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Electronic Visualisation and the Arts

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Conference Papers

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Assessing the Politicisation of Utopian Architectural Space using 3-D Computer Models

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Many Utopian writers from the mid fifteenth century expressed their political and societal ideas within the plans of cities. The city framed their social reform agendas, but most were never built and existed only in reform literature. These writers described the types of buildings, the use of the buildings, and who occupied buildings in these ideal cities. They detailed the ground plans, the parks, the avenues, and in some cases the canals and aqueducts. The strict symmetry of most of these designs gave them the appearance of being more symbolic than practical. Mid fifteenth century author Filarete designed a star shaped ground plan, while the early seventeenth century author Tommaso Campanella created a round celestial like plan and Johann Valentin Andreae developed a square ground plan with triangular bastions in the corners. These three cities were heavily fortified to provide security and safety. While in the nineteenth century writers such as Robert Owen and James Silk Buckingham also considered safety and security in their designs but for protection from the ravages of the Industrial Revolution. In a recent project the author examines these utopian cities closely by reconstructing these cities using a 3-D modelling computer package, ArchiCAD. The reconstructions bring these utopian theories alive and highlights how these cities could function not as a symmetrical symbol of utopianism but as a working city. The project examines the politicisation of spaces and how these utopian political and societal theories could be enhanced by their city designs.

1. BACKGROUND

2016 marks 500 years since the publication of Thomas More's *Utopia;* without a doubt it is one of the most significant books ever written. *Utopia* creates the fictional dialogue that gives its name to a body of societal and political thought and its literary device of a shipwreck or equivalent to discover a new ideal city has been replicated since its publication. More explored political and societal solutions to society's problem of his day. *Utopia* consists of two books; the first outlines the social problems of Henry VIII's England while in the second book the fictional traveller and philosopher Raphael Hythloday tells the tale of the island of Utopia. He described the society, its economy, its customs, its traditions and its cities. While Book 1 outlines the problems of society, Book 2 describes possible solutions to these problems (More, 2001).

The famous front piece designed possibly by Hans Holbein (Figure 1) shows the horseshoe shaped island, Hythloday's ship about to be wrecked in the hazardous waters of the island and the cities scattered throughout the island. In this image the cities appear to have a castle in the centre with towers and crenulated walls. However, although the cities' walls had towers, there was no castle or guildhalls, both of which dominated London at the time. In *Utopia* there 54 cities on the island and the cities

> have the same layout and they look the same, insofar as the terrain allows... If you know one of these cities you know them all, so similar are they in all respects (so far as the terrain allows)... The streets are laid out to facilitate the traffic and to offer protection from the wind. The buildings are by no means ugly; the houses extended in a continuous row along the whole block, facing the row on the other side of the street; the house fronts along each block separated by a street of 20 feet. Behind the houses, a large garden, as long on each side as the block itself, is hemmed in on all sides by the backs of the rowhouses (More, 2001, 57).

The architecture is egalitarian and the layout of the cities is practical and utilitarian. More does not describe any particular centre of the city but puts an emphasis on the gardens. There is a great deal of ambiguity in his description but it would appear that the gardens are the central part of the city. Unfortunately More does not describe the plan or the architecture of the cities well enough for them to be reconstructed. Nevertheless, he politicises the architectural space and the utopian society is framed by their cities' egalitarian plan. Although *Utopia* is the most famous Renaissance description of ideal cities, it was not the first.

Figure 1: Front piece of Utopia

The concept of ideal cities stems from Plato's Atlantis, but the first ideal city to be described in detail originated from Florentine architect and artist Antonio Averlino, now known as Filarete. *Libro Architettonico* was composed in Milan, between 1461 and 1464, while Filarete was in the service of Francesco Sforza, insurgent Duke of Milan (Spencer, xix). Like *Utopia* it was written as a narrative and was intended to entertain; however, its main purpose is in the instruction of architectural theory and like *Utopia* it had a societal and political message.

Filarete's star shaped city (see Figure 2) is the first detailed 'utopian' city. Although it is difficult to construct the whole, as the parts are greater than the whole. It is possible to reconstruct most of these parts. Later ideal cities were heavily influenced by More in their literary devices and political theory. Symmetry became embolic of utopian cities even though the cities of the island of Utopia were not symmetrical. Like *Utopia* many of these texts offered political solutions and a central part of that solution was the city itself. Texts from the Renaissance such as Tommaso Campanella's *City of the Sun*; Johann Valentin Andreae's *Christianopolis*; and from the nineteenth century Robert Owens' Villages of Unity and Co-operation; James Silk Buckingham's Victoria; King Camp Gillette's Metropolis and Bradford Peck's *The World in a Department Store*. Each of these works describe a city that can be reconstructed and the architecture is politicised through their theory.

A project by the author (Morrison, 2015) looks at ten utopian cities by reconstructing them through 3-D computer modelling to investigate how this architecture was politicised. The 10 cities come from literature that describes the cities in detail often with ground plans and a description of the architectural upright elements of the

city. Many of the cities describe the materials as well as the design. When not all of the materials are defined the author has used historical judgement to choose the correct material. However, most do not mention the colours of the material or of the buildings thus more than often the colour in these reconstruction is the author's choice, but the colour is chosen in consideration of the era. The project visualises these cities through reconstructions which assists in their understanding of their spatial and philosophical development. The architecture and the philosophy of these works and their cities have not been examined in any detail nor have they been compared in their social and spatial structures. Each of these ten cities express the change in utopian thought through 500 years of literature and the beginning of the twentieth century was the pinnacle of utopian urban design. This project is unique in its approach of examining the philosophy and urban planning combined with the visualisation of these utopian ideals. This paper summarises the results of that project.
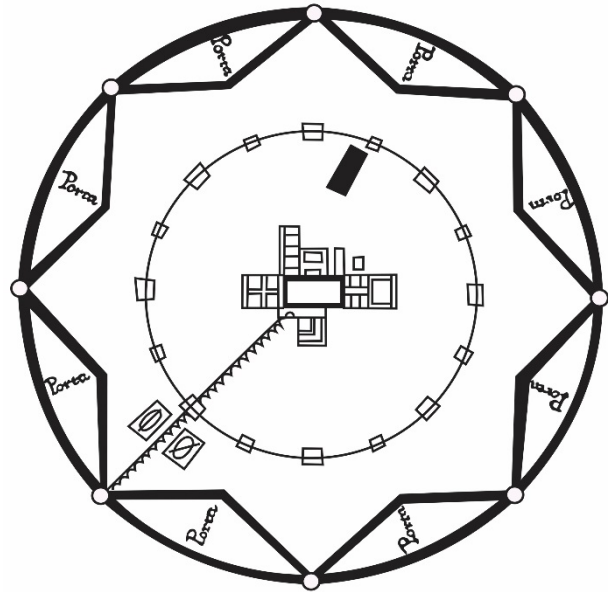
2. UNBUILT UTOPIAN CITIES

2.1 Introduction

After the publication of *Utopia* there was a great deal of interest in creating a 'utopian' Commonwealth. Many books were published that emphasised an ideal government. Although many of these texts were political philosophy that was devoid of a city context there were numerous accounts that centred this philosophy in a city – the city became part of this philosophy. However, in many of these texts the cities are vaguely described and it is impossible to reconstruct them. Some do give detailed accounts of their ground plans and architecture. Although the description is rich in architectural and planning detail, most rarely provide more illustrations than a ground plan of the city or a one perspective drawing. This makes it difficult for most readers to appreciate the relationships of the buildings and the utility of the city to the political philosophy. Reconstructing the cities as a 3-D computer model gives a further depth to the analysis of these cities and particularly illustrates the link to the underlying philosophies.

Figure 2: Ground plan of Filarete's Sforzinda

Figure 3: Overlooking the centre towards the ducal Palace of Filarete's Sforzinda

2.2 The city of Sforzinda: the first Renaissance ideal city

Filarete's city is a political and administration centre. The central buildings of the cities dominate the city plan and the skyline of the city. Although Filarete's city is symmetrical, his central plan of the administrative areas is not symmetrical. According to fifteenth century architectural theorist Leon Battista Alberti there are two types of societies: the Republic and the principality of the King or Duke, and they reflect different demands on the city. The placement of political buildings is distinctly different in the city of the Republic to that of the city of a tyrant. He claims tyrants of the principality required a strong centre while in a Republic the centre can be handed over to the 'rabble' of the poor where they could be contained (Alberti, 1988, 118). Filarete was familiar with Alberti's works and he clearly designed a centre which aligned with this theory for the insurgent Duke of Milan Francesco Sforza.

The reconstruction of Filarete's Sforzinda (Figure 3 and 4) reveals the proportions and power of the central design. All the avenues and canals that begin at the eight gates of the city walls converge to the administrative and political centre. In the centre are the Cathedral and the ducal Palace face each other and are divided by a large piazza. In the political space that is created in Sforzinda there is a tension between the religious buildings which are numerous and the ducal Palace. Filarete (1965) describes all of the proportions and measurements of his buildings making it possible for an accurate reconstruction to be undertaken of the buildings. Although the Cathedral is greater in height, the ducal Palace is larger and more solid looking, leading in no doubt where the power of this city lies. The Cathedral although powerful is secondary to the Palace. There are anomalies in the floor plans since in the piazzas the footprints of the buildings collectively do not fit into the space allowed. However, through reconstruction the relationship between the buildings becomes clearer (Morrison, 2015).

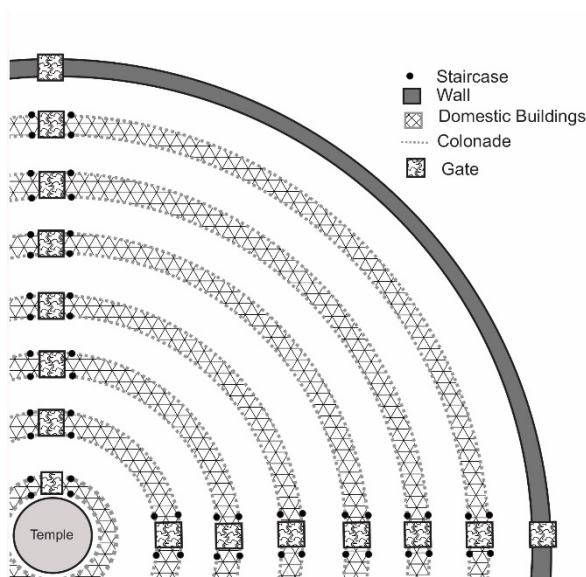*Figure 4: Overlooking the centre of Filarete's Sforzinda with the Cathedral on the left-hand side.*

Figure 5: Ground plan of the City of the Sun

2.3 Ideal cities of the 17th century

Campanella's *City of Sun* (1605) (Campanella, 1968) and Andreae's *Christianopolis* (1619) (Andreae 1999) are the first of the utopian symmetrical cities. In Campanella's and Andreae's cities the central plan of the city is a Temple. The ground plans of both these cities do not show the relationship between the buildings and in the case of City of the Sun (see Figure 5) nor the terrain. The City of the Sun is a circular city surrounded by a substantial wall and then followed by seven circuits each able to defend itself against an enemy if the wall surrounding them was taken by the enemy. Each of the four avenues converges on the Temple precinct travelling through eight gates. It is built on a hill heightening the already massive central Temple. The central Temple is the religious and administrative centre. Unlike Sforzinda there is no tension between the powers of the Church and State. The reconstruction of the city emphasises the domination of the Temple over the city but it also highlights the hierarchy of the circuits in relationship to the Temple (see Figure 6). This domination carries through into the interior of the Temple where the dome is decorated with the night's sky. Both the scale and the decoration make the dome appear to give the Temple an infinite space (see Figure 7).

Figure 6: The City of the Sun

The ground plan of the Christianopolis reveals an almost accurate scale plan of the measurements that are in the text (see Figure 8). However, the perspective drawing in Christianopolis is inaccurate in its proportion and scale (see Figure 9). In the perspective drawing the streets are broader and open, towers are higher, the main square is larger and the Temple is more elongated as well as taller as. The reconstruction (Figure 10 and 11) shows the correct proportions according to the text. Although the streets are 20 feet wide, the same as More's Utopia, the overhanging balconies of the streets change the ambulance entirely. The design of the streets and overhanging balconies is better suited for the zoning of the trades of Christianopolis, where on the ground floor are located the workshops and upstairs is the residential area. However, although there is a general similarity in the bird's eye view on the street level to the design presented by the drawn perspective and the reconstruction from the
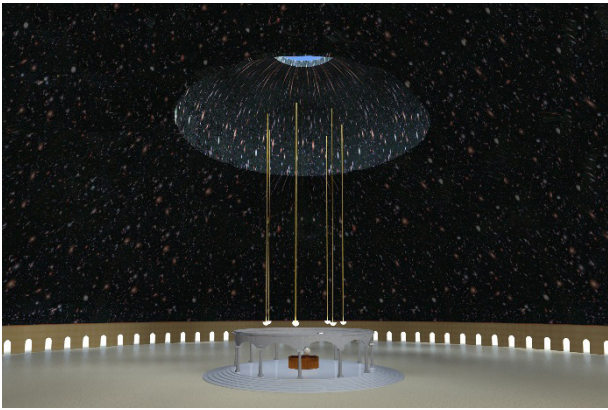
text are very different.

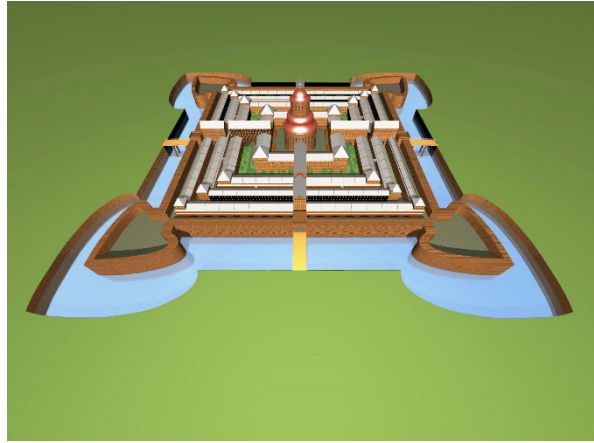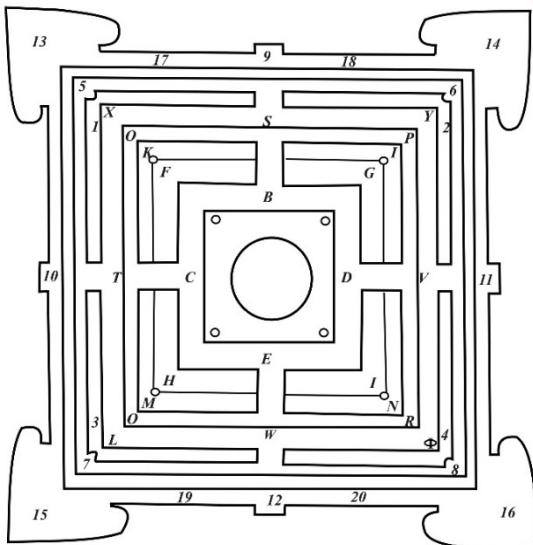**Figure 7:** *The interior of the Temple of the City of the Sun*

Figure
8: *Ground plan of Christianopolis*

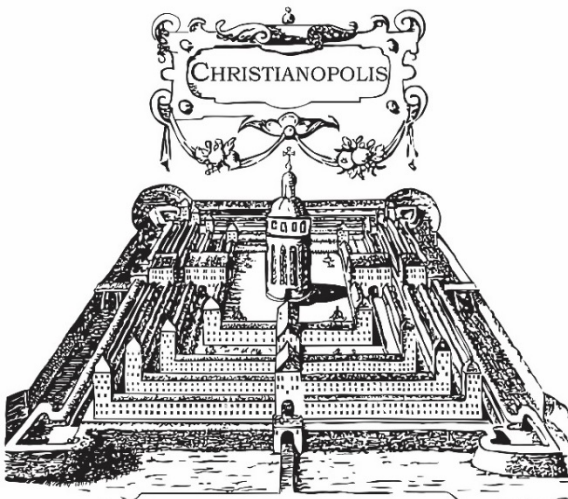**Figure 9:** *Perspective drawing of Christianopolis*

Figure 10: *Reconstruction of Christianopolis*

2.4 **In search of an ideal solution to the Industrial Revolution**

The Industrial Revolution brought with it different social and political problems to those of the fifteenth and seventeenth centuries. Slums, low life expectancy and poorly paid work for the labouring population of England had generated a national housing crisis. The early nineteenth century saw an increase in social reform literature which included housing solutions. The first significant ideal city was designed by Robert Owen with his planned self-sufficient Village of Unity and Co-operation (Owen, 1817). Owen hired an architect, Thomas Stedman Whitwell in 1824, to produce plans which would be able to facilitate his economic and social reforms. In a book published in 1830 Whitwell describes the city (Whitwell, 1972). However, he only produced a single perspective drawing (Figure 12) and he did not even include a ground plan. The description of the city is bland and mundane. Although it gives accurate measurements and describes the architecture, it falls short of giving any feel of the city. The reconstruction looks very similar to the perspective drawing (compare Figures 12 and 13), but the reconstruction was constructed directly from the text. The reconstruction makes it possible to get an understanding of the vast open area in the centre (Figure 14). In the centre is a conservatorium (Figure 15) which differs from the majority of previous utopian cities. Campanella and Andreae also had a large percentage of open area in their cities but because the living area in Owen's design is concentrated on the perimeter the vast open areas give the centre of the village a park-like feeling.
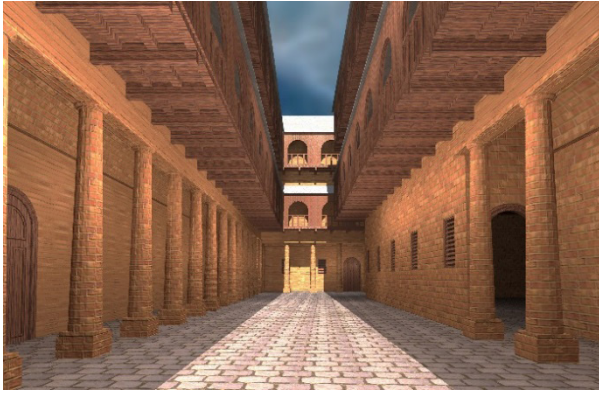
Figure 11: Reconstruction of Christianopolis

Figure 12: Whitwell's perspective drawing for Owen's Villages of Unity and Cooperation

Figure 13: Owens Villages of Unity and Cooperation

Figure 14: View across the centre of the Villages of Unity and Cooperation

Figure 15: The conservatory in centre of Owens Villages of Unity and Cooperation

Owen's Villages of Unity and Co-operation are intended to be self-sufficient villages. Nevertheless, there is a paternalistic side to their governance and they were to be funded through philanthropic donations.

James silk Buckingham also desired to establish self-sufficient villages that were funded by shareholders. His utopian village is the first of the corporate utopias (Buckingham, 1849). His city is not egalitarian but is hierarchical. The ground plan of the city is a square of eight circuits (see Figure 16). The size and quality of the architecture increased in quality the closer it is to the centre. Each row was of a particular class. The perspective of the city (Figure 17) shows an exotic city of minarets and towers. Like Christianopolis its perspective is distorted in its proportion and measurements. The reconstruction (Figure 18) shows the correct proportions and although exotic in its architecture it is not as elongated in its proportions as the perspective etching. The city named Victoria is over 60 percent open space; there are covered walkways that connect the rows. The reconstruction highlights the connectivity throughout the city.

Figure 16: Ground plan of James Silk Buckingham's Victoria

Figure 17: *Perspective etching of James Silk Buckingham's Victoria* (from the author's collection)

Figure 18: *Reconstruction of James Silk Buckingham's Victoria*

There are two American utopian models that take the corporate utopia to extremes; the designs of Camp King Gillette and Bradford Peck. They mark a different type of utopian city that is without strict symmetry, although there is a regular geometry to both. At the end of the n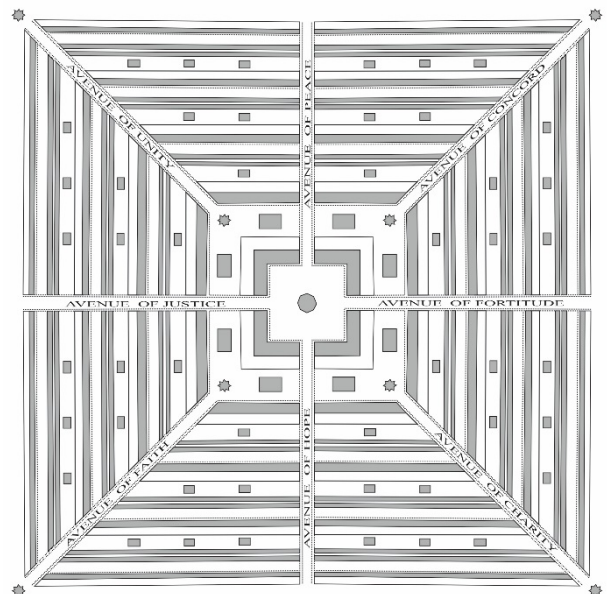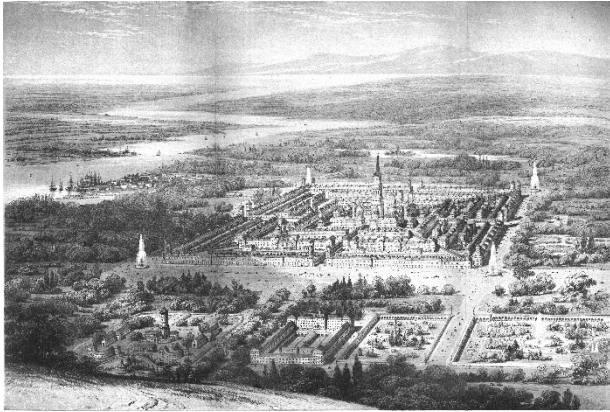ineteenth century American corporatism seemed to be boundless. In The Human Drift Gillette (1976) proposed the forming of a united stock company, United Company, owned by the people. The company would be of significant magnitude to gradually absorb and finally control all the production and distribution of the necessities of life. Such a company would destroy all tributary industries of the present system that do not contribute to production and distribution. He advocated a system of united intelligence and material equality. This system would eventually eliminate the use of money and "the manual labour incident to production and distribution would be equally apportioned to each individual without friction and with perfect justice (vii)." The company would monopolise all production and eventually take over the entire government as there would be no need for government as everything was supplied by the company – the company would be the government but it will be run by the people. The population of America was 70,000,000 at the time and Gillette believed that there was only a need for one city of 60,000,000 people. The housing would be egalitarian and he designed suitable prefabricated housing with buildings of the same in design the decoration and the colours would mark

their individuality. There was no centre, the government buildings were the same as the accommodation for the workers.

Although Peck agreed that a single company could take over the production and the government would become the company's board his approach is very different to Gillette's and the city reflects their political difference. In Peck's The World in a Department Store (Peck, 1900) the society was hierarchical and although the company, Cooperative Association of America, controlled all production, it was not distributed to the people, as they had to buy shares. Since it was a monopoly there was no choice who was the supplier of all things in society. There was structure to society and although hours of work were lower there was still a class structure that regulated wages and even where people could live. To house this society Peck's city is also hierarchical. He chose the architecture of The Beautiful City Movement and in the centre is the administrative building which is larger and more dominant than any building in the city.

Figure 19: *Camp King Gillette's Metropolis*

Figure 20: *Peck's The World in a Department Store*

Each of these utopian cities produces a city that enhances and supports their political philosophy. None of these cities were ever built. Reconstructing the city enables an analysis of the buildings and the urban layout. It is possible to walk around the city to see the relationships of buildings and the permeability of the city. Early in this project the author tested four cities on a modern audience with a colleague Mark Rubin. The cities were City of the Sun, Christianopolis, a Village of Unity and Cooperation, and Victoria. The survey was set up that consisted of walks around these cities and the audience was asked how they felt about the cities. The survey revealed that

the participants of the survey disliked the architecture but indicated a very positive attitude and interest in the environmental quality and livability of the cities, in particular their safety, order and organisation, spaciousness and permeability or spatial planning. In short, the interest was in the desirable qualities of a city that were required by the authors of the utopian literature to promote their political philosophies (Morrison and Rubin, 2014; Rubin and Morrison, 2014).

3. CONCLUSION

The cited utopian authors created these cities in social reform literature and although they were never built they were intended to be true architectural models to satisfy a particular political philosophy. The political philosophies of the chosen cities varied a great deal from era to era. Some had extreme political philosophies such as eugenics, some were extremely paternalistic with a government that acted for the 'good of the people' while others considered equity and egalitarianism in both the lifestyle and politics to be a fundamental principles of the city. However there is commonality in most of their design principles.

The strength of all the utopian models described in this paper is their open space, connectivity and permeability. All elements that are fundamental to good town planning, however in the majority of the cities were designed when town planning did not exist as a discipline. The cities were designed for social networking and although they were designed intuitively the symmetry and large open spaces made that the designs consistent with the principles of good town planning. Like the island of Utopia they had no particular location, they were 'nowhere', but unlike Utopia they were intended to be realised and to create a better lifestyle and working condition for the inhabitants of the city. Reconstructing the models highlights these features. It brings a better understanding of utopian models and philosophy. It brings the utopian ideal alive.

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Making intangibles tangible: Visualisation informing, engaging and empowering community through the public domain.

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Historic Urban Landscapes (HUL) and Visualising Ballarat, are technological innovations with mapping, imagery, a knowledge bank, stories, videos and social networking elements. They support the establishment of HUL in Ballarat - the first international city to implement the UNESCO recommendations for Historic Urban Landscapes. The innovations seek to increase sustainability through embracing, in planning, built environment, intangible heritage, cultural diversity, socio-economic factors and local community values (UNESCO, 2013).

The portal seeks to engage communities in knowledge building and planning, drawing on location specific views of cultural heritage. Through knowledge sharing, crowdsourcing and collaborations, values and culturally relevant conceptualisations of place and space are shared through the medium of technology. In the first wave of a four wave, three year study, the CeRDI research team at Federation University Australia has examined implementation issues and challenges relating to these technologies. Findings show that the theoretical concept of empowering individuals and communities to shape planning has been embraced by government. It is viewed progressively, with values, cultural norms and identity considered pivotal to building connection between the past and the present, particularly intangible elements of cultural heritage and landscape. However, while assessed as an exciting technological innovation, questions remain. Open sharing of government information, and allowing community knowledge to be incorporated into a new public domain of knowledge, is meeting some resistance. Adoption requires a shifting of power and control in community planning and an acceptance of the public domain as a legitimate tool for shaping priorities for action. Trust must be built and individualised perceptions and values embraced; a fundamental shift of control and the establishment of a new cultural norm. This research provides valuable new insights into the cultural shifts required for collaborative decision making within a new public sphere if a culture of inclusion and ownership of change processes is to emerge.

1. INTRODUCTION

In September 2013 the City of Ballarat, Victoria joined an international pilot program to implement the UNESCO recommendation on the Historic Urban Landscape (HUL). The HUL seeks a synergy between the planning and development decisions of urban planners and the complex and interrelated elements that make up a community within its lived environment.

This approach reflects a global movement recognising the critical importance of local voices, values and identity in determining what communities seek within their landscape (Bandarin & Van Oers 2012, Hawke 2012). Increasingly at the local, national and international level, infrastructure and built environment are no longer the single defining features of urban planning. Intangible community traits and identity, tourism, unique community behaviours, values, beliefs and practices, connection with natural settings and cultural and economic elements increasingly play a critical role in building vibrant, sustainable and liveable communities (Schafers *et al.* 2012, Stratigea 2012, Van Oers & Pereira Roders 2012).

Central to this conceptual shift has been a call for greater collaboration between government and community, the building of relationships for planning and development between academics, practitioners, industry and community, as well as greater civic engagement and community participation. This call reinforces the notion that preservation of the physical environment constitutes only one element of planning sustainability and that there are, in reality, a myriad of tangible and intangible aspects of the human environment that are of pivotal consideration in planning and design. (European Union 2011, Stratigea *et al.* 2015, Taylor *et al.*, 2014; Van Oers & Pereira Roders 2013).

The City of Ballarat has been an advocate for this approach (Buckley, Cooke & Fayad 2015) and has embedded this commitment in strategic planning processes (City of Ballarat 2015). As part of this work, the potential of spatiotemporal data in mapping locally specific information was recognised as a pathway for more effective urban planning and analysis. This awareness aligned closely with emerging research insights relating to the use of this type of tool in building smarter cities (Sagl *et al.* 2015).

In 2013, a strategic partnership was developed between the City of Ballarat and the Centre for eResearch and Digital Innovation (CeRDI) at Federation University Australia to explore options for digital solutions to this identified need. The result was online technology through which to build capacity for civic participation and support the proactive involvement of citizens in decision making using spatiotemporal data. These innovations emerged as two web portals that aimed to place the citizen as a key player in the urban planning process. Importantly, the development of these tools supported a paradigm shift for this local government; one in which the rhetoric about inclusion and participation assumed the potential for operational reality through practical, usable and accessible resources.

2. THE WEB PORTALS

The web portals sought, in their establishment, to:

1. Proactively respond to the increasing awareness of the importance of citizen participation for sustainability in urban planning (Bugs *et al.* 2010, Rowley 2011).

   Information technology has been consistently assessed as providing an accessible and inclusive mechanism for citizen participation. It increases the likelihood of decision making informed by public insights on the unique needs of particular locations and contexts. This is, in turn, likely to maximise the success of planning decisions in the lived environment (Dameri & Rosenthal-Sabroux 2014, Toker 2007).

2. Use technology as the conduit through which to maximise knowledge building, reciprocal information provision and participatory planning with the greatest possible number of individuals, groups and communities. This approach aligns with insights from available literature on the role of information technology in facilitating active participation in decision making through access to knowledge and the knowledge management process (Busch 2011, Cegarra-Navarro 2014, Huysman & Volker 2005, Lloyd-Smith 2009, Zimmerman & Meyer, 2005).

   Contemporary businesses, community organisations and government are, in a process of digital transformation, working to engage with service users through the medium of information technology (Baker 2014). This ability to engage through technology is particularly valid for groups and individuals that have traditionally been excluded from urban planning participatory processes. Requirements to write submissions, attend community consultations or be involved in face to face negotiation with planning bodies present significant barriers to engagement and participation (Cahill 2007, Hunt 2013, Jakhanwal 2014, Mahjabeen *et al.* 2009, Storey *et al.* 2010). Technology provides a mechanism to break down barriers and better understand the complexities of urban locales across diverse groups and diverse areas of need.

The two web portals that have been developed are:

1. the HUL portal
2. Visualising Ballarat.

2.1 The HUL Portal

The HUL portal, is a civic engagement tool. It seeks to support community members, practitioners, researchers and other key stakeholders to come together in an interactive way to inform and share. The web portal allows an individual to 'See', 'Show', 'Talk' and 'Research' a range of ideas and thoughts. Through the 'See' portal page, end users are able to see historic before and after images of Ballarat, access photo maps, view timelines, and an image gallery. The 'Show' and 'Talk' pages provide opportunity for contribution through feedback and pictures. The fourth page 'Research' provides a range of resources for academic, industry and community researchers to load and share their research. It has a range of uses – from the practical, such as locating mine workings and landfill sites – to the esoteric, such as immersive augmented reality experiences of historical places and events. A snapshot of the portal is provided in Figure 1.
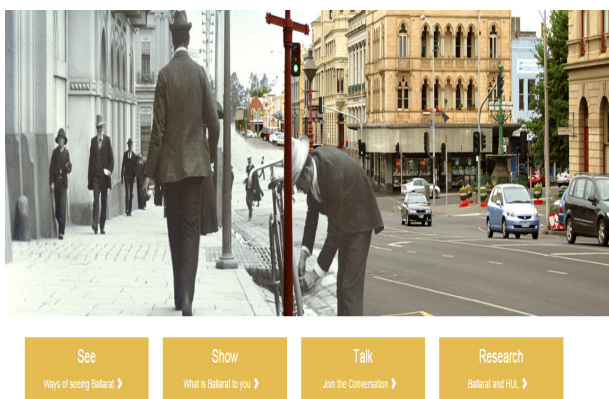

Figure 1: A snapshot of the HUL web portal

2.2 The Visualising Ballarat Portal

The Visualising Ballarat portal is a stand-alone spatial mapping tool (which is also embedded within the HUL web portal). The use of mapping technology has been assessed as an innovative mechanism through which to build, maintain and respect connection to landscape (Casatella & Carlone 2013, Garcia *et al*. 2014, Quon Huber et al., 2009).

In line with these research findings, Visualising Ballarat allows for information sharing across the built, cultural, natural, visual and sound environments. The strength of the portal is that it provides a single point of access to federated data drawn from a range of data sets. The mapping function allows for a visualisation of diverse data which, through layering capabilities, enables elements which capture community values, identity and place to be mapped and highlighted.

The capacity to capture visually, and often simultaneously (through the use of overlays, particularly 3D overlays) a range of physical, environmental, social, economic and cultural domains provides a concrete, hands-on tool for exploration, and for research. It supports the identification of the intangibles that people value within their community but which are often not able to be

captured in written form or through simple descriptors. Through mapping a range of important aspects of an urban landscape such as buildings, streetscapes, sound scapes, view lines and historical points of significance, social and cultural hubs or events, the complex living landscape is more readily captured, defined and shared to inform decision making processes. If end users are able to map and view areas of interest across a range of dimensions, have input, and have it respectfully listened to, then past perceptions around exclusionary approaches to information sharing and input into decision making are more likely to diminish (Detres *et al*. 2014, Fahy & O'Cinneide 2009, Panek 2015).

Most importantly Visualising Ballarat works to establish a platform for collaboration between urban planners and individuals, groups and communities.

Figure 2 provides a snapshot view of this portal.
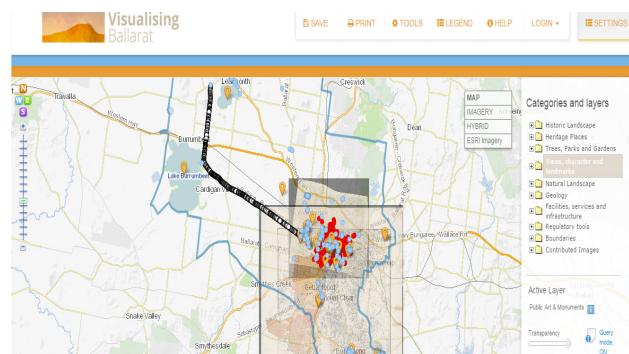
Figure 2: A snapshot of Visualising Ballarat

The focus of the HUL portal is on civic engagement within the context of urban planning and the Historic Urban Landscape, and that of Visualising Ballarat is on spatial mapping of diverse data sets across a range of domains, of which urban planning is just one. In combination the portals seek to provide a mechanism to shift power, ownership and control over knowledge and decision making processes in the following ways.

- Through shifting information flow, knowledge and planning information and input into the public domain. The portals can be accessed on mobile devices as well as desktop computers to facilitate ready access at any time or place.

- Creating a greater capacity to capture defining features of place, identity, values and culture. This capacity strengthens as increasing pools of diverse data are included on, and shared through, the sites.

- Building a gateway for input for both previously engaged and participating citizens and for traditionally disengaged or excluded citizens to tell their stories, share their knowledge and shape decision making. The crowdsourcing capabilities of the site are particularly significant in ensuring that voices are heard in an open access location.

The links between the portals, accessibility, end users

and crowdsourcing in informing urban planning is captured in Figure 3
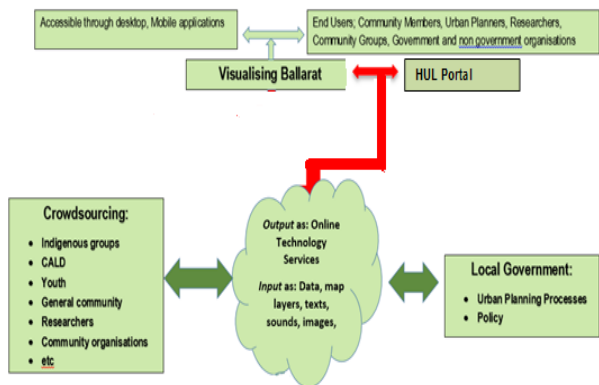
Figure 3: *Linking the portals to urban planning*

This resource has allowed for the development of an alternative way to place information in the public domain and aligns closely with notions of Public Participation GIS and spatial mapping as tools for public participation (Elwood 2006, Nyerges *et al.* 1997). The importance of empowering individuals to become active participants in the engagement and planning process was a key consideration during the developmental process. The initial stages of implementation where characterized by the provision of ongoing support to key stakeholders. This occurred through ensuring that program staff were available at the local government level to meet with individuals and groups and support upload and interface. CeRDI technical and program staff were allocated to work closely with local government, other agencies, groups and communities to support uptake and ongoing engagement. A PhD student was also funded to support the ongoing development of technology to maximise the usability and engagement potential of the portals.

3. THE RESEARCH PROCESS

Part of the development of the HUL and Visualising Ballarat portals, was a commitment to undertaking ongoing research over the first 3 years of the project. The research aims to track implementation, citizen uptake and input, as well as the impact of the portals on decision making, policy development and practice.

The research design for the study involves four (4) waves of data collection. The first wave occurred at 6 months post establishment of the portals, with the second wave set to occur six (6) months after the completion of first wave data collection and analysis. The third and fourth waves of data collection will take place at twelve (12) and twenty-four (24) months intervals.

This current paper reports on the findings from the first wave of data collection for the HUL and Visualising Ballarat portal.

A mixture of qualitative and quantitative methods were used in the study. The use of quantitative methods was driven by the need to track usage levels, to gain assessments of the quality of the portals, as well as insights on constancy and frequency of use by research participants.

Qualitative methods were used to gain the subjective perceptions of research participants around the value of the portals. In particular levels of engagement and empowerment for involvement in the planning and decision making process were examined.

There were a total of 71 participants involved in the research using the following data collection methods:

- Individual and group interview
- An online survey
- Portal usage analytics
- Program document analysis

This multi method approach allowed findings from each of the methods to be cross-referenced. It establishes a process whereby issues that were not addressed/identified through one data collection method were picked up through alternative methods. Data validity was achieved through the use of both methods and data source triangulation. Methods triangulation was achieved through the diversity of approaches used for data collection (interview, survey, service usage analytics and document analysis). Data source triangulation was achieved by ensuring maximum diversity in the type of end user involved in data collection. Participants included local government employees, community members, those with expertise in heritage and museums and academic and community researchers.

The key research questions used to inform the findings presented in this paper were:

- What elements of HUL/Visualising Ballarat have most effectively supported and facilitated knowledge development for the maximum numbers of potential end users?
- What have been the key impacts of HUL/Visualising Ballarat for a range of key stakeholders, including historians, researchers, planners and community members?
- In what ways does open data access, as provided through the tools and mechanisms of eResearch, impact on decision making and facilitate change?

4. RESEARCH FINDINGS

Analysis of the data collected in this first wave of data collection provided valuable insight on usage and on stakeholder perceptions of this type of technology for engagement and empowerment.

4.1 Early stage wins for digital innovation

Statistics for usage and frequency rates showed that there had been a steady increase in usage of both the HUL and the Visualising Ballarat portals in the months since establishment. Usage of the HUL portal was found to have increased by 178% from the first month of establishment to the month in which usage data was collected. Figures for the same timeframe for Visualising Ballarat found an 869% increase in usage. This upward trend for access for both portal was found to be consistent across the six month study timeframe and not attributable to any outlier effects.

Participants consistently reinforced the extent to which the visual elements of the web portals engaged end users. The possibilities that accessibility to spatiotemporal data provides for knowledge building and planning was a strong theme that emerged across both interview and survey data. The provision of a single point of access, drawing on a range of different data sets simultaneously, was assessed as a major strength of the portals and one of the elements most highly valued by end users.

Analysis of qualitative research data tracked a strong theme that the placing of key information in the public domain was establishing a digital pathway through which to disrupt previous, more traditional, practices for consultation in urban planning. The appeal of the portal, for both government and community research participants, as a means to place important information in the public domain, is captured in representative statements such as:

> There is a lot of work about to go on in terms of consulting with communities. The web portal could be an important part of that process. It provides a way to sit down and work with people to capture what is in place, what matters and what they would like to see included and treasured as vital to their community – what they value. This is a very hard thing to negotiate and HUL provides a way to do this… then they would also be engaged in using and contributing to the site into the longer term. We have to talk, talk, talk and the portal can be part of that
>
> [Interview Participant: Local Government Cluster].

> The thing that I really like most is the maps. I think they are fabulous. I love the way using the overlays to look at all kinds of different things like areas of grass being burnt, or where the heritage overlays show up. Things like that are really great [for planning and community understanding]
>
> [Interview Participant: Historian and/or Academic Cluster].

> Public mapping tool is useful for my work…The information provides a good overview and relationship of the urban development, geology, historic mining and geographical terrain. It is interesting to see how the information is presented in different ways…The mapping in particular is what I like and Visualising Ballarat has heaps of potential for a tool for planning practitioners

> [Community Member - Survey participant]

The potential of this type of resource to empower groups that have traditionally been marginalised from involvement in planning was identified previously in this paper. The research found that this theorised potential was being conceptualised as a practice reality through the mechanism of the portals. The portals were assessed by research participants as a means for these groups to disrupt, through a digital pathway, practices and processes that have been inaccessible to them in the past. This view is captured in statements such as:

> … empowering for people that traditionally feel isolated by the standard engagement processes, I suppose. So, if we show people how to use it, or even just go on and look at things two things will happen: it will make people say "I've got a story to tell", or "I could share some information…I didn't think what I had to share was valuable'…It's got lots of potential like that
>
> [Interview Participant: Local Government].

> … a two-way learning process… enabling newly arrived community members to learn about Ballarat's history, but not just one way, a reciprocal learning process of what they can offer to heritage and planners too through how they interact with the city
>
> [Interview Participant: Community Organisation].

> … engaging and empowering those not yet connected to tell a variety of stories, migrants, Indigenous etc. The portal will help connect people who are already connected then has a social responsibility to seek out and engage those not yet engaged
>
> [Interview Participant: Museums & Gallery Cluster].

These findings provide a generally positive picture of the role of information technology in building connection and empowering community. By placing key information in the public domain and ensuring that there was capacity for crowdsourcing, there was a general sense of positively moving forward.

A key finding of the study was the importance placed on crowdsourcing as a mechanism to shift participation from something static (accessing information that individuals might use to lobby council) to something interactive (having the capacity to not only gain information but shape the knowledge building process; collaboration over external lobbying).

> Crowdsourcing…I think there's some really interesting possibilities there both for communities to generate material and to sort of upload their stories. And awareness I suppose of different elements of community culture within the city. And to share understanding and I suppose stories about particular places or events or whatever. So I could see it becoming quite a market place for exchange of information and ideas, and people putting up things… just the fact that there was a mechanism for groups to get involved and operate in a cooperative fashion
>
> [Interview Participant: Museum & Gallery Cluster].

The capacity that the portals provided for interactivity was identified as one of the most significant features of the resources. Research participants identified that interactivity provided a concrete way to begin to capture and record the intangibles that define communities, but are often overlooked in planning processes focused on the provision of buildings and infrastructure. Available literature has consistently reinforced capacity for interactivity as pivotal to sustainable collaborative practice with government and successful e-participation (Hanzl 2007, Kingston 2002, Rowley 2011).

As part of identification, during data collection, of the importance of interactivity in collaboration involving the public domain, a continuum to measure success in building a digital pathway for public participation was developed. At one end of the continuum, web portals are accessed for entertainment. In this context access will be intermittent and, while some end users may access regularly, others will access on a one off basis. Regardless of the number of times the site is visited, the relationship remains one directional; the user takes what is offered and provides no input beyond hits on the site. At the next point the user accesses the site for information of relevance to their need. There is an increased level of involvement in that the information is accessed for a specific purpose and information gained is likely to impact on understanding, perceptions and actions. The relationship itself however remains one directional. As the information provided, and the way in which it is provided, becomes more useful, there begins to be a shift in frequency of access, use of information and level and type of feedback for what is most and least relevant to end users and their communities (personal and professional). At the far end of the continuum, the relationship has become reciprocal. The site provides a range of information, is useful, is entertaining and has the capacity for user input to shape content. The content itself has begun to reflect elements that define and empower the user group. The capacity to move from entertainment to interactivity is determined by the extent to which 10 factors are rated positively. These factors are:

1. level of usage;
2. visual appeal and innovation;
3. frequency of use;
4. quality of information;
5. usefulness of information;
6. community/ industry/ sector connection with, and ownership of, the portal;
7. relevance of content across user groups;
8. capacity to accommodate and support user input;
9. flexibility for change;
10. trust in the power of the resource to facilitate change and empowerment.

This model is provided in Figure 4.
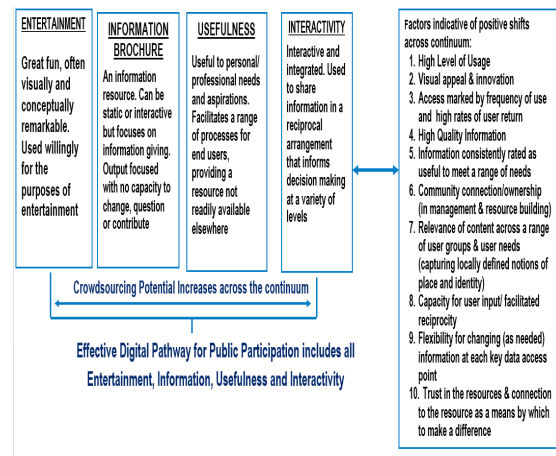
Figure 4: *Increasing the lasting impact of technology*

This model was used in the research as one tool to measure the impact of the portals in achieving a digital pathway between information placed in the public domain and collaborative urban planning processes. Data analysis showed that the portals, at early stages of establishment, had begun to move beyond entertainment and information and into usefulness. The ability to move closer to interactivity was closely aligned with crowdsourcing capabilities and the extent to which end users were able to feel confident that their input was valued and trusted. It was at this point of the research process that potential barriers to using the portal for empowerment, collaboration and participation were identified.

While the feedback at this early stage of the four (4) wave data collection process was indicative of implementation success, the data also highlighted that there remain power differentials that need to be addressed if the portals are to achieve their goals into the longer term.

4.2 Power imbalances limiting digital disruption

A strong and consistent theme in research literature on community participation and local government has centred on issues of trust and power imbalance. Analysis of power differentials and trust building within the context of technology for civic participation has consistently found these factors create barriers to relationship building. High levels of civic participation and equity in decision making are likely to remain limited if key stakeholders are unable to overcome levels of mutual distrust. Barriers to success also emerge if there is a continuing attribution, by local government decision makers, of a low value to community knowledge in informing planning. Position, status and a resistance to the devolution of power to community have been identified as barriers likely to impact negatively on building connection and social capital. At the same time, low levels of trust, by community, of local government, act as a barrier to input and to positive development of collaborative prac-

tice (Brackertz & Meredyth 2009, Luck 2007, Jardine *et al.* 2013, Robbins 2011, Roskrudge *et al.* 2013).

The issues identified within the literature were found to be present amongst participants to this current study. While the majority of participants were strong supporters of the initiative and promoted its value as a tool for inclusive practice, there remained barriers to success based on embedded distrust and resistance to devolution of power. For community, this resistance manifested as a level of cynicism around the capacity of local government to enter into an equitable relationship with community members. There was a view, amongst a small number of research participants, that relinquishment of control of information and of resources was likely to be resisted by local government. This view is captured in statements such as:

> The guiding principal was always that it's not solely a council branded thing setting up a traditional citizen and government relationship, us vs them. The HUL concept is very much about being community driven and not owned by council.
>
> [Interview Participant: Historian and/or Academic Cluster].

From the perspective of research participants from local government, the notion of open access to data was responded to dichotomously. While, when discussed in the abstract, the notion of placing information within the public domain, using an interactive approach, was embraced, there was resistance when discussion moved to the point of practical implementation.

While participants view the portals as exemplars for gaining insights on defining characteristics of local communities, and for better understanding place, culture and identity, the open sharing of resources in a public domain was more challenging.

This view is captured in the following extracts of interview:

> we want that information stored in this single source of truth. We don't want to have new data being put on there and not being made aware of it, when it's something we have perhaps missed. I think it is too problematic and how could you trust the information for accuracy and there are things that I just don't see the benefit in the public having access
>
> [Interview Participant: Local Government Cluster]

> Well we would have to be very sure that it was correct and that people couldn't just put whatever they wanted on the system as people can use this (for their own agenda).
>
> [Interview Participant: Local Government Cluster]

These insights flag the importance of working to address historic tensions and barriers between community and local government to maximise the potential for success in moving urban planning into the public sphere, through technology.

There are a number of existing strategies that are likely to facilitate this within the current approach to project implementation.

A key strength of the initiative has been the existence of a champion within local government committed use of the public domain as a mechanism to engage community. This has been instrumental in shifting perceptions on the value of this type of resource. It has also helped to redefine digital disruption as a positive and inevitable consequence of digital transformation in local government. The role of a champion for supporting adoption and acceptance of technological change has been identified in literature (Kamal *et al.* 2011) and was shown, in this research study, to play an important role in effective change processes.

Resistance to change can also be countered through the use of incentives and the establishment of clear outcomes (Davies *et al.* 2012, Jackson *et al* 2012, Vitartas & Scott 2006). Data collection and analysis for this current study highlighted that this was an approach that was beginning to make inroads in building trust and cooperation. For local government, the ability to minimise conflict in planning, particularly for rapidly changing communities, was viewed as paramount to moving forward. The locality has a number of new developments, a rapidly growing population and key heritage areas. The successful combination of this diversity represents a challenge to policy makers and planners. The challenge of addressing rapid change processes has meant that, while there was concern about shifting the boundaries of power and control, the potential for working collaboratively with community was also an incentive for power sharing. The awareness of these challenges, and the role of the web portals in supporting change processes, was clearly identified as a catalyst for change.

> If we could sit down with people and show them and give them examples and show them…then that sort of thing spreads like wildfire and people spread the word to other people and then they pick it up and so on and so forth. That is my priority at the moment –making connections and understanding how to work together best. The people are just great and anything that can help us ….If HUL can do that then that would be so good... and if they can keep adding stuff then that is even better
>
> [Interview Participant: State & Local Government Cluster].

For community stakeholders incentives were found in building a greater understanding of the history of their location, and in being part of the process of building a local identity. This was consistently acknowledged as a major incentive for working with local government to address historic barriers and create a new planning environment.

> one stop shop portal to be able to find out information about the places that they live, and you know the houses they live in, or the community they live in… so being about to get all that information about my house and what regulatory controls there are on the property in

*one place. Being able to just type in an address and see
is there a heritage overlay for my property, what are the
controls, (and build and add to that story) That's fantas-
tic.*

[Interview Participant: Community Cluster].

As community stakeholders begin to see the ways in
which their input is being used in decision making
processes and as planners begin to gain previously in-
accessible insights to positively inform and shape plan-
ning decisions, levels of trust are more likely to be built.
The use of the web portals in Local Area Planning and
the commitment to gaining community information
through social media and crowdsourcing were out-
comes that were assessed as likely to enhance connec-
tion into the future.

The identification of barriers to change that was iden-
tified in the data gathered through wave one (1) re-
search has provided a good baseline to shape proactive
action for change into the future. A review of research
outcomes has resulted in a commitment to work with
key stakeholders to increase incentives, maximise short
term measurable outcomes and target resistance to
change. The project champion will play a key role in this
process, as will the establishment of a community based
committee that will target representation from across
diverse groups and locations. This embedding of change
at a community level, and with representation from dis-
advantaged, and currently disengaged, groups, seeks to
maximise the capacity for engagement, empowerment
and success.

The extent to which these outcomes and incentives
shift power differentials and build trust is an area that
will be closely monitored in the 2nd, 3rd and 4th waves of
data collection for this study. This is an important area to
monitor to ensure that the emerging capacity for tech-
nology to provide a point of disruption is realised to its
maximum potential.

5. STUDY CONCLUSIONS

The research process highlighted the potential of tech-
nological innovation to empower communities to be-
come involved collaboratively in the urban planning
process. The findings reinforce existing research knowl-
edge relating to the critical importance of stakeholder
participation and civic engagement to effectively plan
for cities of the future.

Technology was found to be particularly valuable for en-
gagement of individuals and groups that had tradition-
ally been excluded from planning processes. The placing
of information into the public domain, while valued, was
significantly enhanced by the capacity for user input
into knowledge building and into shaping understand-
ings of place, culture and identity, and the role they play
as the intangibles of the urban planning process.

While there remained some barriers to integration of
key stakeholders into urban planning, linked to exist-
ing power imbalances and distrust of local government
structures, the identification of these in the early stages
of implementation and research has provided a poten-
tial for the development of proactive response strate-
gies to bring about change.

The imperative to engage, build capacity and map out
incentives for participation was viewed as paramount to
the next phase of development.

The placing of information within the public domain,
supported by tools for interactivity and collaborative in-
volvement represents a shift in traditional approaches to
urban planning. The web portals continue to build a dig-
ital pathway toward inclusion, knowledge sharing and
collaborative participation in planning. The challenge
for stakeholders to overcome historical barriers and em-
brace the change process, accepting the public domain
as a legitimate tool for shaping priorities for action.

The first wave of research has provided insights into the
cultural shifts required for collaborative decision mak-
ing within a new public sphere. These insights will pro-
vide the basis for future development of the initiative to
maximise a culture of inclusion and ownership of urban
planning within the public domain.

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A poetics of computation: critical approaches to reading and writing with data

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We are interested in how data are produced and embodied, both in digital networked culture and as the material for creative and critical inquiry. Our ongoing practice-led research is concerned with the possibilities for thinking about systems in ways that shift dominant ideas about gender, media and technology – in particular, how these ideas are no longer (or perhaps never have been) adequately described by discourses of signification and representation. This year we have been working on a transdisciplinary art project, engaging a material understanding of computational processes and a critical approach to how these processes produce knowledge. We take this engagement as poetic—concerned with the expressive, emergent and (re)combinant capacities of language in a dynamic media ecology. Our work so far has been concerned with the 'real time' of computational and critical labour, manifesting in two durational works for which a co-written text was produced over time while situated in an unfolding public event. The first was 'The Living Index', conceived as part of Zoë Sadokierski's *Book of Days* project at the Sydney Writers' Festival. The second was 'Affective Citations', conceived for Liquid Architecture's 'Beyond Capitalist Surrealisms' event (focused on the intersection of sound and art) and in response to their prompt: 'What would a feminist methodology sound like?' This paper will introduce our collaborative focus and discuss both works in terms of our methodology and the contingencies that come into play with open systems that actively consider how the digital and analogue are entangled. It will also propose the broader aims of the project, in terms of the possibilities of a critical understanding of digital networked culture and the gendered history of technology. We will draw on recent feminist scholarship including key texts by Luciana Parisi, Tiziana Terranova, Jasbir Puar and Karen Barad.

1. INTRODUCTION

An association of code with poetry endures. The phrase 'code is poetry' figures as a kind of truism of programming; used by WordPress, to cite just one example, as a tagline in order to emphasise the flexible back-end of its blogging software. Treating code as personal and personalisable, expressive and idiosyncratic depends on a fairly typical humanist concept of poetry as a—perhaps even the—signal practice of subjective meaning-making. Poetry, in its most conventional sense, is an expression of individual experience that appeals to a shared or connected sense of how experience is made meaningful; a good poem demonstrates insight, sensitivity, perceptiveness, attention to detail, knowledge of form, rhythm, metre and rhyme, and so on. By this account, code as poetry highlights the mastery and artfulness with which programming languages can be composed, demonstrating insight and knowledge of form in a way that is at once individual and in the service of a broader or greater meaningfulness. Conventionally speaking, then, poetry and code are both compositional practices in which the signature of an author is apparent in the closeness (often to the point of assumed indivisibility) between the act of writing and the object of representation (in poetry this is understood as a symbolic meaningfulness or 'truth'; in code as a functional meaningfulness or sublime utility). Good writing is that which seems not at all like writing but like a direct communication with reality.

There is another way, however, to read this association. It requires a critique of the conventions of both code and poetry—or perhaps more accurately, it requires a critique of the very idea of writing. Read differently, writing can be understood as social rather than personal, relational rather than unidirectionally expressive, posthumanist rather than humanist; in short, as a practice that engages and is engaged by a tremendously complex constellation of dynamic and diverse agents. Poetry and code are modes of writing that are attentive to the coming-to-be-made in order to emphasise the aesthetic and political dimensions of making; put differently, poetry and code, in companionable senses, are interested in the explicit connection between composition and consequence. Thinking of poetry contra the conventional sense we outlined above, the poem becomes not a moment of pause for some contemplation of truth, nor a glimpse of truth hidden behind habit, but a site in which the technics of truth are made apparent. Language in the act of becoming is language pointing to the processes by which it is used to lay a claim or make a law. Poems show this becoming as a consequence of their form: materially emphatic, self-conscious, intra- and intertextual. Veronica Forrest-Thomson called this the 'artifice' of poetry; poetry as a form is exceptional for its explicit and reflexive use of its construction (Forrest-Thomson 1978). In other words, a poem is formally and performatively 'a poem' insofar as it is constructed as such, and in constant reference to its broader discursive and aesthetic environs. As Lori Emerson notes, historically speaking poetry has always "registered the media effects of a given moment"; our moment is defined by an overabundance of heterogenous mediatic assemblages and ecologies (Emerson 2015).

In this paper we want to explore the acts of reading and writing data in the context of these mediatic assemblages and ecologies. By data we refer to both analogue and digital phenomena and by reading and writing we refer to compositional practices that include poetry and code. Writing data is typically seen as an act of measure; to extract, record and store values from the world. Reading data could involve the task of simply reading these values, however, to read data usually involves some form of iterative method in order to transform it into information. Tiziana Terranova describes data as material to which scientific or technical labour is applied in the production of knowledge (Terranova 2015). This work involves the iterative processing of data as a way to unveil or draw out information through making perceptually sensible patterns, inconsistencies or correlations between data values. The transformation of data to information is one of sensible re-contextualisation, (usually visual) with qualities of clarity, efficiency and precision marking the success of this process (Tufte 2001). If the above describes a general understanding of data, then our research seeks to examine reading and writing data as practices that are always contingent on particular (and embedded) durations in which highly specific material flows and processes of iteration and enaction contribute critically to acts of composition.

Data labour, the reading and writing of data, generally involves computational technologies and their processes. These processes are written as code and known as algorithms. The ubiquity of networked computation has fostered entropic data production, and its capacity for repetition is employed in the processing (and further production) of data. In this ongoing cycle of cause and effect, code is attributed as essential to and determinant of the logics of reading and writing data. The fetishisation of code as 'the defining logic of all things digital' is being contested in recent writing by Adrian McKenzie, Wendy Chun and Anna Munster (McKenzie 2002, Chun 2011, Munster 2014). Our research continues this line of thought, and through a consideration of critical data labour practices, problematises the writing of data as measure and the reading of data as rationalisation through an engagement with the physis of its artifice. This can be used to draw out and investigate the materialities and frictions involved in coding practices that de-emphasise but do not forgo the human and that acknowledge the many agencies and energetics that are co-constitutive of mediatic assemblages that include code (this is as opposed to assuming code as the fundamental operator and the single element of theoretical and practical investigation).

This 'material turn', so to speak, in critical media studies (a field in which we position ourselves), is no mere shift in emphasis, but engages the enduring contradictions

in the operations and representations of digitality. Incorporeal understandings of computation are still suffused in the quotidian ('cloud' computing) and in media theory (early notions of 'immateriality'). Recently, critics have worked to challenge these reductions and to make sense of and find ways to describe the complex materiality of digital infrastructures and processes. This has occurred, and continues to occur, alongside reconfigurations of the concept of materiality itself, notably in the still-emerging field of new materialism and in ecologically inflected science and technology studies. This has been done forensically, though the display of the gross quantities of physical material substrate of computation and data storage, and formally, in interactive, graphical or textual creative practices (Drucker 2012, Kirschenbaum 2008). Computational processes themselves are not perceptually sensible, we cannot fully know them through looking at, for example, the material substrate of a computer or how they are made to appear as tangibly present 'technologies'. Computation, simply put, is not sensible. This is why there has been the impetus to consider its performative and material dimensions in order to engage with its capacities to produce and be affected by novel structures and processes of 'knowing'. For making in a compositional plane that anatomically includes computational infrastructure, computation is far from immaterial, and its materiality is apparent forensically, formally and performatively. In this paper we are attempting to give an account of our practice in such a way that is open to the different material modalities at play in critical data labour—paying particular attention to the relations, rhythms, durations, dynamics, energetics, movements and affects of and between bodies prior to, during and after the act of composition.

Much art engages computation and data but obfuscates their operations; the focus is on what is formally produced via the engagement. Artists who work with computation and data explicitly/visibly often reflexively and critically accentuate what data is, what data practices do and can achieve, and the broader social, cultural and intellectual impacts of data. This reflexivity is doubled in media arts, a field that claims the politics of mediation and media-specificity as both the object and subject of its inquiry. In data art, we argue, reflexivity is deployed in order to reveal something meaningful about subjectivity in a given world. In a challenge to this kind of reflexivity, we propose a model of approaching compositional practice in which artifice (the 'madeness' in the broader context of making) is emphasised in order to reveal what is unknowable in simple subjective terms and yet which is constitutive of the world never fully given.

This requires, necessarily, a material understanding of what practice actually does—the constructive and performative energetics of composition. This detaches data and data practices from notions of truth, authenticity or objectivity. This is not to say that the information produced in data practice is false, but that the truth claims made by data are not naturally 'so'. Put differently, data are real but not singularly true. Computational data

practice (in art and elsewhere by extension) becomes one of reiteration and recombination in a structure or field of (cultural, social, scientific) discourse; through this, data practices are always-already involved in the real. We align this idea with Karen Barad's theory of agential realism, which rejects measurement as representation, as in, the notion that there is some direct and authentic connection of measurement to the real (Barad 2003). Instead of representation, which deals with and affirms the bond of measure between words/images and things in the world, we instead have "a causal relationship between specific exclusionary practices embodied as specific material configurations in the world (i.e., discursive practices/(con)figurations rather than "words") and specific material phenomena (i.e. relations rather than things)" (Barad 2003 p.814). Practices that treat data are thus exclusionary (insofar as they occur in a specific discursive space) and presentational (or, to use our own term, 'additive'). An insistence on artifice and on causal rather than direct relations (qua representation) shifts critical readings of the outcomes of data practice from value, meaning or representation to presentation. This opens up consideration of the enaction of data— how data are read and written. It also emphasises the politics of making, the way that the codes and infrastructures of data contribute to and limit the possibilities of discourse and composition. These include social, cultural and technological constraints that define the scope and viability of practice and critique.

2. LIVING INDEX

The 'Living Index' was conceived as part of a broader project, The Book of Days, by visual communications researcher and book designer Zoë Sadokierksi. Sadokierski's project involved the production of a book over the duration of the 2015 Sydney Writers' Festival. Installed in a temporary studio space in the open area of the Festival site, Sadokierski worked to curate, edit, illustrate and design a book that collected original text by Festival artists, impressions and reflections by audience members, as well as a host of other related ephemera. The 'Living Index' was initially imagined as an embedded, auxiliary project within The Book of Days, unfolding over the event in order to 'be' an index for the book outcome.

Figure 1: The thermal printer at work in the Living Index

The development of the work, however, immediately challenged any preconceived notions of what the work would actually be and how it would function—logically or not—in the context of the Festival. We came to the collaboration as a writer interested in the poetics of language in broader (non-literary) contexts and a media artist interested in the recombinant capacities of computation in broader (non-instrumental) contexts; to begin, we spent time talking about the shared and idiosyncratic aspects of our practices, figuring out methods by which a particular mode of writing could inform code, which would in turn inform the writing which its processing encountered (making a kind of diffracted compositional machine). Collectively, we speculated a material-discursive space in which an indexical machine was possible as a register of a live event—and yet, no sooner had we started the actual labour of the project that this space of possibility was tested and altered, continually coming up against differently meaningful intensities and flows that intervened in our process. These included not only chance encounters in the dynamic space we were in (ostensibly a public thoroughfare in which we were both highly visible but acting in a way that was not immediately obvious or interesting to punters, who, sometimes mistaking us for Festival guides or booksellers, constantly intervened in the space asking questions or inquiring about our presence) but also the work itself, as it emerged.

The work settled into the following assemblage. Astrid made a Twitter account for the duration of the Festival, and from that account tweeted from selected Festival events (these were selected on the basis of time, interest, external constraints). Some tweets were direct quotes from or appropriated language of the speakers, some direct critiques of what was being said, and some more abstracted from the event and responding in an associative way to triggers or memories. The tweets took one of three predetermined text-forms: list, phrase, or proposition. These text-forms were determined after thinking and talking about Astrid's writing practice and specifically her use of Twitter as a compositional space for certain kinds of short formal modes. Lists responded to the discursive space of the event by collecting disparate items (concepts, proper nouns, ambient conditions); phrases responded to the happy oddities of extemporaneous speech; propositions responded to the event in the form of a direct editorial intervention. Each text-form had a corresponding symbol (list = :, phrase = *, proposition = ~), included as the first character of the tweet to identify itself to Monica's program. Additionally, each phrase was designated a number between 0 and 9 to denote relative distractedness, where 0 denoted an undistracted, directly relevant phrasal association between the event and the tweet and 9 a totally distracted, entirely irrelevant association determined by fantasy/external influence/memory/desire and so on. Each proposition had a variable scale of tentativeness: a 0 denoted certainty and 9 uncertainty regarding the claim being made.

Each tweet, with its text-form symbol and, when relevant, its distracted/tentative variable, was translated by a program coded by Monica and then printed by a thermal mini-printer in a long continuous roll. As Monica worked on how the data of the affective variables could perform within the code body, the problem of how to enact variability visually was resolved through a layer of code. This layer created a relationship between the affective variable and probabilities within the code that shaped the formal composition of the text when printed out. Through this, the affective variable becomes embodied in the text's visual arrangement, where the degree of Astrid's original affect is enacted in the spatial relations of the visual composition. Forms of concrete or experimental poetry have always been concerned with the entanglement of matter as they engage how both text's form and content participate in meaning making, how 'instantiation' and 'signification' are entangled (Hayles 2002). The Living Index foregrounds how this entanglement extends to all processes of formation. The code determined the formatting for each tweet: lists were formatted randomly with their unlike items displayed as threads that wave their letters down the common space of the page. Phrases were formatted with vertical and slash symbols denoting the variable levels of distraction, producing a visual rendering of the 'noise' of interference. Propositions were formatted left to right as per a printed sentence but with rising tentativeness causing a vertical drift such that a tentative proposition dropped down letter-by-letter in a semi-random order.

If at first the idea was to be embedded in both the Festival and the Book of Days in order to report, albeit unconventionally, from the events, the project quickly changed as it began, becoming much more an investigation of how to 'additively', rather than reductively,

respond to the experience of working collaboratively in the context of a live event. Our collaboration relied on a fairly cumbersome collection of hardwares, softwares, materials and agents: the infrastructure of the Festival itself and the constraints of Sadokierski's project; Twitter; a smartphone and its patchy data; a laptop using a second phone to tether an internet connection; an Arduino microcontroller; a program running code to translate tweets into formatted information; a thermal printer. Thinking about this network we realised that the idea of direct reportage—Astrid sends news back to be broadcast—relied on a reductive logics of communicative transmission. Twitter, a platform defined by its character limit and so often imagined as a tool for the quick delivery of distilled information, aims at clarity through brevity and therefore is a kind of reduced-to-the-essence model of information transfer. The code that makes possible the almost-instant publishing mechanisms of computational data into readable 'poem' is often reduced to its instrumentality, that is, considered only insofar as it is understood as the means by which input becomes output. And finally, the genre of the 'review' is reductive in the sense that it is assumed to capture, in both objective (fact-based) and subjective (judgement-based) senses, an event in order that it can be elucidated for others elsewhere or afterwards. Our interest was not in composing a perfectly reduced version of the Festival in the manner of a review or souvenir; rather, we were interested in adding to the Festival's already noisy and trans-material networks. By adding to, rather than reducing, the event we were both a part of and responding to, we became implicated in the Festival in a way that impelled us to better understand our relationship to the technical and affective contexts for our shared labour and individual practices.

Ahmed's recent work, we were interested in how scholarship could enact feminist citational methods; that is, how scholarship can be done differently in order to challenge norms and habits that reproduce canonical and institutional models of power and influence (Ahmed 2013). For example, the way certain male-dominated or male-only lineages are cited as 'the' history of ideas and 'seminal' figures of thought. Also, the way authors are imagined as the sole progenitors of texts and concepts, or the way influence is imagined in patrilineal formations. (Here we are talking about histories of philosophy, theory, politics, art and, more recently, practices of programming/coding.) And finally, the way that scholarship is imagined as a virtuosic practice in constant search for truth through reason. We figured that the standardised forms and means in which and by which scholarship is produced support these norms, as well as being radically restricted by their logic.

Figure 2: The initial mapping of texts for Affective Citations

3. AFFECTIVE CITATIONS

Affective Citations was conceived for Liquid Architecture's 'Beyond Capitalist Surrealisms' event and in response to their prompt: 'What would a feminist methodology sound like?'. Liquid Architecture is an Australian organisation for artists working in and around sound (in theory and practice). This particular event was held at the artist-run space Firstdraft in Sydney's Woolloomooloo. The project spanned the three days of the festival, in which we worked outside the gallery space during the days and then inside the gallery at night while the event, properly speaking, took place. The project was therefore durational in two ways: we publicly performed the work as well as changed its structures and processes in between the 'live' moments. The project looked to critically approach (in real time) how computational infrastructures work in the production of knowledge—as distinctly embodied in the means in which reading and writing data occurs. This exploration focussed on contemporary scholarship and the citational practices that underly critical engagements with theory (who is read, repeated and why). Specifically, and following Sara

For this project, and taking Liquid Architecture's question to do with feminist methodology seriously, we experimented with a reading practice that followed the citational vectors in a constellation of feminist, queer and anti-racist texts on affect, gender, technology and labour. The two central texts were 'Affective Labour' by Angela Mitropolous (from her book *Contract and Contagion: From Biopolitics to Oikonomia*) and "I'd rather be a cyborg than a goddess': Becoming-intersectional in Assemblage Theory' by Jasbir Puar (Mitropolous 2012, Puar 2012). Both texts examine the relationship between politics and technology—in particular, affective politics in a moment of precarity and the impact of that politics on already-precarious lives. We began to experiment with how we could *not* map the relationships between texts and their citations (per genealogical models of influence and inheritance) but co-produce a text with computational infrastructures and processes that sat within the broader discursive and aesthetic arrangements of the constellation and the material configurations that were made possible through our reading and making strategies.

As an example, we experimented with ways that we could diagrammatically present the unfolding of our reading, using dendrograms, tree diagrams and so on, with which we could relationally cluster common citations, concepts and terms within the texts. This experiment was abandoned when we realised that this method would reduce and taxonomise the reading practice (which was ongoing, dynamic, productive) into static data. We started to look at text to speech capabilities and chat bot structures as alternative ways to bring together our readerly responses to the texts. We focused our reading attention to gender, labour and technology (and, critically, their relation to each other) and dedicated time to discussing, often at length, not only the texts' content but also our own understandings to do with the politics of feminist media studies. In the gallery space, this extended to include anyone that came into the work and contributed their own questions or answers to the ongoing conversation. We anticipated that the project would rely on a more typical close-reading method but in fact quickly became importantly independent from the texts as soon as concepts were in play. We decided to code and script a chat bot that would figure as a computational voice in the discussion, taking up our ideas and eliciting new ones.

We used a source code and script (rewritten from its original by Andre Colubri) of an early example of a Natural Language Processing (NLP) chat bot called ELIZA, first developed between 1964–66 by Joseph Weizenbaum at MIT. ELIZA functions as a human-computer dialogue machine, with ELIZA responding to statements or questions composed by a human in a manner that extends (potentially infinitely) a conversation in which the computer elicits more and more language from the human in order to respond again and again. ELIZA's code uses basic text pattern matching (analysis of keywords through decomposition rules), sentence mirroring and rehashing of earlier dialogue to drive its responses. Despite its limited, purely logical workings, the program can project an illusion of intellectual capacity – in the case of ELIZA, the program affects the conversational style of a psychotherapist. The psychotherapist's tendency to ask questions in response to questions (in order to encourage a patient to talk) works well for the code and script: ELIZA can answer anything with a question that appears an intelligent probe for further information or a catalyst for self-revelation.

In AI vernacular, the 'ELIZA effect' refers to the tendency to overstate computational agency in human-computer interactions—to assume that computational systems have or can attain human-equivalent capacities or motivations and have the ability to control what unfolds in the interaction, assuming an equivalence between command and action (Chun 2011). When we know we're interacting with a computer yet still sense an intentional or authentic-seeming 'human' affect, we're experiencing the odd dissonance of the ELIZA effect. The gendered aspect of ELIZA is important here, too: the feminisation of this computational system betrays a long history of affective labour typically carried out by women. The 'uncanny robot', to cite Angela Mitropolous, is the woman worker whose affected unaffectedness performs a kind of distant-yet-available interest. In stock AI narratives, the ELIZA effect is represented as an ill-fated romance: the hapless man falls in love with the perfect woman, who, because she is a computer, metaphorically (or literally!) kills his humanness with her unfeeling erotics.

Figure 3: A punter interacts with the chat bot during Affective Citations

Our aim was to rescript ELIZA in a way that would transform the service affect of the bot's dialogue into something more like the provocations, propositions and dead-ends of political conversation. We wanted to engage with the messiness of knowledge production and to understand the limits and assumptions that underscore reading, writing, talking and listening. We also wanted to think about the production of text, in this case the composition of the bot's dialogue, as collective, authored not only by multiple human agents but also by the program, the structure of the dialogue script, the interface, and so on. We experienced a real tension between our desire to engage with ELIZA's recombinatory potential and our critique of the tendency to anthropomorphise robots or to over-invest in the capacities of human-computer interaction. This tension remained an intellectual challenge for us as the project unfolded, requiring us at every moment to realign our thinking in accordance with how the bot changed, how the environment changed in turn, and how we responded to other people's interactions. This intellectual challenge was not merely a metaconversation around the work but directly impacted (indeed, became) the material of the script. In this way, the problem was exponential—the more ELIZA 'learned' over the three days, the more we had to critique our concept of what such learning means. The reading and writing of data became a continual sequence of cause and effect; rather than engaging computational processes as though their function is to smoothly control and execute tasks, the processes effected "new possibilities in the order of things" (Parisi 2013 p. 73). These new possibilities include not only things that are not anticipated within computation but those which are by definition unknowable—distributed

forms of alien agencies at work in the complexity of relations that the project produced.

As a durational and live work, the operations of the system, our reading, discussion, mapping, scripting of dialogue, code, conversational interactions of gallery visitors with the bot, were presented in a way that accentuated the relations, processes and agencies at play. Considering the already many-layered durational aspect of the project and its position within a larger event, gallery space, and so on, the 'real time' conceit was engaged in order to open our thinking and making to the "possibility of modulating signal as it becomes transmissable", allowing for "intensities and different kinds of durations to materialise" in and as the work (Munster 2014 p.158 [citing, in the first quote, Stavning Thomsen]). Munster calls this kind of media art 'transmaterial', a term that we have since taken up in the consideration of our practice. Affective Citations' arrangement suggest new possibilities in how we can critically and actively work with coding practices in the production of knowledge and also how they guide the sharing of knowledge. In this way the project emphasised materialist onto-epistomological knowing, underscoring how humans, code and material configurations are co-active in meaning-making (Barad 2007).

4. CONCLUSION

Our ongoing project is an attempt to construct, through critical reading and writing practices that include (but are not limited to) poetry and code, feminist forms of knowing and making that can be engaged in order to better apprehend the intensive media environments that are part of the contemporary world. This necessarily concerns questions of embodiment, mediation, techno-scientific practices, biopolitics, surveillance, control, (de)regulation, governmentality, standardisation, access, and so on. Following Anna Munster, our inquiry is to do with thinking (reading, writing, talking, collaborating, knowing and not-knowing) bodies and technics together: "Embodiment is not a 'thing' to be retrieved from or added into a cultural or technical domain. Embodiment is the very process through which the domain of the cultural, technical or aesthetic and the register of the affective, get pulled together" (Munster 2014 p.35). Our interest in durational and real time projects is tuned to the moment, or moments, when the transmissable becomes phenomenal in our shared knowing. In trying to articulate to each other what our work is becoming as it moves, we materialise things that turn out to be at least partly alien to our understanding or assumptions. We are nevertheless connected to these alien phenomena; indeed, they produce us as makers, and our attention to their becomings is central to our inquiry.

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Using data to empower community and build culture

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This paper explores examples of cultural and creative projects in relation to 'transdisciplinary' thinking and Indigenous knowledge systems, to frame linkages between place, technology, science and identity.

1. INTRODUCTION

One does not have to look very far to see that the development of digital tools has had a significant and positive impact for Indigenous communities and individuals in the Australian context. From the creation of language revitalisation apps to augmented reality storytelling to knowledge management systems for preserving living culture, there is an extensive web of activity across remote Australia. Other Indigenous communities further afield, also are innovating in a diversity of ways that challenge assumptions about place and culture.

In this paper, I explore a number of examples of projects from Indigenous communities located in regional and remote Australia, as well one example of a transdisciplinary project which has a layered cultural perspective including Yorta Yorta and Māori context.

I am particularly interested in how these examples are located in regards to 'transdisciplinary' thinking and how they frame linkages between culture, technology and identity. In addition to this, I am also interested in how these communities challenge limitations to online access and how they work around the 'digital divide'.

Although it is clear that Indigenous communities are investing in the development of online and mobile based tools, there are still significant barriers for many communities in terms of reliable Internet connectivity. For example, the majority of the Central Australian, Anangu Pitjantjatjara Yankunytjatjara (APY) communities do not have any form of connection to the Internet via 3/4G, cable or satellite broadband. Curiously, in this part of the world, Indigenous people have a higher percentage of ownership of mobile phones compared to the broader population (Taylor 2012).

Transdisciplinary approaches that embrace arts, science, technology with Indigenous knowledge have the capacity to bring multiple benefits to all these sectors and society at large. There are challenges though - for example, how do we open the network more broadly? Also, how do we as cultural producers work in a way that can facilitate these connected networks to bring great social awareness? Another challenge is how can these networks have a meaningful influence in the areas of government, educational institutions and funding providers?

Finally, I would like to touch on how we also think about 'data' in the context of culture. I suggest that story telling with data is not just an opportunity for collecting institutions to talk about their collctions; other forms of cultural material are also relevant - sites, kinship structures, cultural practices, genealogy and language tell a story about a culture, a place and its people.

2. FINDING GROUND

Electronic visualisation has had a significant impact not only on creative practice and cultural institutions, it has had an impact in many fields of science as well as in gathering of information regarding cultural practices, language and knowledge 'in the field'. The ability to collect and utilise data and information (visual and textual) has manifested in such multifarious ways, it is impossible to explore in this short essay. But what are some examples of activity, projects that are creative and innovative; grounded where the knowledge and culture flourishes?

It is necessary to also consider art that is made in the 'electronic' environment is quite often the result of many fragmented parts made whole - in other words, there are many elements that contribute to the creation of the art object. Artists working with digital/electronic media often collaborate with software developers, electronics and audio engineers and writers to create works. Collaboration is also critical when thinking about transdisciplinarity; as is the importance of social justice and equity. *The Charter of Transdisciplinarity* (1994) states that:

> Whereas an historically unprecedented growth of knowledge is increasing the inequality between those who have and those who do not, thus engendering increasing inequality within and between the different nations of our planet

This essay is focused on a number of projects and programs that could be described as transdisciplinary. These projects are grounded in a multi layered narrative regarding place, also using technology, data and media to empower communities, build culture and to share knowledge across generations. All of these examples demonstrate an integration of science and technology combined with Indigenous innovation and worldview.

2.1 Transdisciplinary approaches

What makes transdisciplinary process and why is it relevant? It is important to define the difference between transdisciplinary from interdisciplinary and multidisciplinary. In short, all of these terms articulate a process that bring together disparate skills, disciplines, knowledge and technologies through the process of collaboration.

Transdisciplinarity has the power to transform and engage on multiple levels. Basarab Nicolescu states:

> Transdisciplinarity complements disciplinary approaches. It occasions the emergence of new data and new interactions from out of the encounter between disciplines. It offers us a new vision of nature and reality.

Not only are there interactions between multifarious forms of knowledge, there is also an acceptance of the tangible and intangible reality of all things, with no one element taking precedence. All are active participants in the process. There is also an acceptance of *the Sacred*, which can be described as the feeling of "infinite solidarity' and 'that which connects' (Kagan 2011).

Transdisciplinarity in action has a focus on cultural and societal transformation, one that is holistic and considers the bigger picture, one that includes the ecology as an active player, not merely as a passive subject. Kagan states this about ecological art:

> Good examples of ecological art link specific multi-dimensional issues – that is issues that combine ecological, social, cultural, political and economic dimensions, with each other.

Artists have a critical role to play in this process, not just as enablers of discussion through art, but also to more deeply analyse the challenges that are presented through such immersive processes. There is no separation between art and life as the transdisciplinary process acknowledges all 'actors' in the space, including the non-human.

For transdisciplinarity to be successful, there also needs to be like-minded systems in place which support such forms of inquiry. For example, the model needs to also be applied to government policy development and funding, with active engagement from the bureaucracy in the process. this is quite a radical proposal, where the funding body is no longer a passive source of funding but a essential piece of the puzzle, actively working with the makers. This is no doubt a Utopian view, but in order to conceive of transdisciplinarity in an ideal setting, systems would support not thwart the process (Nelson 2012).

Recent moves in the Australian government to transform digital engagement also need to be cognisant that such an endeavour should not be just at the 'front end'. This transformation needs to happen at a much more integrated way at the 'back end' too, with government having a much more active role in participating in social and creative transformation.

2.2 From Ara Irititja to Keeping Culture and I-Tracker

In previous writings, a number of media/tech projects in remote Indigenous communities in media were documented as case studies, identified to analyse both the context of the digital divide as well as the innovation happening with technology and communications tools in remote Australia (Benson 2013, 2016). Many of these initiatives were focused on the collecting and managing of cultural material, as well as providing channels for local people to share information about community events and information. Radio, television and teleconferencing are still the key channels in many remote communities as access to online content is limited. This is particularly true in the Central desert region of Australia, especially the Anangu Pitjantjatjara Yankunytjatjara (APY) lands as evidenced on a journey there in July 2015. The APY lands are located in the remote north west of South Australia with the council being formed in 1981 by the passing of the Anangu Pitjantjatjara Yankunytjatjara Land Rights Act, 1981 by the Parliament of South Australia.

On that journey, I joined Renita Glencross (Executive Director, Ethos Global Foundation (EGF)) and Professor David Tafler from Allenstown, Pennsylvania. Renita worked for many years managing arts and media initiatives in the APY lands, including PY Media, based in Umuwa. David, also a board member of EGF has also been working with Anangu (the Pitjantjatjara, Yankunytjatjara and Ngaanyatjarra peoples) on a range of media projects over the past 20 years. While on the lands, we checked a number of satellite public phones that have been installed on small homeland communities on the APY lands by EGF. These phones also had public Wifi capability, which we all tested as part of our work on country.

To give an illustration of the limited access to the online world - for the week we were based in Umuwa we had no access to 3/4G or wireless Internet. The exceptions were visiting the homeland sites mentioned above and one trip to Pukatja (Ernabella). In Pukatja there was a connection to the mobile network, but only for Telstra customers.

Despite the lack of reliable access to the Internet via mobile, satellite or cable broadband, people in remote areas find innovative solutions using digital media. One project that provides an example of early innovation into electronic media can be demonstrated by the Ara Irititja ('stories from a long time ago') database, which was designed at the request of the Anangu (the Pitjantjatjara, Yankunytjatjara and Ngaanyatjarra peoples) in 1994.

Ara Irititja was built to repatriate 'lost' material for Anangu and to contribute to ongoing cultural knowledge. Since then hundreds of thousands of historical and cultural items have been recorded. Right from the start the database had certain levels of access to ensure that the appropriate person could 'see' the item. This ensured that cultural protocols were followed and that custodians had control of their material. The purpose-built software is now called "Keeping Culture KMS" and is used in communities in the Northern Territory, South Australia and Western Australia.

> The software has a profile for every person, plant, animal, place, story or event in the archive. It also has provision for people to make short annotations in either text, audio or movie, in real-time, directly into the archive, talking and telling stories about any item they are viewing or directly into their own private and family profiles.

As described, this rich resource combines genealogy with layers of knowledge about places, events, and the biodiversity of local areas, and as such, could readily be considered a transdisciplinary knowledge system. At the heart of *Ara Irititja* are the stories embedded in the database and its virtual objects, and this mixing of tangible and intangible knowledge that has a demonstrated capacity of keeping culture strong.

Another example of transdisciplinarity can be evidenced by adaptation of a tool that is used by Indigenous rangers in Northern Australia. I-Tracker is a network of Indig-

enous land and sea managers known as NAILSMA (the North Australian Indigenous chapter of the *CyberTracker* Worldwide Network), who work together to collect and share information for better land and sea management. Like *Ara Irititja*, *CyberTracker* has enabled better recognition of cultural sites of significance for Indigenous communities, record biodiversity and strengthen cultural knowledge which in turn offer opportunities to generate tourism and to build knowledge of culture and language more broadly. Chair of NAILSMA, Peter Yu stated that:

> North Australia—its people, cultural traditions, landscape, and biodiversity—is of global significance. There are few landscapes on earth where traditional Indigenous societies and their physical environments have survived relatively intact. However, regardless of the circumstances that Indigenous people find themselves in within their particular regions or nation-states, there is a universal connection.

This universal connection described sits well with transdisciplinarity and also offers opportunities for a deeper learning and understanding of of the natural world and taking care of it. It is also worth noting that NAILSMA collaborate with GhostNets Australia to share information about marine environments. The Ghost Net Art Project also addresses how marine debris can be transformed into art. Long before the formal art project began people in coastal communities were using plastic bag and netting debris to create dilly bags, screening for verandahs and fishing bags.

2.3 DIGITAL RANGERS

Digital Rangers is the brainchild of environmental scientist, entrepreneur and proud Cabrogal (Sydney region) woman Mikeala Jade. It is an augmented reality mobile app that is designed so traditional owners can contribute to the content and share in the profits made from purchases of the app. It also importantly is able to be used offline - a critical feature for many regional and remote areas. Mikeala commented that:

> Working in regional Australia and remote communities - we're not waiting for the Internet to be connected, we're doing it now.

Her point clearly illustrates the sentiment of many people in remote Australia. Access to media and care of culture through digital means is not a new concept to central desert Anangu or to the Yolgnu people of Arnhem land in Northern Australia, where Mikeala is currently based.

Digital Rangers uses a combination of image recognition technology (similar to the facial recognition of photos in Facebook) and a database at the back end to store media like video and photos. Simply described - when the device sees the 'trigger' image, a video, audio file or photograph replaces the trigger image in the screen.

Figure 1: *Image: Mandy Muir, Custodian of Murrumburr Central Kakadu tells a weaving story through augmented reality app Digital Ranger (Indigital).*

What these examples demonstrate is that it is not only the collecting of data and objects that gives these tools so much resonance for Indigenous people, but also that these systems are also designed to keep culture strong, share knowledge and to educate. They operate in transdisciplinary spaces between arts, science, technology and living culture.

2.4 Intercreate and Way of the Turtle

Transdisciplinary spaces are by default collaborative, learning and sharing is a mutual journey when these energies combine. For example, Intercreate is a collective of artists, scientists, technologists and tangata whenua (people of the land) based in Aotearoa, NZ, who are focused on environmental sustainability and cultural bridging.

Since 2006, Intercreate has run a series of artists residencies called SCANZ (Solar Circuit Aotearoa New Zealand), based in New Plymouth in the Taranaki region of the North Island. From the start there was a focus on acknowledging the role of tangata whenua and actively working with them to find practical ways to increase community awareness. This can be demonstrated by the continuing relationship with Indigenous research centre Te Matahiapo as well with the people of the Parihaka community. The focus of Intercreate residency process is to work across disciplines and cultures to focus on issues related to the environment, cultural bridging and sustainable futures.

To provide a very recent example, in January 2016, an Intercreate residency titled "Water, Peace, Power" was held in the Taranaki region of Aotearoa New Zealand. The 9 day residency involved hui (symposium) at the camp house at the Egmont National Park, nestled at the base of Mt Taranaki. After three days the group moved base of the Western Institute of Technology in Taranaki and then two days at Parihaka.

Throughout the event, the group were guided by Māori

Elders, with Māori language being extensively used. The creative result of the process was an outdoor exhibition of artworks, some powered by batteries and solar at Parihaka. The specific project I was involved in was a collaboration between Yorta Yorta researcher Lee Joachim, cartographer Martin Drury and myself, under the banner "Way of the Turtle: Exchanging Breath".
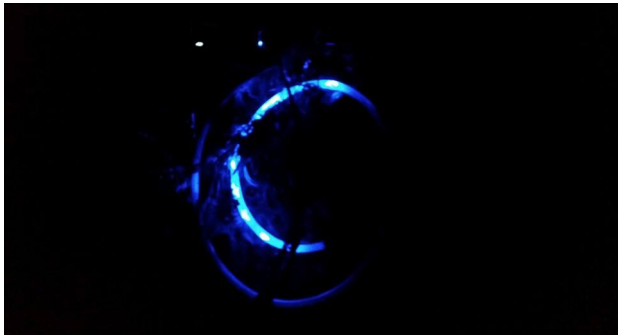

Figure 1: *Image: Tracey Benson. "Way of the Turtle: Exchanging Breath", installation, Parihaka Pa 2016*

For this project we obtained some turtle data from TurtleSAT courtesy of New South Wales Department of Primary Industries and Ricky Spencer from TurtleSAT. The data included the approximate latitude and longitude of Yorta Yorta country and nesting sites of turtles in that region. This data was generated through a sequence of LEDs representing Biami (rainbow serpent) and a Koru (a spiral, a powerful symbol for Māori). We also had an audio component which was in two parts - the story of how the Murray River was created in Yorta Yorta and English by Sharon Atkinson and a water (wai) waiata (song) in Māori by Jo Tito, who is descendant of Parihaka.

It is important to state that Parihaka was a significant site for peaceful protest, with the community resisting the forced acquisition of land in the early 1880s. Men 'ploughed' the fields and were arrested one by one and sent to Dunedin to prison. With each man that was taken away, another would stand in his place. Now Parihaka is a place of pilgrimage for peace leaders, First Nations peoples and people seeking to learn and pay respects.

Also, it is worth noting that Parihaka, like many Indigenous communities, seeks ways to financially benefit the community. Parihaka has access to the Internet and has set up a system for visitors to access their WiFi at a small cost. Although this initiative does not provide a huge amount of income, it does demonstrate how community can reap some benefits by having the infastructure in place.

Our WPP project sought to focus on the cross-cultural points of connection via the technical challenge of creating a data driven artwork that was intended to be presented outside. It also linked to the event themes of Water, Peace and Power. The piece could be run either on batteries or solar energy.

Intercreate is now building networks with other like-minded organisations and alliances (e.g. Further Arts, Ethos Global Foundation, Balance UnBalance and the Clipperton Project) with the intention of building stronger engagement. It is hoped that by joining as a very loose consortium, engagment with communities can be built and we will create better awareness of issues related to environment, and the sustainability of it and of our diverse humanity. On a practical level, we plan to create similar residency programs in Australia that coincide with related events/festivals.

3. CONCLUSION

This paper has sought to provide a number examples to demonstrate the creativity and innovation happening in remote Australia and Aotearoa. It is also a means to identify the great potential for further knowledge building and sharing through transdisciplinary practice. There is much that can be learnt from the Yorta Yorta, Māori, Yolgnu and Anangu examples presented, especially the recognition that scientific and technological systems can be hacked to incorporate other forms of knowledge.

For artists working with digital media and data, there is great opportunity to collaborate on works which incorporate many layers of meaning, existing in the spaces between science and storytelling, data and interpretation, place and people.

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Materialising the invisible conditions of computation

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Computation, data and algorithm operate through non-sensible processes. These processes occur in computational space, below human thresholds of perception, yet produce multisensory materialisations that have the capacity to affect experience. The ubiquity of digital media, escalating quantities of data, the explosion of data visualisation and considerations of algorithmic control each raise questions as to how these non-sensible processes set the conditions for experience. This research uses the philosophical theories of Alfred North Whitehead as a means to discuss and rethink relations, affect and perception when discussing non-human agents.

This paper considers how multisensory artworks made using digital technologies explore relationality in computation, data and algorithm. This relationality extends to considerations of the materiality of computational infrastructure, digital processes and the production of multisensory media. In particular, this paper will focus on artworks that visualise the computational infrastructure of data centres in order to create simulations of hidden or invisible physical spaces. These works utilise the multiple relations between code, data, and algorithm; social and cultural factors, and engagement with concepts of computation, in order to generate relational synthesis—making physical, audible and visible the actions and connections of contemporary computational processes. In doing so, these works draw attention to the relational qualities of computation and allow us to rethink computational processes as a material, affective and relational practice.

1. INTRODUCTION

Processes of digital systems are non-sensible to humans. Although humans write programs to determine algorithmic processes, the actual occurrences of computation are non-sensible, occurring as voltage differences within circuit boards. These processes can only be returned to perception through a transition to a different materiality. These transitions involve each and every movement to and from the digital plane, including all forms of digital recording, on-screen displays, data visualisation and so on, each requiring certain materials: software, algorithm, encoding structures, metadata, operating systems, temporary storage, hardware and electricity. Each of these elements contributes to a relational network of entities that are each required in order to produce a materialisation. This becomes more important as computation becomes more powerful and more prominent in wide-ranging aspects of daily life. Larger digital systems also mimic this invisibility: by being physically and spatially obscured, as "black boxes" (Wiener, 1961: xi), or becoming hidden in disarticulations between the abstract digital systems that we commonly use and the often unseen physical implementation of data infrastructure.

This paper proposes that artworks that explore invisibility in different scales of data infrastructure are able to synthesise these relations into sensory experiences that illustrate the scale and complexity of digital structures in new ways. In my discussion of these works I will suggest that computation has its own affects and prehensions and that these artworks create condensed materialisations of these affects, operating in the space between human and digital. I will focus on three works: *Data and Dragons* by Addie Wagenknecht, *Farm (Pryor Creek, Oklahoma)* by John Gerrard and my own work, *Polymorphism (Data Centre Simulation)*. These works materialise data and algorithm in ways that foreground the manifold relations between data and sound, image and space; between the use of data and the technology that allows the production and control of such data; and between concepts of transition and the conditions of algorithmic control that surround these technologies.

This research will refer to the philosophy of Alfred North Whitehead. In particular, the ways in which Whitehead, firstly, radically reimagines subjectivity and experience outside of human consciousness; and secondly, posits a model of existence that begins with relations—considering relations prior to substance. Thinking in this way allows for reconsidering the agency and actions of digital entities and for prioritising the relations involved in each event. Whitehead's theories in some ways anticipated developments in digital and network theory and have been recently revived in philosophy, art, digital media and affect theory (Lorange, 2014).

2. POLYMORPHISM

My own work *Polymorphism (Data Centre Simulation)* presents a virtual data facility interior that has been constructed using 3D modelling software. The work uses a subset of the hidden internal workings of this "black box" to generate something visual, sonic and affecting. Despite multiple attempts, due to security restrictions and tech company policy, I was not able to gain access to a data centre to view the subject matter first hand, or to acquire comprehensive blueprints or designs of the facilities. The modelling in the work is therefore informed by images, video and sound recordings of existing data centres of large organisations such as Google, Facebook and CERN (Google, 2014; Facebook, 2011; CERN, 2013). Modelling and rendering was completed using Blender, a scriptable, open-source 3D software suite. The work is intended to achieve pseudo-photorealism, with the virtual camera moving between several static shots and slowly panning down aisles of servers. When installed, the projection fills the entirety of one wall, bringing the size of the imagery to human-scale.

The server racks, ethernet cables, LEDs, power, neon lights, surveillance cameras and other infrastructure elements are the major components of an active data centre, although there are details missing or obscured, cables following unrealistic repetitive patterns and lack of resolution in some objects. The fact that it is a computer simulation rather than film is not immediately apparent. The scenes are darkly lit and many objects barely visible. The visuals show a space of duplication and repetition, dark and somewhat foreboding. The network cables and surveillance cameras in the space indicate connectivity to the outside world, the former to networked data traffic and the latter to the watchful eyes of the facility's gatekeepers. The sound component is a close reproduction of the physically operational versions of this space, created through synthesising the sound of hundreds of servers and fans, together with that of cooling infrastructure—a broad spectrum of noise, the low rumbles of large machines and the rapid blips of switches that match the flickering of LED lights and signal computational activity.
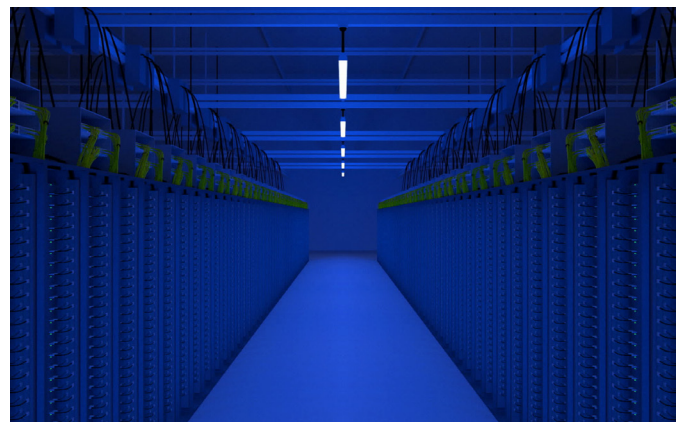

Figure 1: Polymorphism (Data Centre Simulation), *2015, Still, Kynan Tan*

When installed the work is loud and the low frequency sound (reinforced by a subwoofer) is physically impact-

ing to the viewer, suggestive of a great deal of energy and computational power. In this way the depicted data centre is not a static archive but is rather in constant activity—the aspiration of continual, 24/7 operation requiring perpetual activity and energy usage.

Figure 2: Polymorphism (Data Centre Simulation), *2015, Installation shot, Kynan Tan, Perth Institute of Contemporary Art, Perth, WA, 2015*

Polymorphism explores the conflicting patterns of thought around the materiality and locality of data and algorithmic processes. By creating a virtual representation of a real yet hidden space, the work creates a multisensory simulation of the interior of the "black box". In doing so it raises questions about the invisibility of the specific operations occurring within, although the computational inputs and outputs are unknowable from this specific reconstruction. The work attempts to create a direct link to the physical aspects of networked computing practices—complicating the tendency to think of computational activity as an abstraction, a virtual entity, without considering the multiple relations computation enters into, including the concrete physical, spatial and material aspects. Intentionally paradoxical, this simulation attempts to highlight the physical aspects of data by way of a virtual representation—an abstract perceptual entity that draws attention to the concrete. Compared to instances of data visualisation that attempt "direct visualisation" (Manovich, 2011), the work visualises indirect data. Data pertaining to the spatial dimensions, physical configuration and hardware setup of these data centres is used to construct the virtual space. However, the question here is not one of the data at hand, but more of the means required to present this data in a way that reflexively refers to its situation, context and conditions of existence. The work creates a space that is capable of exploring the capacities of data to affect us and of our affective relations with invisible data processes.

2.1 Whitehead and prehension

A key tenet of Whitehead's philosophy is *prehension*. To prehend is to grasp, perceive, or take up, and is used by Whitehead to describe relations. Any entity organic

and inorganic, human and nonhuman prehends. The use of this term shifts the emphasis away from what is typically thought of as sense perception, which Whitehead terms perception in the mode of "presentational immediacy," instead embedding this within the broader concept of "causal efficacy" (Whitehead, 1985: 17). Whitehead's causal efficacy is vague and associative, providing the substratum that allows presentational immediacy to emerge, giving the "causal background of experience itself" (Hansen, 2015: 20). In this way, causal efficacy is "at one and the same time a mode of perception and an actual physical process" (Shaviro, 2014) and the "overwhelming conformation of fact, in present action, to antecedent settled fact" (Whitehead, 1985: 41). Following this, we can rethink computation as a series of relational connections—or prehensions—that provide the conditions for a particular kind of perception to take place. When we observe or utilise technology we sense these connections, which lie outside of what is typically referred to as sense perception, in a way that is "vague, haunting, unmanagable" (Whitehead, 1985: 43) yet nonetheless has the capacity to affect and also to be affected. In this sense, data, algorithm and computation are entities that are able to prehend other entities and form relational capacities that form the structural conditions of experience.

The interplay between technical prehension and human prehension is an important part of *Polymorphism*. The work speaks to the productive and contrasting difference in the ways computation and humans prehend. Through focusing on the non-human assemblage of entities that comprise the data centre, *Polymorphism* highlights the technics of prehension taking place in networked computation. In this scenario, the human is observing a specific layer of the physical correlates of computational activity, demonstrating the disjunction between what is observed and the actual relations taking place in the manipulation of each byte of data or processor cycle. Thinking this activity through Whitehead, these computational arrangements of hardware and software are prehending the world and one another. This activity is outside of the scope of human perceptual limits, however we are vaguely aware of its action and the capacities for this action to affect change. Through causal efficacy, we are able to vaguely perceive the conditions that allow computational activity to have become incredibly important to the world.

The concept of prehension allows space for considering how various entities come into relation in order to produce experience. In thinking computation through, that which is experienced is the unity, the coming together of relations—the "actual occasion" of reality (Whitehead, 1978: 18-20). Here computation prehends data sets and other computational devices that remain outside of human sense perception through the "technics of prehension" (Brown, 2014: 142). What is seen by the human is the result of these transitions or *prehensive processes*: prehensions that form real relations between the data, algorithm, outputs of sound and light, the space of re-

ception and conceptual abstractions (Shaviro, 2012: 37-8). Thinking relations through Whitehead allows us to consider this mode of prehension as a process that can "reflexively encode the manner in which an object becomes a technical object (and an "art" object) through the relation of perception, affect, concept, and technical mediation" (Brown, 2014: 151). These prehensive processes correspond with a theory of affect as "the power to affect and be affected" (Murphie, 2014). This power or capacity is the relation at work in algorithmic subjects and the digital processes that move between non-sensible and multisensory.

3. THE DIGITAL AND CONTROL

In the current moment, digital systems are ubiquitous, playing increasingly significant roles in almost every facet of society. These systems have evolved out of cybernetics—the field of study "concerned with information flows in all media, including biological [and] mechanical" (Hayles, 2010: 145)—but have moved beyond prediction and calculation of information to asserting control. Luciana Parisi describes the far-reaching implications:

> "This is the sense in which postcybernetic (and postdigital) programming cultures have to be understood… they now seem to be almost ubiquitous (from the modeling of urban infrastructures to the modeling of media networks, from the modeling of epidemics to the modeling of populations flows, work flows, and weather systems)—so too are their intrinsic incomputable quantities building immanent modes of thought and experience" (2013: 18).

Computation plays a major role in the determination of the future, as past data is used to shape and predict. Hansen describes this change as a "shift from a past-directed recording platform to a data-driven anticipation of the future" (2015: 4). Examples of algorithms penetrating and exerting influence upon everyday life can be found in the stock exchange, urban planning and architecture, data mining, targeted advertising, data visualisation, social media, microsensors in mobile devices, electronic surveillance, search engine ranking algorithms and the mass collection and commerce of user data. The majority of these examples of algorithms exerting influence on daily life involve computational devices exchanging data with other devices, outside of the purview of human sense perception. These modes of control are both invisible and affecting: computational processes take place below the thresholds of human sensory perception, yet they affect real, material changes that impact experience. Media theory is now beginning to look more deeply at the computational infrastructure that creates the conditions for these increasingly powerful structures, particularly in the form of data centres.

3.1. Data Centres

Data centres are an infrequent topic within digital culture studies, however awareness has been growing recently with videos and schematics being distributed across the internet by Google and Facebook as well as several scholarly, political and environmental investigations into the scale and impact of these facilities (see Google, 2014; Facebook, 2011; Hogan, 2013; Cook *et al.* 2015). Data centres are physically inaccessible, hidden and remote structures that seemingly avoid criticism due to their displacement from what we typically consider to be computation. They are ghostly entities that cannot be directly seen or felt, yet are constantly producing and reproducing the structures of society through the various ways that algorithmic processes affect everyday life. The data centres operating today exist in a strange space in that they are responsible for the structure, organisation and efficacy of a huge proportion of digital activity—especially that occurring on the internet, or in 'the cloud'—yet are largely unseen and unknown. They are highly restricted, massive concrete buildings with no windows. They are a realisation of a "black box" engineering approach: an opaque system which performs an operation with inputs and outputs but no way of knowing the internal workings (Wiener, 1961: xi). These facilities utilise huge amounts of energy to power and cool hundreds of rack-mounted servers. They are engineered for redundancy, incorporating backups of power, cooling and data to ensure that the facility (and 'the cloud') stays online practically 100% of the time and that data is available at a click, perpetually. They are typically built in remote areas outside of cities and towns where the land, electricity and labour are cheaper than in cities (Mosco, 2015: 35). The strange space in which these facilities operate has been a thematic for some recent works investigating the invisibility of data and computational activity.

Data centres involve the controlled placement of computer infrastructure in order to abstract networked computing. In "A Prehistory of the Cloud", Tung-Hui Hu explains that "for data to be placeless and borderless, data must first be displaced; for the cloud to appear decentralized, its data must first be centralized" (2015: 79). This causes a disjunction in the relational connections that form computing. Hu goes on to state that data centres produce "a layer of abstraction that masks the physical infrastructure of data storage. Paradoxically, then, data centers exist at the border between the dematerialized space of data and the resolutely physical buildings they occupy" (Hu, 2015: 81). In addition, the centralisation of computing infrastructure allows corporations to no longer house their own data department and instead deploy resources through virtualisation—the allocation of computing in a way that separates the software layer from the hardware layer and manages the utilisation of numerous machines as if they were a singular unit, known as infrastructure-as-service (Mosco, 2015: 39). The abstraction and invisibility of software makes it particularly important as the tool for developing an un-

derstanding of modern society. Wendy Hui Kyong Chun states that software's "combination of what can be seen and not seen, can be known and not known—its separation of interface from algorithm, of software from hardware—makes it a powerful metaphor for everything we believe is invisible yet generates visible effects, from genetics to the invisible hand of the market, from ideology to culture" (2011: 2).

The co-location of infrastructure provides the capabilities and structures for the extensive reach of digital control. The computational processing power and storage capacity of these facilities set the conditions for an unprecedented phase of capture—the ability to record the activities of users in the form of huge quantities of data. This data is then sold, analysed or processed by other powerful technology corporations and governments. The rise of data-aggregation companies and data exchanges indicates that "cybernetic capitalism" has shifted scale to become more diverse, networked and all-encompassing (Raley, 2013: 124-6). This is the mode through which theorists such as Parisi have argued that algorithms enact control by the prehension and anticipation of change, which is then set in motion, affecting transformation in the present (2014: 81). If we are to take this claim seriously, we need to think about the structures of computation that allow this to be possible and the ways in which the relations between computation and humans are affecting change.

4. ARTWORKS RECONSTRUCTING DATA

John Gerrard's *Farm (Pryor Creek, Oklahoma)* is a 3D simulation of a data centre. Specifically, it constructs in virtual space the Google data centre in Oklahoma that Gerrard photographed from a helicopter after he was denied access. The work is described by Gerrard as a "three dimensional portrait" (Gerrard, 2015). The simulation is a painstaking reconstruction of the facility that shows cooling towers, scaffolding, diesel generators and an opaque, nondescript building—all in near-photorealistic imagery. This work is generated in real-time via a gaming engine designed for massive military simulations. The simulation engine is constantly generating unique images over the course of a year—a camera seamlessly and ceaselessly panning 360 degrees around the virtual facility (Gerrard, 2016).

In *Farm* (and other works in Gerrard's *Grow Finish Unit* series) the data centre is shown as an automated facility that is producing *something*, although that something is hard to discern—immaterial and spatially estranged. We are left to make guesses about the facility's function, knowing only that it is a Google data centre and that Gerrard was unable to gain access. We can make presumptions about the way this facility is used—possibly handling the trillions of Google search queries or providing the algorithmic and data storage backbone for other Google services such as Gmail, Google Drive or Google Maps. At a panel discussion held in conjunction with the exhibition of *Farm* at Thomas Dane Gallery in March 2015, Robin Mackay introduced the work and described it as dealing with "power and visibility" (Mackay *et al*. 2015). Mackay goes on to say that the space portrayed in the work is "a kind of non-place, something that doesn't really exist in our everyday image of what the internet means to us" and further that it creates a "disarticulation between the experiential texture of the internet and…its physicality, its energy footprint" (ibid). In this sense, the work reveals a problematic disjunction between the way we think about data and the fact that data infrastructure is "an industrial scale energy intensive operation." Mackay also notes that in showing the work in a gallery space, this "strange disarticulation is doubled by the work bringing this physical site into the site of consumption in a virtual form" (ibid). The affect of *Farm* is a kind of banality, an indifference to the nowhere locality of the space and the inactivity of the outside of the building. There is no event, no sound, no change. The machines powering the internet simply continue running and producing a particular kind of subjectivity and control—specifically, Google's search, data collection and data commerce. *Farm* asks the audience to think about the use of digital infrastructure as part of the chain of production and consumption. We are left to question the size, scale and environmental impact of these physical spaces that protect and maintain digital infrastructure.

Addie Wagenknecht is an artist who has a keen interest in the political and social ramifications of the digital, as evidenced by her work with the Free Art & Technology Lab and her founding of the Deep Lab project (Wagenknecht, 2016). The two works *Cloud Farming* and *xxxx. xxx* are each constructed using custom printed circuit boards connected by a tangle of ethernet cables—*Cloud Farming* as a floating overhead structure, *xxxx.xxx* as a set of wall units resembling servers or telecommunications technology. Wagenknecht has described the work as "manifesting 'the cloud,' social networks, data, leaks, and that which forms social capital into a single object" (ibid). These circuits run packet sniffing software—capturing the anonymous flows of data passing through surrounding unprotected wireless networks and exchanging this confidentially between the different circuits via network cables. The only visual symbol of the data is the blinking pattern of LED lights that is indicative of data processing of unknown quantities and qualities, yet clearly signifies interactions, relations and machinic prehension at work.

Regarding this series, Wagenknecht says it "is really about how society is becoming a byproduct of the network. I wanted to create a notion of the digital body… Like a 'black box' of social currency, we depend on these devices to be seen, to interact and exist, both offline and on." (Pepi, 2014). The ephemeral network is here becoming a physical entity, materialised and embodied. The data captured does not, however, pass to any other entity, it is captured and processed by these circuits but

never sent outside or over the internet. Wagenknecht demonstrates a subset of the chain of capture, one that is rendered inert by a lack of further connections and relations. The capacities of this configuration are unable to be enacted without further connections to other digital technologies, data mining, broadcasting or a transition of the data to a visual format.

4. RELATIONAL SYNTHESIS

My suggestion here is that art practices working with and around data are currently seeking to defer the idea of "direct visualisation" (Manovich, 2011) and the idea of "data itself" (Whitelaw, 2008). By choosing to avoid the emphasis of the informational, aestheticised or media-specified aspects of a data set, but instead presenting further constitutive elements of data technologies, these works are able to present the relations of the arrangement. In these works, one layer of invisibility is uncovered in order to reveal further orders of invisibility—suggesting prehensions and relations beyond human sense perception. As computational activity is traced backwards from its interfaces and visual aspects it can be found that there are further layers of abstraction, further instances of digital devices interacting with other digital devices in networks that are outside of human temporalities and thresholds of sense perception.

These manifestations of data infrastructure provide an opening for rethinking the multiple relations that computation enters into. By specifically focusing on the physical and material aspects, we are asked to consider computation beyond its effects of visualisation, interfaces, feeds, updates, and streams. Instead, we ponder the material, environmental and ethical considerations that are found in the conditions that relationally enable the virtual spaces of computation. We are asked to think of the causal efficacy of computation as it relates to the background processes that give rise to perceptible media.

Data centres are one specific element of the network of relations that makes up contemporary computation. Focusing on data centres reveals a blank object—a "black box"—but reconstructing this space allows other relations and connections to be formed and important questions to become part of the equation. These questions are generally ignored or glossed over by more typical forms of data visualisation. Instead of asking what the data is saying, it asks how is the data possible, where is it located and why is that data significant? It questions the abstraction of data from all of these conditions and instead asks, how can we think about and through computation in its full complexity of relations?

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How does a painter's hand think about generative art practice?

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In this paper, we consider the influence of traditional painting methods with respect to recent case studies of generative computer art. A grounding of tacit, embodied knowledge in painting reveals ongoing tension around aesthetic completeness, in art practice focused on generative systems. Early modernist painting explored systematic methods of picture making that emphasised the use of irreducible pictorial elements of dot, line and shape. We show examples of contemporary generative art that recapitulate these aesthetic experiments of modernist painting and how automated algorithmic creation using simple pictorial elements gives rise to complex, emergent forms. We conclude by discussing the issues facing the artist that may still account for the importance of embodied knowledge and intuitive intervention as a key to picture making in generative art.

INTRODUCTION

In this paper we will draw parallels between generative art and traditional painting to discuss how tacit knowledge of traditional painting has informed generative art processes. We reveal connections between attempts in early modernist painting to codify picture-making into a set of fundamental pictorial elements and rules, with similar strategies from contemporary generative art practice.

In consideration of the emergent character of forms that are created by simple systems in generative art, three works by the primary author will provide case studies against which we discuss the ways that a generative art practice sits with the tacit mastery of traditional painting. This discussion includes the ways that embodied knowledge might inform the creation of computer code and the ways that artists intuitively respond to and interact with emergent forms.

Establishing connections between early modernist painting systems and the creation of computer code will be of interest to artists, designers and programmers in generative visual art practice.

BACKGROUND

Michael Polanyi's idea of tacit knowledge suggests we "know more than we can tell" (Polanyi, 1962), in the sense that, while expert actions are being performed, they operate against a deep field of background knowledge that happens outside of verbal articulation.

While tacit knowledge may not be possible to entirely account for through language, the primary author's grounding in traditional painting has nonetheless informed a practice of generative computer art. Tacit knowledge has been codified through adherence to rules of computer code. This leads us to ask: In what ways does tacit knowledge inform an approach to generative art?

Traditional methods in painting are well documented across centuries: a flat ground provides both a frame to constrain and a space to perform the act. Tone, colour and line are applied to produce: line weights, graphic marks, geometric forms, tonal gradation, colour blending, contrast, discreet edges, pattern value and compositional arrangement with control and efficiency. Transparency and texture on the surface of the painting, also plays its own seductive role. Weaving these methods together to form the image; the painter's hand embeds choreographies of honed practice.

For all the ways paint arrives on a surface, a painter can produce a categorisable array of marks. The use of *point*, *line* and *plane* were established by Paul Klee in his *Pedagogical Sketchbook* (Klee) and Wassily Kandinsky in *Point and Line to Plane* (Kandinsky), at the Bauhaus as fundamental elements in picture making. These artists' summation of fundamental pictorial elements were:

- Point (dot)
- Line
- Plane (2D Shapes)

2.1 Point

The reduction to point as a deliberate and obvious pictorial element began with impressionist painting and was later developed by George Suerat to a refined degree from 1883. Suerat's 'Pointillism' used the steady, evenly distributed dot to build a pictorial field where the viewer is able to explore subtle shifts in hue, tone and light effects.

Kandinsky emphasised the point – or dot – as the simplest pictorial element from which to build a painting. We see this strategy brought to bear by generative artist Joshua Davis. Davis's work sees compositions, in some cases, entirely comprised from coloured points, dots.

2.2 Line

Line, the extrusion of a point, is the second primary pictorial element. Drawing is comprised of line, but it was during Klee and

Kandinsky's time at the Bauhaus (in Weimar from 1920–25 and Dessau from 1925–31) that it was first used and promoted as an autonomous pictorial element. Both artists emphasise the pictorial potential of line for its own sake.

In the early work of Casey Reas, co-founder of *Processing*, we see fine line being used as a constant element that builds up traces in to elegant, undulating knots. The pictorial ingredients are laid bare, all the more for the viewer to contemplate the fine variations in the algorithmic processes Reas describes as "synthetic neural systems" (Reas).
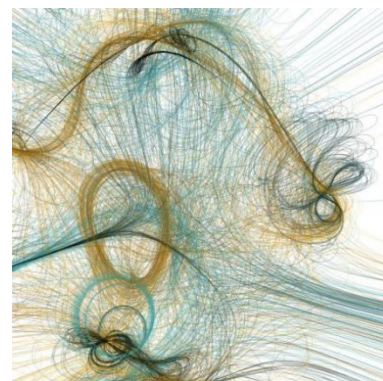

Figure 1 Path 17. (Reas. 2001)

2.3 Plane; Shape and Collage Elements

The practice of collage preceded its categorisation as a fine art medium, where people intuitively combined photographs and other 2D ephemera in to decorative forms for pleasure and memorialisation. Pasted paper shapes on oil painting made by Braque and Picasso in 1912 began the rise of a practice that endured through the 20th century and continues to be an area of rich experimentation among generative artists. Laurie Frick hand-builds collages based on a rule set driven partly by her Fitbit data and self-tracking through urban space. This system gives rise to compound geometries built up from even, tiled elements.
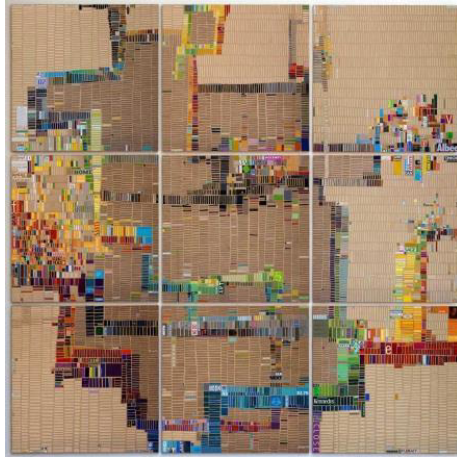
Figure 2 Walking Week 42. (Frick, 2012-15).

Sergio Albiac's generative portraits sample photomedia - images from the Hubble telescope - to derive collaged dots.

Figure 3 'Stardust' series. (Albiac. 2013–14)

The pictorial elements described are also the primary elements of Cartesian space up to 2 dimensions; enough to create 2D art. As paint builds up on a surface, the repeated application of these elements gives rise to other distinct artefacts:

- Texture

- Transparency

- Edge conditions

- Contrast

- Gradation (blending/gradients)

With any combination of the above in play, it is typical for a viewer to also respond to:

- Composition

- Pattern, tiling

Having discussed the background process of pictorial elements raises an important question. What is the role of the artist in generative art if the art is derived from a systematically reduced process? To explore this question further we discuss three case studies of generative art works by the primary author to further illustrate the use of pictorial elements: *Bokehnade* (Power, 2013), *All the Worlds* (Power, 2014), *Coenosarcoid* (Power, 2015). The generative software programs *Scintillascope* (Power, Haines; 2013) and *Processing* (Reas, Fry; 2001 - 2015) used to create these works are not so much works of art, as machines for making art. A pictorial method in an art machine might be designed to be self-sustaining in the way it generates the pictorial order.

3 METHODS

To demonstrate the systematic use of pictorial elements, we show three case studies that use software platforms (*Java Script* and *Processing 2*) that array visual elements and tools. *Java Script* was chosen by Stewart Haines – who did the programming - for the advantage of enabling work to be played in an online browser window and to be accessed remotely. *Processing 2* has built-in functions that anticipate the need for visual artists to conjure the basic elements of picture making. *Processing 2* was chosen because of the flexible license permissions (payment by donation) and the broad support of a vibrant generative art community.

Elements of Painting	Related commands in *Processing 2*
Point	Point, vertex, beginContour, beginShape, bezierVertex
Line	Arc, line, Bezier, curve
Plane; shape	ellipse, quad, rect, triangle, shape createShape, loadShape, PShape
Transparency	Alpha [transparency], tint, blend
Gradation	Lerpcolor (creates colour gradation)
Image elements	PImage (imports images)

Table 1. A list of the elements of painting – left - against a corresponding (truncated) list – right- of 'primitive'

elements in the Processing program (many of these terms are common to graphics in computer languages).

3.1 Case Studies from Practice

3.1.1 An art machine: *Scintillascope*

The program, *Scintillascope* (fig.4), consisted of a graphical interface to control pictorial actions such as placing coloured dots in a painterly order. The artist can work intuitively with sliders, watching changes take effect in real-time. Settings can be recorded in a file, for later editing. The *Scintillascope* works as a sequencer, whereby rotating oscillators sample RGB values from a graphical image. This allows for these values to be graphed, helping visually-oriented people work intuitively with the interface. Variability in the run-time computer performance and the way the code performed tasks, meant *Scintillascope* exhibited a seeming organic imperfection to the placement of pictorial elements.

*Figure 4 The **Scintillascope** (Power, Haines, 2012–16) interface allows a non-expert to adjust the speed, size, colour, transparency, and position of brushes, to create their own generative 'painting'. Rotating oscillators (lower left) sample an imported graphic*

3.1.2 *Bokehnade*

In the first case study *Bokehnade* (fig. 5) used the *Scintillascope* program to generate repetitive points – dots – to build up forms. This experiment also used transparency to experiment with colour mixing. The resulting image consists of coloured points repetitively layered one over the last.
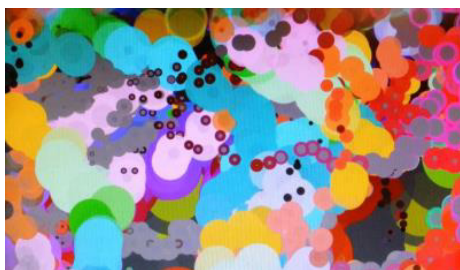

*Figure 5 **Bokehnade** (Power, 2013). Oscillators progressively laid down varied coloured dots.*

3.1.3 All the Worlds

Power used *Scintillascope* to generate the second case study *All the Worlds*. The program is used to paste the shapes prepared by the artist (fig. 6) as image elements to generate time-based generative collage in real-time. The program manages the position, orientation, transparency and scale of image elements according to settings determined by the artist (fig.4). The oscillators provide machine-like movement where each event is generated in a somewhat predetermined, but variable sequence. *All the Worlds* built on experiments from *Bokehnade* (above), the outcomes of which revealed efficiencies in using oscillators for controlling composition and transparency.

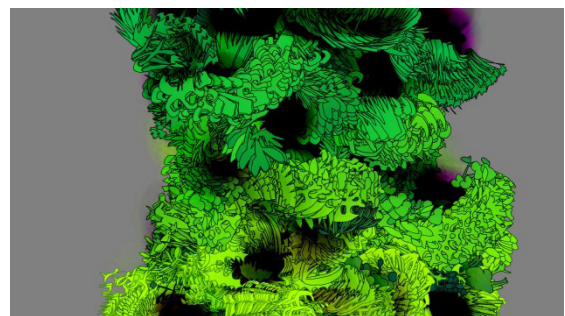*Figure 6 Prepared shapes, created for 'All the Worlds'.*

*Figure 7 Prepared shapes (fig. 6) generatively distributed across the screen using the **Scintillascope**.*

3.1.4 *Coenosarcoid*

The third case study *Coenosarcoid*[1] (fig.8) used the *Processing 2* program to generate the artwork. The basic pictorial elements of the artwork consist of two 'immortal' agents that periodically spawn a dozen or so mortal children, who in turn have mortal children of their own. Unlike the previous works the pictorial elements have a degree of agency where the elements are context aware. These children are driven by flocking rules that give rise to branching forms. Splayed, curving networks of lines build up in a mass effect to create larger forms, without losing the identity of each line.

1   The title is taken from **Coenosarc,** the name for the protoplasmic branches connecting the polyps of colonial organisms, such as corals.
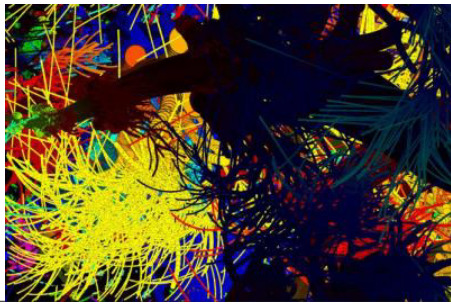
Figure 8 **Coenosarcoid** *(Power, 2015). Detail.*

The generative works described were created progressively through a continual accumulation of marks. The system was conceived as though the screen was an indelible ground being constantly overwritten. For each successive mark, there is essentially no undo; one must simply proceed for better or worse. This approach allows visually rich, detailed effects to build up quickly on high resolution 'canvases'. Upon reflection, this approach seems driven through a painter's logic. This is counter to the general approach to the field of real-time computer graphics that presupposes the screen be refreshed (cleared entirely of content and rebuilt) many times per second.

These painterly experiments have informed future work that will extend to the use of real-time 3D platforms, and the incorporation of real-time interactive facility that would allow viewers to affect the artwork.

4. RESULTS

4.1 Formal Orientation

From examples of the primary author's and others generative art works, we see painterly strategies recognisable from early modernist experiments in the formal, overt use of simple visual elements; dots, lines and shapes. Furthermore, strategies of collage in generative processes combine visually discrete image elements sampled from other media.

4.2 Emergent Properties in Iteration

We see from the examples that the repetitive use of the same element reveals emergent properties in picture making. From dots, lines and shapes emerge: pattern, texture, and gradation, colour blending, areas of contrast, varied edge conditions and pictorial composition.

5. DISCUSSION

Galanter definition

In defining generative art practice, Philip Galanter asserts that:

"… a machine, or other procedural invention, … is set

into motion with some degree of autonomy contributing to or resulting in a completed work of art." (4)

Basic image elements set upon a system can lead to complex, painterly results. In the primary author's practice, the process of devising such systems involved translating existing tacit knowledge in to parsing code.

Generative art and painting

The primary author's generative art can be seen in relation to painting practice. The relationship between the two lies partly in embodied knowledge of using a systematic approach to picture making.

5.1 Embodied Knowledge

Embodied knowledge, as posited by Maurice Merleau-Ponty, cannot be wholly accounted for, other than through action. Embodied knowledge is the knowledge accumulated through practice that is perhaps not wholly modelled through language:

"If habit is neither a form of knowledge nor an involuntary action, what then is it? It is knowledge in the hands, which is forthcoming only when bodily effort is made, and cannot be formulated in detachment from that effort." (144)

Painting practice embeds a systematic repertoire of actions to produce endless variation of pictures, but also an intuition of which act to perform when. Devising code for the creation of art-making machines is, in the primary author's case, a process of translating embodied knowledge in to a different domain. Translation of embodied knowledge into formal grammars of computer code does not settle the matter of artefacts *explaining* embodied knowledge, as generative art practice is still attended by intuitive, creative intervention. Like a painter, artist must 'know' when they see "a completed work of art" (4).

Combinatorial vs Blended Media

Steven Pinker perhaps identifies the rub in this translation process, by distinguishing two categories for the systematic use of media: *combinatorial* and *blended*. In the case of *combinatorial media*, Pinker identifies both language and DNA as examples being constituted through: "… a finite number of discrete elements… Combined, and permuted to create larger structures…". These larger structures exhibit distinct properties and "… an unlimited number of completely distinct combinations with an infinite range of properties." (85) As a clear distinction, Pinker points out that blended systems, such as cooking or colour blending, the properties of the elements merge to undetectably subtle degrees.

So, generative computer art uses *combinatorial* systems to generate *blended* artefacts.

The primary author writes code for art machines, aiming to embed painterly actions within the algorithmic agents. As we have seen with emergent complexity, there is a point quickly reached where we cannot wholly make an account of the relationship between the two, without referring back to artistic intuition.

Emergent Properties

Generative systems produce mass effects, say, in Seurat's pointillism. The relentless repetition of the point leads to broader pictorial effects of subtle variations in hue, tone and pattern. As with Seurat, some generative art employs a single visual element or modality. This systematic constancy works to place emphasis on the more complex, emergent result; we see it in Reas's constant line weight; Davis's and Albiac's constant dots, Frick's constant tile. This modal approach creates a field effect where the system itself becomes appreciable, as it brings forth emergent compositional and textural subtleties. The viewer can intuitively decode this focused strategy – *see* the system at work -and, at the same time, respond to the artistic voice in the image as a whole.

Visual elements combine to create optical effects, purposefully or not: tiled repetition gives rise to patterns; illusory contours imply shapes, lines or edges; negative space, patina, texture. Depth is implied through multiple cues of line, edge, gradation, and colour. It is a trait of generative art (born of the tirelessness of computers), that simple systems, iterated countless times, give rise to emergent complex results that cannot be accounted for in the knowable methods they are constituted from. This emergent property was anticipated in the formal experiments of modernist painting.

Seeing is generative

Donald Hoffman explains that the very act of seeing is a generative process, comprised of sense perception interacting with what we know about the world; allowing us to quickly get the gist of an image: "… like Seurat's painting … you see more than dots; you see curves and surfaces. You construct each curve and surface you see." (64)
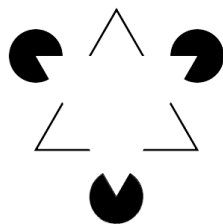

Figure 9 Gaetano Kanizsa's illusory triangles show Hoffman's idea that vision itself has a generative property.

It is not only the pictorial elements themselves, but the final visual effect that the artist is responding to, as they build an image toward completeness.

Klee and the Walking Line

Paul Klee famously described drawing as "taking a line for a walk". This playful and simple take on art making could also be adopted as an instruction for generative art. Klee suggests that the line has agency; tenuously steered by the artist as it veers from one point to the next. Klee's aphorism curiously aligns with the 'random walker' of the generative artist.

Both musicians, Klee and Kandinsky theorised about the time-based nature of pictures and how musicality could be expressed in painting through a codified approach. Paint strokes were to be thought of as action, just as much as they were a graphical mark. For both artists, the way musical notation could systematically create aesthetic forms, guided their thoughts on picture making. Indeed Kandinsky presaged generative art practice in speculating on pictures being made "by purely mechanical means" (37).

6. CONCLUSION

The visual artist is bound to that first smudge on a two dimensional support, succeeded by more mark-making. In applying a painter's hand to generative art, a systematic approach to picture making can be found in traditional practice. Virtuosity strives to act without attending consciously to small elements and operations; free instead to move intuitively toward a broader expressive form.

Generative visual art works organise media in ways that partly recapitulate the formal operations of painting. In the age of computer-driven generative art, the rational mathematics of line spill over in to the practice of intuitive mark making. Generative artists are working with principles of picture-making that continue from modernist painting and yet working intuitively with novel, emergent forms. Klee's "taking a line for a walk" reminds us of the intuitive guidance of the artist, herding algorithmic cats toward some kind of aesthetic order.

The writing of art-making systems enables an attenuated, emergent artistic repertoire that is certainly beyond the hand of the traditional painter. As much as generative artists relinquish the actions of the hand to the computer, however, the embodied part of picture-making still works through the eye.

The cycling of evaluation/experimentation seen in traditional art practice is recapitulated in Casey Reas's Process Compendium. In the documentation of work by Reas that spanned from 2004 to 2010, the foundation is given as processes described in English ("Draw a transparent circle at the midpoint of each Element", a so on)

– an approach with roots in 1970s conceptual Art - while the definition of visual elements are characterised in terms of Dots, lines and shapes.

Deterministic, though these processes may seem, Reas still allows room for creative intuition, where:
"The software interpretation is secondary to the text. The text leaves many decisions open to the programmer, decisions that must be made using personal judgment. The act of translating the Process from English into a machine language interprets the text." (Reas, 113)

Perhaps there is a conceptual sleight of hand in Gallanter's definition that explains how generative systems are used to arrive at "… a completed work of art." Who or what can determine this completeness other than an intuitive artist? Surely the ultimate act in picture making is to say "it is complete".

Generative or no, the art relies as much as painting did on the intervention of the intuitive, experienced artist. In the 1920s, Kandinsky anticipated a "science of art" far in the future that would aim to balance the "creative powers" between "intuition and calculation" (20).

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Dimensions of digital history: how the internet has empowered the amateur historian

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Australian history used to be the domain of a select group of academics and professional writers. The amateur historian could self-publish a hard copy book, but would only reach a limited audience. With the advent of the internet, a new platform emerged giving amateurs both a forum for publication and access to vast online databases. The growing popularity of history websites, blogs and podcasts produced by enthusiasts rather than academic specialists, raises interesting questions. Does allowing non-specialists to engage in historical debate undermine academic research? Does the proliferation of amateur history websites and blogs dilute history and weaken the search for "truth"? Have academic institutions been too slow to recognise the benefits of engaging with the online world? I will argue that there is much amateur online historians can teach the professional historian. The online world also gives oral and community historians the opportunity to present their research to a wide audience and attain greater credibility.

 There's frustration that online publications do not always supply sources and references. However even primary sources can be inaccurate or corrupt. By opening historical debate to the widest possible audience, the internet democratises the teaching and dissemination of history and enables a free-flowing debate via the digital public sphere, that can only benefit 21st century Australian society.

1. INTRODUCTION

In their defence of the importance of the study of history in intellectual and public life, the prominent historians who are the authors of *The History Manifesto,* have called on historians to write "new narratives capable of being read, understood, and engaged by non-experts". (Guldi & Armitage 2014). It's encouraging to see academic historians urging their colleagues to reach out into the public sphere. Previously, the work of most historians was confined to classrooms and books, with specialised audiences. Now, any historian can share their work online, and if they make it engaging enough, they can gain a bigger audience than ever before. But perhaps the key word is "engaging". If historians want to take their research to wider audiences, they need to feed the public's insatiable desire for a good story.

It is here that the professional historian can learn from amateur online historians. These lessons include identifying a hook to draw readers into the story, writing in an accessible and lively way without jargon, and using visual stimulus such as photographs, videos and diagrams to enhance the text.

In this paper, I will present examples of the varied ways in which the internet is being used to disseminate historical research. These include an amateur Ned Kelly researcher, teenage boys whose Twitter account featuring historical pictures has attracted millions of follows, and a multi-partnered Australian academic oral history project.

I will also look at concerns over accuracy of online information sources, such as Wikipedia, and compare it with the accuracy of traditional historical sources.

I am concentrating on the presentation of historical research rather than the practice, which has been equally transformed by digital tools such as the Gutenberg project, google books and online newspaper and government records.

2. NEW DIGITAL FRONTIERS

My academic history qualifications are limited to an undergraduate honours degree, but throughout my years as a journalist and documentary writer, I have always been drawn to the colour, scope and audience interest in historical stories. Now I am working on a PhD in journalism that includes a creative thesis which will be a novel about the true story of a convict escape from Hobart in 1833.

Through my studies I have developed an appreciation for the many ways in which people are using the web to present historical research. Of course there are the government institutions such as Tasmania's state archives that has placed all its convict records online in original form, and London's Old Bailey court records that are also freely available and key word searchable. But there are also tiny historical societies who have used volunteer labour to transcribe and upload graveyard inscriptions, individuals who have taken it upon themselves to digitise 19th century almanacs and blogs on obscure and fascinating snippets of history.

While some academic historians have prioritised theoretical discourse over storytelling, amateur historians have been ferreting out interesting historical stories for generations. Before the internet, unless they were fortunate enough to attract the attention of a commercial publisher, their only publication avenue was vanity publishing. The establishment of the World Wide Web in 1991 provided a new option for those who were technically literate. Ned Kelly enthusiast Brad Webb is one of these people.

In 1995, Webb was offered a free website as part of his internet subscription. He decided to create a site devoted to Ned Kelly, as he was constantly annoyed by inaccuracies and misinformation circulating about the bushranger, especially in books. Webb sees his site Ironoutlaw.com as a place to debunk Ned Kelly myths and in his own words, "shout the idiots down." (Webb 2015). He has been involved in online feuds and sometimes copes with considerable vitriol, as Ned Kelly enthusiasts are a passionate and unruly bunch, but unlike some web citizens, he doesn't hide his identity online.

Iron Outlaw sees massive spikes in visitors whenever a Ned Kelly story is published in the media, but on average has 10,000 to 30,000 visitors a month or 120,000 to 130,000 a year. Webb is aware that he could monetise the site through advertising, but he thinks it would be too distracting for readers and instead uses profits from books sold via Iron Outlaw to cover the cost of running the site.

Sites like Iron Outlaw are invaluable as a repository of knowledge; a place for lists of links, photographs, documents and people's reminiscences. Webb's site has more comprehensive information than any other Kelly site, including the Australian National University's Australian Dictionary of Biography and government websites like Victoria's Public Records Office and State Library. It's also constantly being added to and updated. Iron Outlaw is just one of the passion sites run by amateur historians. Their subjects are wide-ranging and diverse - from crime to military to fashion history.

They may not be peer reviewed in an academic sense, but the public nature of their online presentation gives people the opportunity to comment on and expand or correct their research. In the digital public sphere, the web provides a democratic forum where anyone with online access (an exponentially increasing proportion of the world's population) can present or participate in online history.

2.1 Veracity of online sources

Wikipedia is a key platform for public engagement in this sphere. Like any publication it has ongoing issues with accuracy, fairness, copyright and defamation. But unlike a non-digital publication, these issues are constantly tussled with in public. Go to any Wikipedia page and click on "view history" to see every edit ever made to the page, including justifications, the identity of those doing the edits and sometimes, a request for Wikipedia's Arbitration Committee to resolve a dispute. A community of like-minded digital curators refine and polish entries, working to ensure that every stated fact is linked to a source. This is the most democratic and comprehensive encyclopedia ever published, but its use as a source of information is contentious among academics.

This is partly to do with concerns about accuracy (Child 2007). However, Eijkman's 2010 survey of academic attitudes towards Wikipedia found a generalised worry about the possibility that the online encyclopedia and other Web 2.0+ applications might undermine "traditional power-knowledge arrangements". Several of his respondents said they would only feel happy recommending Wikipedia for academic use if it was incorporated into an academic institution and subjected to peer review. (Eijkman 2010).

Yet Wikipedia is no more or less likely to contain correct information than any other source, including the primary sources that historians rely on to recreate the past. In her article "Online and Plugged In?" Meg Foster says: "Original sources are regarded as largely authentic, truthful relics of the past, and the history they support is legitimised by this tangible connection to times gone by." (Foster 2014).

However as someone who has accessed thousands of government records and 19th century newspaper articles over the past couple of years, I have found many mistakes. In the Tasmanian convict records, they range from incorrect names, birthdates and birthplaces - some entered incorrectly, some deliberately falsified by the convicts - to transposed records that link to the wrong convict. Newspaper articles are frequently inaccurate or incomplete and if retractions or corrections are made in future editions, they are easy to miss. I would argue that Wikipedia is an excellent source of historical information, as long as the researcher takes note of the sources, or lack of, as they should do with any source of information. Consistent questioning and testing of information that is presented as historical facts, is one of the key tasks for any history researcher.

2.2. Online zeitgeist

Another place where academic historians are being challenged by amateurs, is on social media. As with hard-copy media, images are the life-blood of the World Wide Web, especially with the growing popularity of internet-enabled devices such as tablets and smart phones.

The integration of government data into creative blogs about subjects such as convicts, sparks far more interest than the dry presentation of records, as can be seen at the collaborative site, The Digital Panopticon. There, researchers pick out interesting events and personalities from convict records and present them as entertaining blog posts.

Because it is moderated by academic researchers, all information is fully referenced. However, there's frustration that online publications do not always supply sources and references. At publichistorycommons.org, Jason Steinheur provides an excellent summary of the debate surrounding the Twitter account @HistoryinPics. (Steinheur 2014).

Founded by two teenage boys, the account tweets regular historical photographs - 11,400 of them as of January 2016, and boasts nearly three million followers. Steinheur notes that the boys who created the account have a history of identifying viral opportunities and the ability to leverage these into successful businesses. But @HistoryinPics has been criticised for sending photographs into the digital sphere without attribution or context and infringing copyright.

Steinheuer ponders whether these criticisms are tinged with jealousy, with historians envious of the ease with which two boys have attracted public interest and engagement. He acknowledges that the lack of academic rigour governing a social media feed that calls itself "history" is problematic if its audience views it as an authoritative source. However, Steinheur calls on historians to recognise that @HistoryinPics is symptomatic of a shift in the online zeitgeist that sees an audience bombarded by so much information, it demands to be presented with media in ever more concise packages.

2.3. Capturing a digital audience

Understanding how the public consumes online material is one of the most important lessons for historians and other researchers wanting to launch their work into the digital public sphere. Ordinarily, academics are presenting their work to their peers via journals, books and conferences. Presenting academic research online is a completely different scenario and it's here that the amateur historian has the jump on their professional counterpart. As they are looking for as wide an audience as possible, they use the tools of journalism to identify an interesting or quirky "hook" to engage the reader's interest in the first paragraph.

One of the first lessons you learn in journalism is "don't bury the lead". This means leading with the key information, generally a summary of the story and constructing the story in what is known as "the inverted pyramid" where the most important facts are told in the first paragraphs, tapering off to the least important. This comes from the practice of newspaper editors cutting stories to fit from the bottom up.

There are no space limitations on a web site or blog, but there are other constraints that make it desirable to limit the word count. One is people's short attention span when they are web surfing. They might be flicking between pages, scanning to get the information, then quickly moving on to the next site. Many people dislike scrolling down a page to read. Even if there are multiple pages, accessed by links at the end of each section, often people can't be bothered clicking forward and instead move on to their next search. Researchers can cater for this by keeping their posts short and to the point.

The Conversation website is an excellent example of combining academic research with conventional journalistic style, presented in an engaging online format. To be published on the site, researchers need to fit within a word count, write in an accessible style that's understandable to a general audience, and provide images to illustrate the research. They then have the opportunity to engage directly with readers via the comments forum. The stories can be republished in conventional media or easily shared on social media, giving academics the chance to share their research with a much wider audience than most were able to before.

2.4. Oral history online

In an essay published in 1986, historian Michael Frisch pleaded for a study of history that encompassed the "'why' or 'so what'" that he believed added depth to historical research, rather than "the dispassionate voice of social science". This search for meaning and context has been a key driver in Frisch's work as a social and urban historian. In 1986 he issued a call to action: "We need projects that will involve people in exploring what it means to remember, and what to do with memories to make them active and alive, as opposed to mere objects of collection." (Frisch 1986). In the 30 years since this was published, Frisch has lived up to this ideal, becoming one of the world's foremost digital oral historians. He and his colleagues have developed frameworks and adapted technologies to collect, collate and present oral histories in the most practical and efficient ways possible.

The ambitious Australian Generations Oral History Project embraced these aspirations when it commissioned researchers to interview 300 Australians born between 1920 and 1989. Headed by Monash University, and partnered by La Trobe University, the National Library of Australia and ABC Radio National, the project resulted in an archive of approximately 1,220 hours of recordings, many of which are now available online and a radio history series that is also available to stream or download.

This project demonstrates the huge potential for history to enrich the digital public sphere by supplying reams of searchable rich source material accompanied by bite-sized media, tailored to a time-limited audience. Oral history in particular is the perfect partner with the online world, as the original audio or video interviews can be repurposed into individual narratives, while access to the original sources provides a level of integrity that is not always possible with primary sources.

3. CONCLUSION

Academic historians have been slow to engage in the digital public sphere, but a recognition of the opportunities available through the online world can only assist in their research. To have an impact, the study of history needs to be made as widely available and as relevant as possible. Amateur historians have been swift to identify the possibilities of self-publishing via websites and blogs. The countless number of online forums that enable enthusiasts to connect with each other and exchange information on the most esoteric and random subjects, demonstrate the many possibilities of presenting research on the web. The popularity of Brad Webb's Iron Outlaw site demonstrates the audience engagement that can be generated when a passion project is disseminated online.

Academics who embrace the digital public sphere as a place to showcase and expand their professional practice benefit their own work, institutions and public life. This is apparent in those who share their research with the public via *The Conversation*. According to the website, it has a monthly audience of 3.5 million readers, and access to a further 35 million people through republication. Academic historians also need to be open to allowing non-specialists to engage in historical debate, something that will only contribute to historical research. The proliferation of amateur history websites, blogs and social media accounts such as @HistoryinPics, enriches the study of history and has no effect on the search for "truth". By opening historical debate to the widest possible audience, the internet democratises the teaching and dissemination of history and enables a free flowing debate via the digital public sphere, that can only benefit 21st century Australian society.

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Touching with the eye: science films, embodied technology and nanoscientific data

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Science filmmakers have created new forms of image-based scientific data through techniques, such as stop-motion and time-lapse, predominantly using optical instrumentation. These techniques enable direct observation via the lenses of cameras and microscopes without further augmenting the human senses. However, these optical techniques cannot capture suprasensible phenomena – those that cannot be directly perceived without further translation. Observing these phenomena must be technologically mediated on multiple levels via instrumentation, hardware and software, effectively disrupting the filmmaker's experience of embodied technology, a crucial aspect of cinematographic practice. We speculate how to incorporate embodied technology that will enable filmmakers to depict suprasensible phenomena of nanoscale environments in experimental media works. This short paper details our practical experiments and experience with audio, visual and tactile representations of nano-data.

1. INTRODUCTION

The sensitivities of scientific instrumentation allow the collection of data on phenomena such as molecules, atoms, quarks and neutrinos that have properties that fall far outside of the range of human perception. The role of the science filmmaker then, becomes one of mediating and translating these complex forms of data rather than working with recorded film. In this role, we will discuss two challenges that scientific filmmakers face. The first challenge deals with scale - how might one communicate infinitesimal suprasensible phenomena occurring at the nanoscale in a meaningful fashion? The second is authenticity in contemporary science film - a term that refers to the level of objectivity achieved in the production - and which we compare to scientific objectivity. We suggest that an experience of embodied technology, for both the filmmaker and audience, is one framework that we can use to connect the perceptual experiences of data from the nanoscale.

2. BACKGROUND

Film culture welcomed science into its folds under the auspice of avant-garde cinema, or cinéma pur (Gaycken 2012), however the term science film describes the multiple film genres that address and incorporate any form of scientific imaging. Works by Jan Painlevé, the French film director and biologist, were exhibited in an educational and general entertainment contexts (Gaycken 2005), while others such as Charles and Ray Eames dominated commercial contexts. Such commercial films are still being made in institutional media departments, for example WEHI TV, a biomedical animation studio (Walter and Eliza Hall Institute n.d.). Science films can also be seen as part of an expanded field of documentary practice, however, like the essayistic film form, the limits of the science film are unclear (Bazin 2007 [1947]).

In the process of making science films, contemporary cameras and scientific instrumentation can separate the user from an embodied experience of the subject matter. More specifically, in nanoscopic environments the human embodiment of technology is disconnected due to the increasingly complex technological mediation pathways involving layers of instrumentation, hardware and software. Light microscopes, on the contrary, are direct extensions of the hands, (through the knobs that control stage movement and course and fine focus), and eyes (through the two ocular eyepieces) and the body curved over into an enfolding position over the microscope. However, the bodily position in relationship to much modern scientific imaging instrumentation is such that an instrument on one side of a room is remotely controlled via a computer on the other side thus creating a physical distance between the operator and the instrument.

2.1 Science film, authenticity and scale

Artists increasingly literate in the sciences are engaging with scientific imaging techniques to reveal questions around scientific media and scientific interpretation and analysis. To explore authenticity and scale in science film we describe three works: *Black Rain* (2009), *A Boy and his Atom* (2012) and *Powers of 10* (1977).
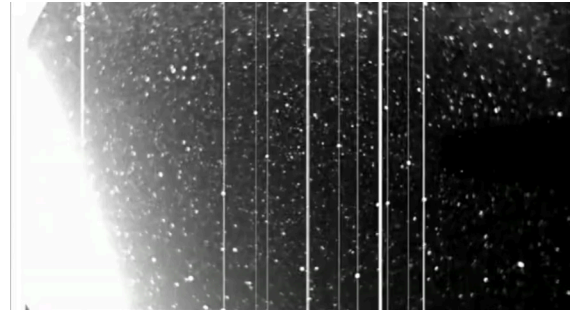

Figure 1: Still from Black Rain (2009)

Black Rain (2009) is an audiovisual work by the British duo Semiconductor – Ruth Jarman and Joe Gerhardt. It is created from heliospheric imagers aboard two solar mission satellites (STEREO), and is presented on screen in edited form, but importantly has no other post-production processes applied - no animation, motion graphics, text, colour grading, cropping, or sound editing for example (fig. 1). Semiconductor avoid altering the image in favour of revealing the immediacy of the raw data through its anomalies and artefacts (Kahn 2010). As such, the absence of the scientific, functional aestheticisation of the image in Black Rain is as artistically important as what we do see.

In contrast, to make *A Boy and his Atom* (2012) IBM scientists used a Scanning Tunnelling Microscope to meticulously animate individual molecules of carbon monoxide across a copper substrate (fig. 2). Scientists worked in shifts for eight days to capture the 242 frames of the film, using a microscopic instrument for stop-motion filmmaking. Since 2013, this film has held the Guinness World Record for Smallest Stop Motion Film, based on a "frame size" of 45 nm x 25 nm. This category highlights a fundamental problem for films made at the nanoscale, and that is the relationship between square nanometres and pixels and the way media-makers understand the translation of image across scale. Even with the very best screen resolution available a single pixel is bigger than this frame size, which makes the film theoretically impossible. This issue tests the boundaries of what might be considered authentic in non-optical technologically mediated imaging.
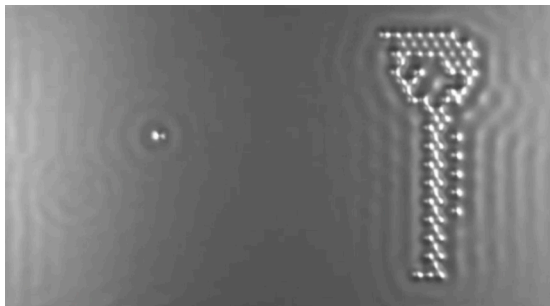
Figure 2: Still from A Boy and his Atom (2012)

Figure 3: Still from Powers of 10 (2007)

Discussions of authenticity include considerations of what the subject is like before the filming (measurement), and how the camera placement or editing affects the representation of the subject (Nichols 1992, Röhl 2008, Oancea 2015). Cameras and lights must be placed *somewhere*, and a beginning and an end to a shot must be selected, and this affects the viewer's perception of the material's authenticity (Röhl 2008).

Artificial light at the nanoscale substantially affects phenomena. Because light has momentum and energy it therefore disturbs nano-phenomena (Barad 2007). Some nanoscientific imaging imparts such a large relative disturbance through the act of measuring with laser light that it must be accounted for using algorithmic post-processing of the data (Dimension Icon User Guide n.d.).

When integrating nano-data into audiovisual science film, communicating documentary authenticity is impossible without a meta-discussion of *what* is being shown, and *how* it is being manipulated. In the production of nanoscientific images, how can a filmmaker be explicit about issues of authenticity in ways that usefully critique the scientific use and manipulation of these types of data?

Semiconductor's work has provoked online debates about authenticity. *Magnetic movie* (2007), which shows animated magnetic fields in a NASA laboratory, sparked discussions around the reality of the images (Semiconductor 2008). The computer generated visuals were mistaken by prominent scientists as depictions of real data recorded as part of a scientific experiment.

Consideration of the reality of images exposes a significant issue for filmmakers: how explicit should the authenticity of components, be they conceptual, digital or material, communicate an accurate audiovisual representation? For example, the use of scales in film illustrate the issue of authenticity.
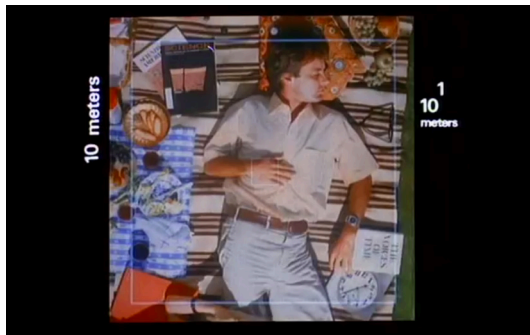
Neither *Black Rain* nor *A Boy and his Atom* use overt depictions of scale. The scales of the two works are at the opposite end of the spectrum of scientific observation, the cosmological and the atomic, and yet they approach the communication of scale in a similar way. Neither offers any scale information, allowing the viewer to draw on preconceived notions of the cosmological and atomic scale. This is contrary to the IBM science film, *Powers of 10 (1977)*, which introduced scale bars as the camera zooms between the universe and the atomic scale (fig. 3).

3. EMBODIED TECHNOLOGY AND NANO DATA

In this section we explore the challenges of making science films using nano-technological instrumentation and discuss preliminary experiments in translating nanoscientific data for integration into a hybrid experimental science film.

We use the term embodied technology to align the practices of science filmmaking and non-optical nanoscientific imaging. This term describes the notion that the focus of human perception shifts from the intersection between the body and a piece of technology, such as a hand gripping a hammer, to the intersection between the technology and the world, such as the hammer hitting a nail.

We have elected to work with data from an instrument called the Atomic Force Microscope (AFM) located in the MicroNano Research Facility at RMIT University. Deep within the AFM, a stylus, much like the stylus on a record player, is used to scan and "feel" surfaces, resulting in spatial (x, y and z values corresponding to three dimensions) that are computationally translated into images. Nanoscientists use the AFM to characterise properties of materials, for example roughness. The resultant tactile data is usually transformed into topographic 3D mats and two-dimensional images. However, we access and use the raw data produced by the AFM to forge new experiences of nanoscientific data.
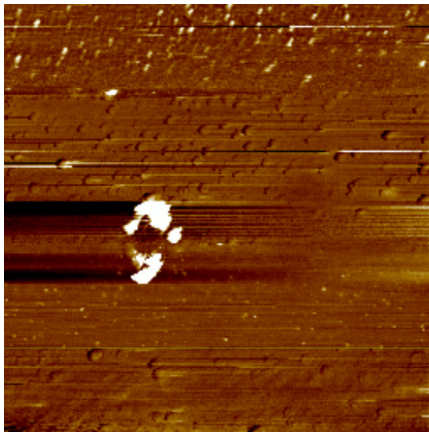
Figure 4: AFM image (Rassell 2015)

The raw data collected from the AFM to make the film is measured in units of LSB - these refer to the change in position of a laser on a photo-detector. The information that is meaningful is height data, so initially a conversion of raw LSB data is required. For an example of 54 LSB, the following calculation is performed:

(54LSB) – (0.00008154536 V/LSB) . (12.50 nm/V) = 0.005504 nm

This formula atones for various errors introduced by the technology, as well as converting what is initially a change in laser position to height data. We can only access the output values of height in nanometres, which represents as "near-to-raw-as-possible" data.

In developing an embodied audience experience with this "raw" data we have created a prototype project, titled *Wildly Oscillating Molecules.* We have been experimenting with translating data from a collection of gold flakes   deposited on a Silicon chip at near-atomic thickness as our sample. In line with the sensory mode of the AFM, and its extension of our tactile ability, the *tactile* experience of the data is privileged and a visualisation is not constructed.

In our recent experiments, sub-only speakers have been positioned to exploit the vibrational properties of materials in the space. In this way we are exploring different materials with a view to creating a transducer-powered interactive interface that viewers can make direct contact with. This approach, combined with a denial of aural listening (through the use of industrial-rated earplugs and earmuffs) forces the participant to engage with the work on a bodily level. The seemingly non-directional properties of sine waves combined with the inherently low frequencies of the sonic components result in an experience that is felt, rather than heard. This positions the experience of the work in an installation-appropriate space rather than in film-viewing spaces such as cinemas.

4. DISCUSSION AND FUTURE DIRECTIONS

In a mediascape that includes works such as the afore-mentioned *Black Rain* and *A Boy and his Atom,* we suggest that *Wildly Oscillating Molecules* further explores notions of embodiment, authenticity and scale in science film. The separation between the data portrayed in these science films, and their creators, is increased by the technological and algorithmic layers that are required to enable them to interact at the appropriate scale. We propose the tactile/haptic experience of *Wildly Oscillating Molecules* is therefore both diminished and enhanced by technological amalgamation.

We have developed strategies and constraints for the project including focussing on one specific technology. Additionally we have opted to work with raw data, controlling its manifestation into audiovisual digital assets (i.e. audio, moving and still images) in order to explore issues of authenticity and scale in film making practice. For example we have developed a method of tactile sound by translating the data to infra bass, manipulating the speed and frequency of the sound and playing it back through sub bass speakers, sometimes using transducers, giving the audience a tactile experience of tactile data.

In developing *Wildly Oscillating Molecules* we suggest that by initially stripping the image away and privileging a tactile experience of the data that we may provide a way to question and reconstruct the embodied experience of the film maker. By displacing accepted scientific data processing workflows, and inserting the data into experimental media workflows, the opportunity to observe, and communicate, authentic and inauthentic happenings present themselves.

The technological perspectives, workflows and approaches to data developed and explored in this paper may offer artists and filmmakers further insights into issues of materiality, scale and phenomenology. This work also opens up further questions around: a new nomenclature of digital assets created at the nexus of media and scientific imaging; the role of stop-motion animation at the nanoscale; and the relationship between scientific objectivity and the "constructed" scientific image.

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