "internal to its significance" (p.246).

One might have assumed that graffiti (heavily associated with hip-hop culture) and street art (seen as a similar act of rebellion) had no real difference in function or purpose, however this research has found that this is not the case. Graffiti was in no doubt a precursor to the contemporary street art practice we see today, although as Riggle (2010) explains, that does not mean that all graffiti is writing on a surface. "Not only can graffiti be street art, but it can be very good street art," and its meaning can still be dependent on its creative use of the street (Riggle, 2010, p.251). Put simply, graffiti entails a general use of a public surface, mainly for publicity, whereas an intentional use of specific features of public space defines street art. Driven by a need to convey a message or an idea, street art encourages social engagement and civic participation. In the next section, this research examines the possibilities of using street art as a model for the re-appropriation and reclamation of space.

Social Engagement in the Creative City

Before continuing, it is important to establish a general understanding of a space versus a place, how that differentiation is made, and how that effects social interaction within either environment. Space is associated with the 'anonymity' of the environment, however, a place is defined by the meaningful experiences of that site (Visconti et al., 2010). According to Edward Relph (as cited in Visconti et al., 2010, p.512), "places are fusions of human and natural order and are the significant centres of our immediate experiences of the world". Ciolfi and Bannon (2005) continue this thread by saying, "places both constrain and enable us: they offer us structural, cultural, social clues that shape our conduct; and our actions and interactions within that place add to its meaning and value" (p.222). Relating this back to street art and public interventions, Borghini, Visconti, Anderson, and Sherry (2010) discuss street art as being a "vision of space re-appropriated as place, where commercially noisy or entirely silent streets are reclaimed by artist for their proper 'owners'" (p.113). With this information we can deduce that a space can be transformed into a place by simple human interventions, creating a layer of social and cultural interaction that add to the value and meaning of that space.

Visconti, Sherry, Borghini, Anderson. (2010) put forth the notion that goods (even space) become public goods when a collective of citizens claim to have ownership of those goods (p.526). Ferrell (1995) determined that the hip-hop graffiti of the time disrupted a methodical system of authority and reclaimed public space for those that felt excluded from it. Whether this was because of local governmental pressure or the commodification of that space by consumer advertising, artists who felt disenfranchised by this decided to reclaim the city by "adapting visual artwork into a format which utilises public space" (Alpaslan, 2012, p.53). This in turn, developed into a relationship where artists obtained the power to influence the aesthetics of the city with their work (Burnham, 2010). Here we can see that the contemporary practice of street art holds those similar values as graffiti artists in the late 20th century, establishing a culture of 'creative socialism' that denies hierarchies and induces communal values (Borghini et al., 2010, p.123). Claiming space as a collective good instead of a private commodity helps create a socially inclusive environment for expression and creative intervention. Furthermore, a city that can be augmented and reimagined as the public saw fit would help advertise that city as being open to all manners of creative input.

The idea of the creative city is a heavily discussed topic within recent years, notably because of the rapid growth of street art. By engaging with the city's messaging system (Irvine, 2010), replying, responding and engaging with the city is now a form of civic participation. Because people value input more from their peers as opposed to corporate culture (Crang & Graham, 2007), citizens are starting to challenge the "rules of engagement between the individual and the city" (Burnham, 2010, p.139). Changing the way people interact with their city environment is allowing for a new form of urban art that is progressively moving towards open source urban design. As a result, the creative city is in the middle of a hacking culture manifesting itself in urban interventions (Burnham, 2010). Alison Young (2010), who was appointed by the Melbourne City Council to develop a draft strategy for graffiti management in the city, recognised that graffiti writers and street artists' work adds cultural value to the city. Young (2010) asserts that "cities are sites of intense cultural and aesthetic production, engaged in a continual process through which they develop and refine their self-image" (p.99). Thus, it is in a city's best interests to cultivate and nurture this image of being a creative hub. Having an image based on loose networks allows for newcomers, promoting innovation with new resources

and ideas (Florida, 2003), and street art interventions can help the building of direct social interactions and “cement connections among city inhabitants” (Visconti et al., 2010, p.520). In summary, creating a place from a space can help build social ties to that environment through interaction. Creating a place that is associated with a certain cultural or social order changes the way people interact with each other in that space. Claiming space through artistic interventions helps promote communal values by using the space as a collective good, to be shaped and re-interpreted for expressing an identity or idea. In this section, the literature points towards opportunities for creative cities to market themselves as socially and culturally inclusive. Though this is already happening across the world, especially locally in Wellington, New Zealand, changing the restrictions regarding public space could help cultivate a creative culture of socially and environmentally engaged citizens. This next section will examine historical and current attempts at policing both graffiti and street art, to help inform a potential restructuring of local policy and laws.

Public Policies and Permission

Going back to New York, even to this day, some groups’ efforts to beautify or utilise public space are policed and criminalised because of their war on graffiti (Dickinson, 2008). This message that they are not allowed to have a say or an influence on the aesthetics of the city that they live in, contradicts itself when the same imagery will be used for commercial purposes. Similarly, Young (2010) points out the flaws in the current governance of urban space; stating “it is crucial to ask why graffiti and street art presents such a challenge to the territorialisation of urban space into a zone of intolerance and exceptionality that has become so paramount to the self-definition of the contemporary city” (p.113). By questioning the ‘authority of authorities,’ Young (2010) dreams of a community founded on communication, proposing that until such a community arrives we should look to the graffiti writers and street artists making use of what Dickens (as cited in Young, 2010, p.113) calls the ‘in-between’ spaces. After drafting this proposal and forwarding it to the Melbourne City Council, she was surprised to hear that nothing had come of it. To her surprise, the initiative was scrapped but at the same time Tourism Victoria (Visit Victoria, n.d.) were still using street art for a lot of its own advertising. Banet-Weiser (2012) proposes that street artists should be challenging corporate and governmental efforts to contain and control creativity (p.116).

The easiest way to explain the differentiation between vandalism and sanctioned artwork in public or private spaces, is that of permission. The city of Melbourne claims that “we recognise and celebrate street art as an important part of our vibrant urban culture. The difference between graffiti and street art is determined by the permission of the property owner” (City of Melbourne, n.d., para. 1). In this case, the city of Melbourne also create their own definition of what is graffiti and what is street art, that being permission. Though this may be an incorrect interpretation, based on previous discussion, it does draw a definitive line through what is acceptable and what is not in the council’s eyes. Kramer (2010) sheds light on a subset of artists that have been working around these restrictions as early as 1989, stating that “a portion of writers have focused exclusively on the production of legal graffiti” (p.243). Kramer (2010) also believes that most graffiti writers he studied, based in New York, did not seek out financial rewards as a result of their work. Instead, the artists would prefer to gain “mutual recognition from their peers, most of whom will view the work on the Internet or perhaps in magazines after it has been documented” (p.243).

After looking into the issue of legality in cities like Melbourne and New York, it is clear that similar tactics are emerging in the control and policing of both graffiti and street art in other urban centres. As Kramer (2010) states “writing culture cannot be reduced to a singular entity united through a shared disregard for the law” (p.249). Although he is strictly discussing graffiti writing, the same can be said for street art in all forms. This showcases an opportunity to decriminalise or re-evaluate how public/private space is used in relation to the laws of local government. Already, by working within these boundaries and shunning material gains for their work, some artists are producing an interesting dichotomy between the authentic and the commercial. In the next section this research will look into the possibilities of using the urban environment to create a brand and/or a following.

Commercialisation and Branding Creativity

The rapid growth and embedding of street art into popular culture has created a common interest between advertising and commercial or non-commercial street art (Borghini et al, 2010). This shared aim of ‘elaborating communication structures that inform and persuade their audiences’ (p.114) has a positive impact on both fields. For both cases, broadcasting a message to a wide audience is the primary goal, the publics’ reaction to that message is where the two differ. For the artist, ideally, their message would hope to provoke a proactive response; for the advertiser, their message would hope to provoke a purchase or an investment of time or money. However, in a world where commercial entities are no longer able to hide their commercial motivations, the consumers’ question of authenticity will soon focus on that brands ability to contribute as a cultural resource (Holt, 2002). This is where artists are starting to adapt similar tactics to advertising, to essentially advertise their brands by creating a ‘counter-brand’ that “critiques and rejects the increasing privatisation of city resources and shrinking public spaces” (Banet-Weiser, 2010, p.110). Using the same examples earlier of Banksy, and Shephard Fairey, these brands intentionally attack how capitalist societies are using public spaces by packaging their creativity for world-wide art consumers in the form of savvy wordplay and distinctive image styles (Banet-Weiser, 2010).

In the case of Banksy, Banet-Weiser (2012) describes his practice as “political and arguably subversive. His work challenges hegemonic institutions such as the military and state practices, exposes hypocrisy in advertising and marketing, and questions the fundamental premises of advanced capitalism. Yet while he critiques the world of advertising and branding – calling such practices ‘brandalism’ – he is clearly a brand in and of himself” (p.94). Chasing notoriety and hiding behind a nickname was the basis for Banksy’s practice and still is to this day. On the other hand, people like Shephard Fairey are using their nickname as a tool for branding and choose to operate in the open, taking part in debates and being involved in the public sphere, turning their outdoor practice into a commercial business (Visconti et al., 2010).

In both examples, and in countless others, street art has started to permeate the dignified galleries of contemporary art. Loeffler (2012) explains that “graffiti in its original appearance did not engage in commodity activities. In its purest sense it was neither financed by the private industry nor was it state-sponsored public art. This concept underwent drastic changes with the current market value of graffiti and street art. Inside and outside zones have become blurred” (p.71). Because a market value is now being associated with these public interventions, what was once a subversive mode of communication, is now being legitimised in the eyes of the elite (Dickinson, 2008). Banksy began as somewhat of a prankster, quickly become a nuisance to the

art world but now his works are being protected by local and state institutions because they are in such high demand by collectors (Irvine, 2010). Even though their works are being displayed in high regard, some artists do still feel that they may face consequences as a result. “With the commercialization of street art, in most cases, even with legally exhibited art, the artists tend to choose anonymity” (Alpaslan, 2012, p.53). This could also be because of the looming threat that they will be personally criticised by other artists, as many will view using a specific style and choosing to profit from it as morally wrong (Kramer, 2008).

In short, creating a brand from your own creativity can have both negative and positive effects, depending on your intention. Choosing to act under the veil of anonymity provides the opportunity to speak openly and freely, however that may manifest. Doing so in the full view of the public eye can instead bring you a lot of scrutiny, but this may be a part of the brand that you want to portray, not being afraid to speak out about the issues you see in the world. This section discussed the possibilities of branding creativity in the hope of presenting it to a wide audience, in some cases this is in direct conflict with the notion that the placement of the art is paramount to its meaning – once removed from the street, its context is no longer in play (Riggle, 2010). In the next section this investigation will continue by discussing the opportunities afforded by new technologies surrounding 3D printing and online virtual communities, and the potential this may have to disrupt existing social etiquettes surrounding street art.

3D Technologies and the Information Age

Exponential growth in the 3D printing industry, especially at the consumer/civic level (Wohlers & Caffrey, 2014), has and is continuing to promote innovation and creativity by giving the opportunity to design and customise to the general population. With 278,000 desktop 3D printers (under \$5000) sold in 2015 (Wohlers, Caffrey, Campbell, 2016), we can assume that a good portion of these were purchased by solo enthusiasts eager to bring their ideas to life. Ratto and Ree (2012) state that virtual communities are now being established online that “make the outsourcing of 3D printing more accessible, streamlined, entrepreneurial and interactive” (para.17). By creating an environment that incorporates the idea of the machine shop with a social network, sites such as Shapeways (www.shapeways.com) and Thingiverse (www.thingiverse.com) are “bringing together thousands of Makers worldwide to share a virtual version of the collective studio or workshop space” (para.17). These new spaces for collaboration and fabrication are providing a sense of citizen empowerment, by granting the experience of making with others “through both receipt and dissemination of resources,” that can only be afforded by digital media (Ratto & Ree, para.20). The sharing of digital media is no longer merely a form of material exchange, but also a “site of social and cultural production, supporting new forms of social connection, the maintenance of social ties and identity expression” (Lindtner, Chen, Hayes & Dourish, 2011, p.2). These ‘co-creation’ platforms are also variants of “mass customization that afford prosumers the opportunity to interactively personalize products in such a way that encourages users to feel more like ‘designers’ of objects rather than passive recipients” (para. 23). The authors here posit that with the growth of rapid prototyping technologies like 3D printing, scanning and modelling, the idea of the consumer will change, giving the power to edit, reverse engineer and design your own products to the general population. Similarly, this also shines light on the potential avenues for personalising and customising the consumers own environments.

Taking the previous discussion into account, this poses the question; when we bring in the new information age and 3D digital technologies, what effect might they have on the way we interpret and communicate in spaces? Ciolfi and Bannon (2005) claim that “Design must now concern itself rather with the physical environments that people will experience through their daily lives. People will encounter technologically enhanced spaces and artefacts as they move through a variety of environments. These systems will change the way in which physical spaces are used and shaped by people. The activities of interacting with the space and its elements and interacting with the computer system will merge into each other” (p.217). Additionally, Crang and Graham (2007) ask “what happens to places and people in networked environments where small informational devices and data are brought together – repeatedly, in real-time, and automatically, through systems that sink into the urban background?” (p.790). Although the points made here are from roughly a decade ago, the idea of creating highly customised and interactive environments that promote social engagement, also discussed earlier, aligns itself very well in conjunction with 3D printing technologies and the ‘maker’ practice. Through the use of 3D printing and 3D scanning, with the help of interactive technologies, this may allow for an augmentation of an experiential world, where media adds to that environment as opposed to taking it over. By embedding technology into spaces and creating ‘coded space’ (Crang & Graham, 2007), this allows for a greater connection to be built between the wanderer and the spaces they move through, as well as the innovator and the places that they live in.

Conclusion

In conclusion, after examining graffiti and street art culture to establish a model for expression and engagement with the urban environment, this research highlights various opportunities for civic participation and collaboration to customise and claim urban space with the use of 3D technologies. By allowing the creative city to be treated as a collective ‘maker-space’, constituents may take the opportunity to express their ideas or philosophies in an attempt to promote cultural inclusivity, and add to the values and associations with a ‘space’, transforming it into a ‘place’. Traditional 2D media is limited in the amount of information it can convey, though ‘the picture is worth a thousand words,’ this research shows that the object acting in the third and possibly fourth dimension can deliver so much more on an interactive scale.

TAXONOMY OF PRECEDENTS

Figure 1.1: Invader – HK_19, Hong Kong, 2001.

Transforming a once unassuming public ‘space’ into a ‘place’ of meaningful experience (Visconti, Sherry, Borghini, & Anderson, 2010) can manifest itself in a variety of forms, materiality, tactility and interactivity. The intention behind the selected works discussed here may differ in motivation and potentially ideology, but they all seek to add some sort of extra ‘layer’ to an environment. These can range from simple surprise or delight from a visually contrasting intervention, through to more provocative and critical uses of space to convey a message or idea. This taxonomy collates selected artists and projects based on themes identified during the earlier literature review. A copy of this thought process can be found in Appendix.

Location-Oriented

As the name may suggest, Invader is an artist who has adopted a popular or easily understandable style, stemming from the 1978 Space Invaders arcade game for the Atari. The Parisian has treated his work similar to a game by embarking on a continued series of ‘missions’, whereby he ‘invades’ cities and installs multiple pieces made from mosaic tiles. The material of choice reflects the aesthetic of 8-bit pixellation, and are suited to the environment purely because the tiles are designed to be outdoors. With time Invader has applied other relatable characters from popular television series or games, in a way that coincides with his style and sometimes even the setting. Examples of this can be found in the invasions of London (Figure 1.2) and New York (Figure 1.3).

Figure 1.2: Invader – LDN-149, London, 2016.

Figure 1.3: Invader – NY-163, New York, 2015.

In a similar fashion, Portugal-born Alexandre Farto (Vhils) has gained popularity for drilling into plaster and brick to create relief portraits. These portraits usually hold some degree of social or cultural significance with the local area, commemorating people for their contributions and/or turning them into iconic figures. Using etching acid, bleach and pneumatic drills, Vhils has created a series of works that truly embeds someone into an environment permanently. By creating one-off unique pieces, these works are treated as memorabilia, helping define the space it inhabits.

Figure 1.4: Vhils - Serhiy Nigoyan portrait in Ukraine. Kiev, 2015.

As mentioned earlier, one of the more notorious contemporary street artists who still manages to garner headlines through his provocative statements, Banksy, operates under similar terms of engagement. His street art remains displayed all over the world, partly because of the reception it gets from news media as a subversive and satirical approach to political commentary (Banet-Weiser, 2012). One of his more notable works was sprayed on a wall inside the Calais refugee camp in 2015. The piece pictured the late Apple founder Steve Jobs, with an original apple computer, showcasing that one of the world's leading companies was founded by the son of a Syrian migrant. This example, and many others like it, aims to address attitudes towards an issue by using the surrounding environment as its context.

Figure 1.5: Banksy – Steve Jobs Mural, Calais, 2015.

Figure 1.6: Joshua Allen Harris - Air Bear Project, New York City, 2008

Parallel to the previous examples, Joshua Allen Harris created inflatable sculptures that came alive using the numerous air vents running above New York City's subway system. By using plastic bags discarded in the local area, Harris created a piece where the environment is clearly inherent to its significance (Riggle, 2010). At first the response was with joy at seeing a polar bear come alive and flutter in the breeze, but the effect of it deflating and slowly decaying back to its flat state conveyed another possible meaning. Polar bears are used as a symbol of the effects of climate change, thus the reliance on a public transport system to keep this sculpture 'alive', serves as cruel irony and a reminder to passers-by.

In a recent installation, State Street Global Advisors, a 'passive' fund manager of roughly \$2.5 trillion in assets, commissioned the artist Kristen Visbal to create an immediate and powerful response to the lack of diversity on the boards of various companies in the USA's financial district (McClean. B, 2017). Installed on the eve of International Women's Day 2017, the 'Fearless Girl' (Figure 1.7) was accompanied by letters sent to the 3500 companies in question, calling for them to take action and increase the diversity on their boards (McClean. B, 2017). Similar to the work of Banksy, this action accumulated a huge response from the public, so much so that the temporary nature of the work had been made permanent by local government to ensure it stands through to 2018.

Figure 1.7: Fearless Girl, New York City, 2017

Collaborative

Locally, the Napier City Council invited Pangeaseed (an international non-profit) to transform blank walls in the area as part of a global street art project. The Sea Walls program provides an opportunity to create understandable visual narratives that engage with the public in a non-aggressive manner (Pangeaseed, n.d.). By crossing representations of marine life with a potential harsh reality (Figure 1.8), the murals aim to raise issues such as pollution from plastics, overfishing, climate change and loss of habitat for marine life (Napier City Council, n.d.). Beginning in Napier in 2016 and returning in 2017, Pangeaseed take this project all over the world, involving local artists and volunteers to help spread their messages.

Figure 1.8: Sea Walls - Dside, Napier, 2016

Specifically in Wellington, there are a large number of instances where knitting enthusiasts have taken their craft to the urban environment and wrapped their handiwork around industrial structures. Usually popping up in the colder months of the year, 'Yarn Bombers' take to the city to warm up industrial structures such as park benches or handrails, but sometimes even other public works. This is an example of a practice that can be applied anywhere and is not specific to an exact location or environment because of the flexibility of the medium and the intent behind it.

Figure 1.9: Monster-footed, yarn bombed bench on Willis St, Wellington, 2015

Similarly, Jan Vormann's Dispatchwork involves using LEGO bricks to fill in broken down or missing structures in the urban environment. With an online map (<http://www.dispatchwork.info/>) a user can see installations from different cities, not dissimilar to Invader. This method of open-source repairing is an example of a project that takes online submissions from people all over the world as part of a collective project. By using easily accessible and iconic materials, anyone can mimic the style and become a participant in a global installation.

Technological

Although Vormann's Dispatchwork uses the internet to display and receive submissions from other would-be artists, a lot of the work is carried out himself as he travels the world, more than likely for this purpose. On the other hand, Tui Breweries (<http://www.tui.co.nz/competitions-and-events/yeah-right-gallery>) run a competition that strictly crowd-sources the taglines for their iconic billboard campaign. Using the public as a resource, Tui have created a competition that people genuinely want to be a part of because of its high prestige as iconic kiwi humour (Figure 1.11). There is a reward for the best monthly suggestion in the form of a bag made from a "Tui billboard skin", but the real prize is being able to say that you came up with this line and it's now on display to the rest of the country. You may not be famous or known for your efforts, but you are part of a long-standing tradition.

Sophie Kahn's work uses a combination of 3D laser scanning and printing to create fragmented sculptures that aim to "engage questions of time, history, vision, identity and the body." (Kahn. S, n.d.). The end result is not 3D printed, rather the technology is used to create moulds for metal or clay casting. But as she points out, the end product shows all the marks of the digital processes that it has encountered, digital faceting from the scanning and in some cases the print lines from fabrication (Figure 1.12). Kahn's work seeks to show the difficulty of capturing the moving human form to create a memory or representation of a moment in time. As Kahn describes the reasons behind her work, it becomes clear that the manifestations of this are rare and articulate in a way that steers them towards that of gallery or exhibition works.

The Zew (<http://thezew.com>) is a curation of 3D printed interventions in the city of Melbourne, but instances also appear in other parts of NSW and Victoria. Although this collection does contain pieces from other artists, the majority of the examples shown are recurring uses of the word 'ZEW' in a variety of fonts/colours. This is where the ideas of graffiti culture and 'getting your name out there' through repetition comes into play. By creating sometimes identical pieces that are recognisable, the artist(s) is creating a pattern through visual cues and the materiality/physicality of the 3D printed objects. The Zew consists of small scale FDM (Fused Deposition Modelling) prints, most likely because the artist(s) is using technology available to them at the time, as a lot of the images date back to as early as March 2013. The outputs clearly reflect the digital input and their process of creation, print lines and linear colour structures show how they were produced, albeit crudely fixed into place (Figure 1.14).

Figure 1.10: Jan Vormann *Dispatchwork* – W 12th Street, New York City, 2015

Figure 1.11: Tui Breweries Billboard, New Zealand, 2011

Figure 1.12: Sophie Kahn - Triple Portrait of E, 2014

Figure 1.14: The Zew, 2016

Figure 1.13: Sophie Kahn - L:Degrade, 2012

Figure 1.15: The Zew, 2016

Findings

Though I have attempted to group these examples into distinct categories for their primary traits or drivers, these examples all lend themselves to one another in different ways. I have found that these interventions can either be influenced by the surrounding area as a context, or can define that area because of the intervention alone. The environment being inherent to the pieces significance (Riggle, 2010) has been reaffirmed in some cases, but it is clear that this significance can be mimicked in other locations as part of a greater whole. This greater whole uses contemporary technology, and particularly the internet, as a resource for both collaboration and crowd-sourcing, turning the world or at least some parts of it into one big co-design project. How 3D printing technology weaves into this area of creating designed objects to elicit thought or debate, is still very much in its infancy. Tentative attempts have been made to use 3D printing to mimic the graffiti ethos and/or style, but being able to create immersive and potentially provocative 3D printed street art that is both 'of the street' and 'of the technology', remains elusive.

2

METHODOLOGY

M E T H O D O L O G Y

This thesis employs a combination of both action research and reflective practice. Archer (1995) describes action research as a calculated investigation carried out through practical experimentation, the goal being to communicate knowledge via testing new ideas in the real world (p. 11). Reflective practice is treated as a 'reflective conversation with the situation' where constraints are identified within a problem, attempts are made to reach a solution, and the results are constantly evaluated (Valkenburg & Dorst, 1998, p. 251). The 'tacit knowledge' (Friedman, 2008) gained through this process of inquiry helps to develop solutions to problems that were once only theoretically planned for, as part of the overarching method of research through design (Frankel & Racine, 2010).

The first phase of this research is to identify existing cultural, social, historical and theoretical contexts associated with traditional 2D media as a form of customising and claiming space. By also investigating emerging manifestations of 3D and 4D media in urban spaces, this results in an in-depth literature review and taxonomy of precedents, shown in the previous chapter.

From here, phase two involves designing and producing interventions (3D prints) as a model for demonstrating active engagement with the urban environment. Initial experimentation with 3D scanning and CAD modelling forms the basis for a review of the technology being used, and observational/field research will identify opportunities to provoke a response in the built environment. By employing research 'through' design as a method, abstract physical experimentation will test the intersection between 3D media and the built environment before moving into scenario development. In this final stage the research identifies and consolidates social issues to develop scenarios for 'making with meaning', and creating 3D printed objects as a response.

3

ABSTRACT EXPERIMENTS

ABSTRACT EXPERIMENTS

This next section is dedicated to documenting and discussing the initial experimentation with 3D scanning and printing technologies, to discover constraints or requirements for accuracy and efficient use of equipment before proceeding into more resolved experiments in the next chapter.

By exploring the city of Wellington as a local context for the built environment, this research will be influenced by my own observational or field research that locates suitable or interesting aspects of the built environment to be customised via 3D printing. This exploration was a process of creating awareness and exposing myself to spontaneous moments of realisation of potential sites for experimentation. This is also why the majority of the photography in this section is taken using a cell phone camera, the same device used to capture and 3D scan different environments as I find them.

These experiments are focused on employing action research and reflective practice as part of research through design to assess the potential opportunities provided by the technology as well as the local context. The main goal of this abstract experimentation is to test the intersection between 3D media and the built environment, specifically how 3D objects can convey different digital languages or aesthetics and be embedded in any given context.

Fig 3.1: Site: Waterfront exposed foundation

Fig 3.2: Digital model in Autodesk Remake

The aim of the first set of experimentation was to test potential scanning technology and CAD software and then examine the level of detail and accuracy that can be achieved. Autodesk ReMake uses the process of photogrammetry (making measurements from photographs) to create a 3D model for use in other CAD software.

Using my own cell phone as part of my observational research, I took a series of images on-site and created a digital model of the site to enhance with digitally-generated objects. By creating a contrasting form with spheres, and in another example a single cube, I then used Rhinoceros 5's Boolean modifiers to replicate the surface that the models were attaching to.

After these initial tests it became clear that I had no accurate sense of scale when trying to translate objects onto these surfaces or structures. To solve this, I needed to incorporate a unit of measurement into every scan I took from there onwards. This could be either part of the entire scan by adding a ruler, or by accurately measuring key parts of the site afterwards.

Fig 3.3: Embedding spherical structure

Fig 3.4: After boolean modifier

Fig 3.5: Embedding single cube

Fig 3.6: Contrasting visual languages

Fig 3.7: Initial accuracy problems

Fig 3.8: Single cube

Fig 3.9: Site: Train station broken bricks

Fig 3.10: Site: Spherical structure on bricks

Fig 3.11: Growing through multiplication

Fig 3.12: Train station prototype 1

Fig 3.13: Train station prototype 2

Fig 3.17: Wrapping open-source fist

Fig 3.18: Wrapping cubic structure

Fig 3.19: Crack Scan 1

Fig 3.20: Crack Scan 2

Fig 3.21: Filling cracked pavement

Fig 3.22: Filling/Repairing - Crack 2

Fig 3.23: Fractured/Shattered/Growing - Crack

Fig 3.24: Fractured/Shattered/Growing - Chipping

Fig 3.25: Site - Wellington Police Station, 41 Victoria St

Fig 3.26: Filling in a damaged surface

Fig 3.27: 3D scan of broken edge in Autodesk Remake

Fig 3.28: Filling broken edge in Rhino

Fig 3.29: Filled broken edge model

Fig 3.33: Site: Waterfront earthquake damage

Fig 3.34: Filling broken structure and testing accuracy

Fig 3.35: Potential interaction with social media

Fig 3.36: Large repair from multiple participants

This particular site (Figure 3.33) was a result of the November 14th earthquakes in 2016 that struck Kaikoura. After the events, my observational research focused on finding broken and damaged structures in Wellington that could be in need of repair. As this was a chaotic and undulating surface to work with, I saw this as a good opportunity to test the accuracy and reliability of 3D scanning using an everyday device, my cellphone.

During this stage of the research I was working predominantly with a small scale FDM (Fuse Deposition Modelling) 3D printer, and my restrictions in size led me towards sectioning the full repair to something manageable. As a result, the notion of multiple participants essentially 'tagging' their own additions to the city became apparent. Though this remains a speculative scenario of what could happen, it demonstrates that even with what could be perceived as somewhat basic technology, civic participation to fix and repair broken structures is entirely possible and easily accessible.

This site has since been repaired as of 29/03/2017 (Figure 3.44)

Fig 3.37: Bubbly/Viral

Fig 3.38: Fractured

Fig 3.39: Cubic/Pixellated repair

Fig 3.40 Embedding cubes

To create different ‘digital languages’ or aesthetics, I experimented with multiple packages of software to mimic both organic and artificial structures. The best results came from using Blender and its remesh function on pre-made digital objects, resulting in 3 distinct visual qualities.

Fig 3.41: Bubbly/Viral render

Fig 3.42: Cubic/Pixellated render

Fig 3.43: Fractured/Shattered render

Fig 3.44: Repaired waterfront structure

Fig 3.45: Barnard St - Anchor

Fig 3.46: Cubic/Pixellated Growth - Barnard St

Fig 3.47: Cubic/Pixellated Growth - Barnard St 2

Fig 3.48: Barnard St - Fungal growth

Fig 3.49: Waterfront Repair - Voronoi modelling

Fig 3.50: Waterfront Repair - Voronoi prototype

Fig 3.51: Experimenting with human forms

Fig 3.52: Applying fractured aesthetic

Fig 3.53: Increased fractured aesthetic

Findings

Through my own observational field research in central Wellington, I located multiple sites that I felt would be well suited to my experiments due to their complicated surface quality or interesting location based on high foot traffic, damage, destruction, or significance. A lot of the pieces produced in this stage were purely for testing the accuracy of my methods for 3D scanning- using a cell phone to create a series of images and then stitching them together using Autodesk ReMake. I also experimented with using various packages of software to create digital forms or languages, and familiarised myself with 3D printing technology at a small scale.

Autodesk ReMake provided an opportunity to create 3D meshes from photographs but with its limitations, only being able to use 50 images at a maximum. Ideally to get an accurate scan you would want to be using as many images as possible to get detailed and accurate meshes. On the other hand, this constraint leant itself to my process of scanning a location as I found it, creating a digital mesh to model from, and fabricating an object to fit to that location. While using both proprietary and open-source software for digital modelling, the primary facilitator of creating objects to suit any environment, is a device that everyone has access to and are already carrying with them at all times. As for the accuracy of the scans, this method performed better than I'd originally expected. For small areas I had no issues with improper fits or incorrect geometries, but the limitation of 50 images ruled out larger, more complicated surfaces or structures.

Most of my digital modelling occurred in proprietary software such as Rhinoceros because of its Boolean operations being able to handle the OBJ (.obj) files exported from ReMake. When trying to convey different digital languages or aesthetics, I used open-source packages like Blender and it's ReMesh function to turn the volume of a pre-defined object into three distinctly different expressions of form. The first mimics a bubbly or viral growth that oozes over surfaces, similar to a fungus or slime. Second, I experimented with digitising a form using cubes to create a pixelated quality, reflecting on turning the environment into a digitally enhanced space. Lastly, the triangular meshes generated allude to a fragmented or fractured space, lending itself towards the structures that are in need of repair after being damaged.

Through this period of abstract experimentation, I discovered multiple ways to intersect objects with the built environment. By embedding, wrapping, growing, oozing, overlaying, filling and contrasting objects into, onto and around surfaces or structures, I have tested the capabilities of 3D printing to create one-off objects that are made to fit specific sites. These experiments, though rudimentary, have helped me to gain a more acute understanding into how digital form might convey meaning compared to traditional forms of media.

4

MAKING WITH MEANING

MAKING WITH MEANING

After discovering the possibilities of the technologies outlined in the previous section, this stage of the research will discuss a number of speculative scenarios that showcase the potential for using 3D printed interventions to respond to or convey a message about contemporary issues in our built environment. The issues raised are based on current events combined with prior research or opportunities that have been discovered through the observational and field research.

These scenarios will be discussed individually as their corresponding physical outputs differ from those in the previous stage of research. Because of their changes in scale, materiality and interactivity, each scenario has a different intended response from the public, based on the location or context. The proposed outputs will be designed and fabricated in a way that the use of the technology, and the environment that it is placed, is inherent to the pieces significance (Riggle, 2010). Once removed from their location, the pieces will lack meaning or context and can no longer be fully appreciated or even understood as a point of debate or discussion.

SCENARIO 1: What have we lost?

The first scenario began with an aim of recreating nature, notably species native to New Zealand, using 3D scanning and printing to fabricate representations of local fauna. At first, there was no real purpose behind recreating nature and installing it in the built environment, apart from the availability of scans/specimens revealed during background research. The goal was to simply explore how easily nature could be mimicked to potentially provoke some sort of response or discussion. The subject matter of this discussion remained unclear for some time, but became apparent with continued experimentation both digitally and through physical prototypes.

Fig 4.1: Kereru 3D scan

Fig 4.2: Kakapo 3D scan

The taxidermy specimens shown were provided by The Museum of New Zealand (Te Papa Tongarewa), and were 3D scanned (photographed) on site, to gauge the accuracy that can be achieved with a full 360 degree scan using only 50 images. Because of this constraint, the resulting mesh was flawed in many places, problem areas either did not have enough coverage due to the lack of images, or not enough detail because of the device used. Nonetheless, the overall form of the birds were reasonably recognisable at first glance, so prototyping began at a small scale to see how these imperfections would manifest themselves.

While creating these prototypes, further investigation for more advanced software discovered an alternative to Autodesk ReMake that provided the means to produce digital meshes from a maximum of 250 images instead of 50. Using Autodesk ReCap, I reprocessed the same specimens with a small number of extra images (10-15 each), and achieved a vastly improved result compared to previous attempts. Not only were surfaces less warped or missing contours, texture mapping even managed to pick up feather structures and clear colour differentiation, as seen best in the digital examples of the Kakapo.

Fig 4.6: Material Experiment - Wood

Fig 4.7: Build paths

Fig 4.8: High side shot

Using this same process it was possible to produce an improved version of the Kereru before moving into full scale experiments. Upon reflection, I entertained the idea of fabricating a native wood pigeon, from exactly that, wood infused PLA filament. The model had to be split in two halves because of the definitive tail feathers that, in this case, extended downward past the mount of the original specimen. The result proved useful as a material experiment but lacked intent if it were to be installed into the built environment.

After attempting to imitate living nature, the next step was to explore the possibilities of scanning bones or fossils and reproducing them using 3D printing. With further online probing I discovered another source of printable data in the form of downloadable files hosted by Sketchfab. Uploaded by Auckland Museum, these files ranged from insects to marine life, but notably a skeletal structure of a Moa. Combining this with my previous observational research, I discovered a unique opportunity to question the built environment and expose the hidden remnants of what we have lost in much the same way that fossils are exposed at archaeological sites.

Fig 4.12: Scanned site

Fig 4.13: Digital model of moa intersection

Fig 4.14: First moa skull prototype

Fig 4.15: Reducing protrusion

Fig 4.16: Floating material due to flimsiness

Finding suitable sites for this experimentation proved somewhat difficult, as the ideal placement for something like this would eventually undergo repairs, as shown in the previous chapter. The site used here had the ideal surface I was looking for, undulating and broken in a way that gives enough variance in texture and shape to embed an object. After accurately scanning and scaling the site, I took the skull portion of the full Moa skeleton and created prototypes to test the intersection of the object and the environment.

While going through this process of initial exploration, criteria were established to ensure that the end result clearly alluded to the issue that I was aiming to evoke. Firstly, the object needed to seamlessly integrate with the environment, but give enough tactility or visualisation of the full piece so it is discernible and recognisable. This meant that it could not extend too far out from the surface, but if it was pushed too far in it would create problems with loose material and smaller points of contact. I also needed to consider how this object could be interacted with once discovered, ideally using mobile technology.

Fig 4.17: Material experiment - Bronze

Fig 4.18: Testing QR code orientation

Before moving to larger testing with interactive elements, I sourced metal-infused PLA filaments to test the possibilities of adding a commemorative or plaque-like quality to the object. In this instance the metallic qualities became overpowering on the environment, and it did not add any extra context to the piece. The neutral colours better reflect the fossil aesthetic, similar to that of bone, and works well with the grey tones of the scanned site.

Although I carried out the experiments illustrated on site, for the purposes of presenting this scenario I decided to acquire my own piece of construction rubble. At this stage of the project I had spent a significant amount of time sizing and scaling scans to the correct size, based on measurements during the photographic process. This turned into a rather streamlined process and I was able to create accurate models very quickly without any worry that they wouldn't fit. Immediately I orientated the moa skull to fit the rubble, with the criteria I had defined based on the previous experiments, and printed it at a larger scale using an UP Box.

Fig 4.19: Final Moa shots

Reflection

The result is an urban intervention that exposes an issue that is rarely considered, that the infrastructure of our built environment has paved over millennia of existing ecosystems in the pursuit of presumed progress. This piece serves as a symbolic reminder that humans have caused irreversible damage to creatures that no longer walk our forest floors. Instead, in a twisted irony, these creatures have become part of the built environment that we glorify, in a location that is intentionally discreet, meaning the fossil had to be ‘discovered’. This irony is displayed further with a QR code embedded in the ‘archaeological’ or ‘fossilised’ object which, when scanned by a mobile phone, can link the viewer to anything from a national archive through to an activist group.

SCENARIO 2: Public Endangerment

This second scenario stems from an article published online during a time where the New Zealand public were still assessing the damage from the Kaikoura Earthquakes in late 2016. In the article titled “Wellington heritage building owners putting lives at risk by not strengthening, says Lester” Collette Devlin discusses the public threat posed by structurally damaged buildings in the Wellington CBD, namely heritage areas along the Cuba St Mall and Courtenay Place (Devlin, 2017). According to the article, Wellington Mayor Justin Lester believes that building owners were either “dragging the chain” or taking a “head-in-the-sand approach” because they were either unaware of the funding provided to move the process along, or were halting the job entirely (Devlin, 2017).

As a response, this issue could be presented to the Wellington public in a way that incorporates the buildings in question and their immediate context, and uses large-scale 3D printing to simulate in a tangible way the danger that this lack of action presents. While the 3D print presents a physical obstruction or barrier to arrest pedestrians, a 3D printed QR code brings them immediately into the discussion using the very same article referenced earlier.

Figure 4.20: Wellington City Council – Earthquake Prone Heritage Buildings, 2017

Fig 4.21: Facades observational research

Fig 4.22: Original facade inspiration

The focus of the observational research was to find suitable structures with notable features based on the information provided by the Wellington City Council on earthquake prone heritage buildings. By examining the facades of the buildings along Cuba St, the initial intention of scanning characteristic elements or sections of the façade immediately raised questions surrounding access and safety. A more workable response was to examine the facades and look for discernible features that could be replicated without the need for 3D scanning. Because the facades are geometric and repetitive in form, this results in a relatively simple process of replicating those forms digitally using proprietary software. The final installation needs to be easily understood as a part from the facade of a nearby building, allowing no room for confusion as to what the fractured 'chunk' represents.

Fig 4.26: Scanned location for Facade

Fig 4.27: Fallen chunk

Fig 4.28: Print simulation

Fig 4.29: During printing

The intersection between the 3D printed broken balcony element and its ultimate physical location needed to be carefully articulated. The form needed to be of a reasonable size and detail so its origin was clear, as well as embedded in the location in a way that the size and weight of the object did not cause it to tip over. Not only was the intersection with the location important, but also the surface quality of the fractured section. To achieve this ‘broken’ quality, 3D scans of fractured surfaces were used to progressively split the model using Rhinoceros’ Boolean functions.

Fig 4.30: Model in location

Reflection

The result is a large scale, made-to-fit, simulation of what could happen if a non-compliant heritage building, and its owners, continue to ignore the potential risk to the Wellington public. This physical intervention uses 3D printing on a large scale to create an object where its size, form and location is vital to its significance and meaning. The 3D printed QR code embedded in the model provides an additional virtual layer by linking to the news article that served as the primary source of information and inspiration for the physical output.

SCENARIO 3: Confrontation, Begging

This third scenario responded to the long-standing and complex issue of confrontational begging, homelessness and where that meets the Wellington general public at key locations, like ATM's and food courts. This scenario aimed to explore the possibilities of printing a full 1:1 scale of a person, and in doing so creating an object that viewers become intrigued or curious about. After overcoming the initial technical problems with large-scale printing, the intention was to design an urban intervention that creates awareness of an issue and simultaneously attempts to solve the problems surrounding it. The response was a digital avatar in the form of a 3D printed object that provides a non-confrontational conduit to possible solutions. The concept of a digital avatar also offered an opportunity to test the 3D printing facilities on offer to their limit.

Fig 4.31: Testing 3D scan of human subject

Fig 4.32: Raw model of human subject

Fig 4.33: Low-Poly

Fig 4.34: Translucent

Starting with scanning and reproducing scale models of a human subject, I examined the qualities that the digital modelling and 3D printing processes provided. To create a once-removed level of anonymity the full form was re-meshed in Blender, resulting in a unique digital visual aesthetic that reduces polygons and makes the object indiscernible.

Using MakeHuman, an open-source tool for 3D character creation, I generated the human form as opposed to scanning and tweaking an already existing model. This provided the opportunity to create an intentionally anonymous or unidentifiable persona that had a highly considered digital quality and surface structure because of the exterior mesh. This aesthetic quality would then make the piece 'of the technology' by reflecting the processes used during its creation.

Fig 4.35: Modelling in MakeHuman

Focusing on the homelessness and vagrancy aspects of this scenario, my next concepts revolved around 3D printing a representation of a homeless person or beggar sleeping or sitting against a wall or on the ground. Although the majority of the objects created in this research are made to fit certain environments or locations within the built environment, this scenario tested the opportunities for a 'universal' intervention that can be moved from site to site.

Fig 4.36: Digital model of sleeping figure

Fig 4.37: Low resolution model of sleeping figure

Fig 4.38: Leg build simulation

Fig 4.39: Head build simulation

Fig 4.40: Leg print on BigRep

Fig 4.41: Material Testing - PETG

Before moving to full 1:1 scale prints on the BigRep, tests needed to be carried out to assess the constraints of both the printer and the material being used. In this case the material is a PETG filament created from recycled plastic bottles. The design consideration stems from wanting to create a 'ghost' of a person and the translucent nature of the material achieved that because of its see-through quality. Given that the material is also made up of recycled plastic and consumer waste, this aids the piece in becoming 'of the street' by reusing discarded objects that could potentially be from the environment that it's placed.

From these tests I learnt that the 0.4mm layer height results in a significantly improved quality compared to the 0.6mm. With the recycled PETG, layer adhesion is the biggest problem and the only way to counteract this is to slow down the printing speed by changing the layer height. From here prototypes of problem areas were printed at full scale to determine printability and need for internal support structures or extra top/bottom build layers in Simplify3D.

Fig 4.42: Customising support

Fig 4.43: Customising infill

Fig 4.44: 1:3 scale upper torso at 0.6mm height

Fig 4.45: 1:1 scale foot showing faceting

Fig 4.46: Problem area testing infill and adhesion

Fig 4.47: Bridging material across large distances

Fig 4.48: Adding top 6 top layers with 0.4mm layer height

Fig 4.49: Smooth PETG build quality

Fig 4.50: Observational research for location

Fig 4.51: MakeHuman pose

Upon reflection, the digital model of the sleeping figure was universal, but the neutral human form and characteristics left the object looking like an abandoned mannequin. Further observations identified areas in the CBD that garnered a substantial amount of foot traffic, essentially hotspots for pedestrians in areas where they might not normally be confronted with the issue. Through this and an article published in the dominion post regarding beggars sitting near ATM's (see appendices), I found inspiration for locations that tackled the different issues I was aiming for. In response to both location and printing requirements, the avatars pose needed to be altered to a sitting position and the back made flat to allow for installation against flat surfaces.

Fig 4.52: Creating print surface

By applying what I'd learnt from the smaller material tests I adjusted the file in Simplify3D to create 6 top layers, 2 bottom layers and only one line of infill to ensure build quality. Combined with the flat surface, this allowed for a much more flexible build orientation, reducing supports, build time and material use. This also allowed the full model to be printed all at once, making it the largest object printed on the School of Designs BigRep 3D printer, focused on efficient and economical printing. The full build took roughly 90 hours with a few complications including a power outage and straying support structures, but were easily overcome.

Fig 4.53: BigRep print simulation

Fig 4.54: Start of print job

Fig 4.55: Horizontal build structure with added top layers

Fig 4.56: Minimal support structures

Fig 4.57: Reaching the upper parts of the limbs

Fig 4.58: After power surge and realignment

Fig 4.59: Final figure in context 1

Fig 4.60: Final figure in context 2

Reflection

The result is an urban intervention that responds to different issues dependant on its location. When placed in a 'hotspot' for beggars near ATM's and storefronts, the piece acts as a critique to whom it is mimicking by taking over the area under the guise of anonymity. In this situation it becomes unclear who to blame for the confrontation because of the digital language and material combining to create a 'ghost' of a person. The only clue lies within the QR code linking to the news article (Devlin, 2017) that served as the inspiration for the piece.

Fig 4.61: Final figure in context 3

Similarly, when placed in a food court viewers and consumers are presented with an issue in a more non-confrontational manner. The QR code would run as a donation scheme for the Foodbank Project, and through a QR code viewers would be able to make a donation to the foodbank via their mobile phones.

Though the piece is universal in its level of integration with its surroundings, in both situations the environment in which the figure is placed in provides context and meaning behind the installation, making it 'of the street'. This prototype also showcases how to effectively use a digital visual language to convey meaning and make the object 'of the technology'.

SCENARIO 4: Play

Fig 4.62: Solace in the Wind

During my observational research I found myself asking the same question, ‘How could I create an object as a response to this or that and what issues might it raise?’ I wanted to find out how someone might react to a certain location or site without being burdened by issues. Similar to the aims of yarn bombing, the intent is simply a light-hearted and creative response to the built environment. While exploring the Wellington waterfront I walked past the sculpture titled ‘Solace in the Wind’ by artist Max Patte, my immediate reaction being that the figure is in a precarious position over the water supported only by Wellington’s wind.

From here I spent some time determining how to use irony or humour as a creative response. Initial scanning attempts established the obvious constraint, that I could not scan the entire sculpture without leaning into the harbour myself, putting me in an even more precarious position than ‘Solace’. Instead, I needed the response to interact with an area that could be accurately 3D scanned, or as a separate entity entirely. The intended response needed to be joyful and reflect a spontaneous reaction to the sculpture, a child-like and innocent response to save ‘Solace’ from his fate.

Using MakeHuman again, I experimented with different orientations using its pre-defined poses and skeletons. While doing so I entertained the idea of creating just the opposite, generating a model that appeared to be kicking 'Solace' into the water. Though this did serve as a humorous response, as a standalone object it barely embedded into its location and did not meet the criteria I had set out at the beginning of this research. This concept was a response to but not 'of the location' and its placement was only inherent to its significance up until the point it was moved and used in a different setting.

Moving forward I decided that the final output needed to interact with the sculpture in a way that it either cannot be removed easily, or if it did, it would no longer have any meaning because of the lack of context. To achieve this, I began digitally modelling a child wrapping his arms around the legs of the sculpture, weighing him down and stopping him from falling into the water. The use of a child to rescue 'Solace' was also a logical solution to the scanning difficulties identified earlier. This was created by exporting the skeletal structure to Blender, another open-source software, and modifying the model to the correct position.

Fig 4.65: Modifying skeleton in Blender

Fig 4.66: Interacting with location

For the model to locate onto the sculpture effectively, areas where the most surface contact occurred needed to be split in a way that allowed the parts to snap on during installation. To ensure printability, the model was first cut through the waist as well as vertically in the area where the arms join the torso. In doing so, the amount of support structure required during the printing process was reduced to a minimum, decreasing print time, material use, and potential build errors, thereby ensuring that the installation was not only 'of the street' but also 'of the technology' as well. Test parts were also printed to quickly ensure accuracy before moving onto the full build

Fig 4.73: Printing torso section

Fig 4.74: Printing Legs section

Fig 4.75: Printing Arms section

Fig 4.76: Images of child installation

Fig 4.77: Final model in context

Reflection

This scenario used predominantly open-source software such as MakeHuman, Blender and Meshmixer to create a relatable, personal and light-hearted response to a well-established local icon. The result is a playful response to an existing sculpture that uses the geometry of the location to create a made-to-fit urban intervention. The final piece in context also displays an interesting dichotomy between the notion of temporary and permanent vandalism. Though this wraps around the original sculpture, it is not in any way fixed or glued in place, instead the piece was designed to be as easily removed as it is installed.

6

CONCLUSION

CONCLUSION

Conclusion

'Making' a Statement has explored new strategies for customising and claiming space by using Wellington as a local context for the creative city. After examining street art and graffiti culture, both locally and internationally, this research identified criteria for creating urban interventions that apply 3D printing at different scales to make engaging or thought-provoking statements. Beginning with abstract experimentation, new technologies were assessed by designing and producing objects that intersect with the built environment.

These experiments and the resulting scenarios showed how customised physical objects can enhance a space in new and unexpected ways, as such 3D printing presents a powerful tool for 'making' statements in public spaces. The physical presence of these objects mirrors the environment that they have placed in because of their tactility, material quality and form. The opportunity to connect to wider audiences through technologies like QR codes, also suggests an additional level of interaction in the built environment.

This investigation developed scenarios around current social and infrastructural issues in Wellington, and responded to them using both low-cost and specialist 3D printing equipment. The objects created were 'of the technology' by tailoring their production to both the constraints and opportunities that 3D printing presents while utilising its opportunities for a digital aesthetic. In parallel, each object's intimate connection to its location provided not only meaning, but also a significance that could only be achieved in that space, thereby making the object 'of the street'. These twin conceptual considerations form a consistent reference point for critical reflection of the different scenarios through their development.

A number of the physical outputs were the first large scale experiments to be carried out on the School of Design's BigRep 3D printer, in this respect it tested the large scale printing technology to its limits for the first time. This resulted in varied outcomes and revealed some limitations such as sourcing material available in the desired quantities, scheduling for builds spanning multiple days and using slicing software to streamline the printing process. While these limitations will eventually be overcome as new materials and expertise become accessible, new challenges are likely to emerge. Inevitably, being an early adopter of emerging technology presents a range of challenges, including adjusting to new developments and exponential rates of change and availability.

These scenarios show that using 3D media as a means of customising or claiming space is in its infancy and that the potential for customised, co-created, digitally-generated and physically-augmented environments is not only possible, but imminent. The investigation exemplified both playful and critical responses questioning the built environment, at a comprehensive range of scales and complexity- As such the research represents a state of the art case study for 'Making' statements in offering a reference point with which we can expect more to follow.

FURTHER RESEARCH

Further Research

This investigation exposed as many questions as it provided answers. Many areas of potential future research are linked with the rapid rate of technical development in this area.

The Internet of Things

In addition to demonstrating how customised physical installations can offer a new form of engagement with public space, this research reveals how traditional graffiti in the form of tagging inspires another potent layer of interaction that can be added to public space through new forms of 'digital tagging'. Using technologies like QR codes or RFID tags, these could be to artists' personal blogs or social media, as well as connecting to discussion and debate through news media and other open forums. The possibilities for digital connectivity and digital tagging linked to physical objects in the urban environment are endless, and these experiments serve as but a small example of that potential.

Large Scale Printing

Similarly, large scale 3D printing is in its infancy and still requires systematic and rigorous experimentation with both software, materials and printing hardware to mitigate current limitations. This experimentation only begins to tackle these problems and further investigation as well as increased availability can only improve the capabilities of this technology.

Open-Source & Cooperative Design

This research found that the potential for 3D scanning a given location using photogrammetry, has become so accessible that more demanding methods have been made redundant. By using the cell phone as a primary facilitator for customising space, this research found the opportunities for existing and developing technology to facilitate co-creation in and customisation of the built environment.

Implementation

Any installation or intervention in a public space raises issues of consent, approval and public safety. Therefore the actual implementation of this research would need to follow (or be pursued through) a number of distinctive creative pathways:

1. This field of research could be applied by application to local government bodies or foundations as part of public art programs or initiatives.
2. Where de facto approval is part of the process and thought provoking statements are often a desired outcome, artists could operate under the banner of 3D graffiti. By customising and modifying the built environment without permission, these artists would create 3-dimensional, physical forms while remaining anonymous in the tradition of street art.
3. Through cooperative forums such as makerspaces and crowdsourcing 'Makers' and the wider public could also collaborate to augment the built environment through a system of crowdsourcing ideas, anonymously or otherwise, and implementing these ideas in a similar fashion to the Tui Breweries billboards.

From this research it is clear that there are endless scenarios for imagining, designing, producing and implementing 3D media in public space. The rate of development and pending ubiquitous nature of the required technology now begins to fuel this field of inquiry to reach its full, as yet, unimagined potential.

WORKS CITED

- Alpaslan, Z. (2012). Is Street Art a Crime? An Attempt at Examining Street Art Using Criminology. *Advances in Applied Sociology*, 2(1), 53–58. <https://doi.org/10.4236/aasoci.2012.21007>
- Archer, B. (1995). The nature of research. *Co-Design Journal*, 2(11), 6–13.
- Banet-Weiser, S. (2012). Branding creativity: Creative Cities, Street Art, and ‘Making your name sing’. NYU Press. Retrieved from <http://www.jstor.org/stable/j.ctt9qfmw0.7>
- Borghini, S., Visconti, L. M., Anderson, L., & Sherry, Jr., J. F. (2010). Symbiotic Postures of Commercial Advertising and Street Art. *Journal of Advertising*, 39(3), 113–126. <https://doi.org/10.2753/JOA0091-3367390308>
- Burnham, S. (2010). The call and response of street art and the city. *City*, 14(1), 137–153. <https://doi.org/10.1080/13604810903528862>
- City of Melbourne. (n.d.). *Graffiti*. Retrieved from <http://www.melbourne.vic.gov.au/residents/home-neighbourhood/graffiti/Pages/graffiti.aspx>
- Ciolfi, L., & Bannon, L. J. (2005). Space, place and the design of technologically-enhanced physical environments. In *Spaces, spatiality and technology* (pp. 217–232). Springer. Retrieved from http://link.springer.com/content/pdf/10.1007/1-4020-3273-0_15.pdf
- Crang, M., & Graham, S. (2007). Sentient Citites: Ambient intelligence and the politics of urban space. *Information, Communication & Society*, 10(6), 789–817. <https://doi.org/10.1080/13691180701750991>
- Devlin, C. (2017, April 6). Wellington heritage building owners putting lives at risk by not strengthening, says Lester. *Stuff*. Retrieved from <http://www.stuff.co.nz>
- Devlin, C. (2017, May 23). Wellington retail group asks banks to help solve ATM begging problem. *Stuff*. Retrieved from <http://www.stuff.co.nz>
- Dickinson, M. (2008). The Making of Space, Race and Place New York City’s War on Graffiti, 1970—the Present. *Critique of Anthropology*, 28(1), 27–45.
- Ferrell, J. (1995). Urban graffiti crime, control, and resistance. *Youth & Society*, 27(1), 73–92.
- Florida, R. (2003). Cities and the Creative Class. Retrieved August 16, 2016, from <http://creativeclass.com/rfcgdb/articles/4%20Cities%20and%20the%20Creative%20Class.pdf>

- Frankel, L., & Racine, M. (2010). The complex field of research: For design, through design, and about design. *DRS Montreal—Design and Complexity*. Retrieved from http://www.academia.edu/download/38456887/The_Complex_Field_of_Research.pdf
- Friedman, K. (2008). Research into, by and for design. *Journal of Visual Art Practice*, 7(2), 153–160. https://doi.org/10.1386/jvap.7.2.153_1
- Holt, D. B. (2002). Why Do Brands Cause Trouble? A Dialectical Theory of Consumer Culture and Branding. *Journal of Consumer Research*, 29(1), 70–90. <https://doi.org/10.1086/339922>
- Irvine, M. (2012). The work on the street: Street art and visual culture. *The Handbook of Visual Culture*, 235–278.
- Kramer, R. (2010). Painting with permission: Legal graffiti in New York City. *Ethnography*, 11(2), 235–253.
- Lindtner, S., Chen, J., Hayes, G. R., & Dourish, P. (2011). Towards a framework of publics: Re-encountering media sharing and its user. *ACM Transactions on Computer-Human Interaction*, 18(2), 1–23. <https://doi.org/10.1145/1970378.1970379>
- Loeffler, S. (2012). Urban warriors. *Irish Arts Review (2002)*, 29(1), 70–75.
- McLean, B. (2017, March 13). *The Backstory Behind That ‘Fearless Girl’ Statue on Wall Street*. The Atlantic. Retrieved from <https://www.theatlantic.com/business/archive/2017/03/fearless-girl-wall-street/519393/>
- Napier City Council (n.d.) *Sea Walls: Murals for Oceans*. Retrieved from <http://www.napier.govt.nz/napier/parks/community-art/sea-walls-murals-for-oceans/>
- Obey. (n.d). Since 1989. Retrieved from: <http://zine.obeyclothing.com/about/>
- Pangeaseed (n.d.) *Bringing the Oceans Into the Streets Around The World*. Retrieved from <https://www.pangeaseed.foundation/sea-walls/>
- Ratto, M., & Ree, R. (2012). *Materializing information: 3D printing and social change*. Retrieved August 28, 2016, from <http://firstmonday.org/ojs/index.php/fm/article/view/3968/3273>
- Riggle, N. A. (2010). *Street Art: The Transfiguration of the Commonplaces*. Retrieved May 29, 2016, from <http://www.jstor.org/stable/pdf/40793266.pdf>
- Sophie Kahn (n.d.) *Artist’s statement*. Retrieved from <https://www.sophiekahnn.net/about>
- Valkenburg, R., & Dorst, K. (1998). The reflective practice of design teams. *Design Studies*, 19(3), 249–271.

Visconti, L. M., Sherry, J. F., Borghini, S., & Anderson, L. (2010). Street Art, Sweet Art? Reclaiming the “Public” in Public Place. *Journal of Consumer Research*, 37(3), 511–529. <https://doi.org/10.1086/652731>

Visit Victoria. (n.d.). *Official site for Melbourne, Victoria, Australia*. Retrieved from <http://www.visitvictoria.com/>

Wohlers, T, Caffrey, T (2014) *Wohlers Report 2014: 3D Printing and Additive Manufacturing State of the Industry: Annual Worldwide Progress Report*.

Wohlers, T, Campbell, I, Caffrey, T (2016) *Wohlers Report 2016: 3D Printing and Additive Manufacturing State of the Industry: Annual Worldwide Progress Report*.

Young, A. (2010). Negotiated consent or zero tolerance? Responding to graffiti and street art in Melbourne. *City*, 14(1), 99–114. <https://doi.org/10.1080/13604810903525215>

LIST OF FIGURES

Figure 1.1: Invader. (2001). HK_19, Retrieved from <http://www.space-invaders.com>

Figure 1.2: Invader. (2016). LDN-149, Retrieved from <http://www.space-invaders.com>

Figure 1.3: Invader. (2015). NY-163, Retrieved from <http://www.space-invaders.com>

Figure 1.4: Vhils. (2015). Serhiy Nigoyan portrait in Ukraine, Retrieved from <http://vhils.com/>

Figure 1.5: Banksy. (2015). Steve Jobs Mural, Retrieved from <http://wired.com/>

Figure 1.6: Joshua Allen Harris. (2008). Air Bear Project, Retrieved from <https://londonartportfolio.blog.com/2011/05/19/animals-7/>

Figure 1.7: Federica Valabrega. (2017). Fearless Girl, Retrieved from <http://www.bostonmagazine.com>

Figure 1.8: Pangeaseed. (2016). Sea Walls – Dside, Retrieved from <https://www.pangeaseed.foundation/>

Figure 1.9: Weird in Wellington. (2015). Monster-footed, yarn bombed bench on Willis St, Retrieved from <http://weirdinwellington.com>

Figure 1.10: Jan Vormann. (2015). Dispatchwork – W 12th Street, Retrieved from <https://www.janvormann.com>

Figure 1.11: Tui Breweries. (2011). Tui Breweries Billboard, Retrieved from <http://cargocollective.com>

Figure 1.12: Sophie Kahn. (2014). Triple Portrait of E, Retrieved from <https://www.sophiekahn.net>

Figure 1.13 Sophie Kahn. (2012). L:Degrade, Retrieved from <https://www.sophiekahn.net>

Figure 1.14 The Zew. (2016). The Zew, Retrieved from <https://www.facebook.com/Zew3dGraff>

Figure 1.15 The Zew. (2016). The Zew, Retrieved from <https://www.facebook.com/Zew3dGraff>

Figure 4.20: Wellington City Council. (2017). Earthquake Prone Heritage Buildings. Retrieved from <https://www.stuff.co.nz/>

All other images are photographed by the Author Mark Bagley

APPENDIX

Full interactive diagram available at: <https://coggle.it/diagram/V-XklOWllwYXCf3Z/45f678cc6c805b2b3c5ba9327107ef07267c90b0cd0e4140e0e48c6a66046f85>