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Sensorial Language in Biomimetic Structures: Form and Media to Convey Coral Bleaching in the Great Barrier Reef

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ABSTRACT

Pressing environmental topics such as coral bleaching, are often difficult to convey in a less dogmatic way. Chief scientists, CSIRO and Inspiring Australia Expert Working Group are among a community of scientists who look for creative and innovative ways to promote science through emotional humanised engagement. Understanding aesthetics in the context of science is critical to emotional engagement which can lead to the assignation of value. Awareness can transform to behavioural change towards environmental conservation. While issues of communication in scientific discourse have been extensively examined, this research looks at communication through non-formal modes of sharing scientific knowledge. We examine the potential of the public arena as agency for humanised engagement and the potential of hyper-personal dimensions of technology-mediated language and cognition. The synthesis of the linguistic and the material through embodiment produces opportunities to enable effective learning and provokes new horizons of understanding. Our method will combine four keystones based on Kolb's Experiential Learning Model to develop a language that encompasses the human sensorium, that is, the body's entire sensory apparatus, to enable active experimentation, concrete experience, reflective observation, and abstract conceptualisation. The language with be a rhythm of tactile, visual, audible and ambient stimuli to restore participation of the body and emotion in a contemporary discourse. Finally, future work based on computation, biomimicry, spatial urban interventions, immersive and interactive capabilities for embodied structures is proposed as a strategy for understanding aesthetics and abstract narratives in the Great Barrier Reef and the issue of coral bleaching.

Keywords: Biomimicry, Coral Bleaching, Great Barrier Reef, HCI, Sensorial Language.

1. Introduction

It is argued that narrative complexities critical to understanding our inter-relationships with the natural world are rarely encompassed in characteristic discourses in science and environmental

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education (Gough, 1993). For the service of environmental conservation multidisciplinary research must explore contemporary strategies for greater impact and efficiency in delivering crucial environmental narratives such as the devastating coral bleaching in the Great Barrier Reef (GBR) (Quigley, 2017).

While issues of communication in scientific discourse have been extensively examined, this research looks at communication through non-conventional and non-formal modes of sharing scientific knowledge. Researchers have identified that when environmental and scientific issues such as climate change, are integrated into the everyday narratives that people tell about themselves and their world, people are more likely to take action (Lejano, Tavares-Reager & Berkes, 2013).

One of the key themes the Inspiring Australia Expert Working Group reported in 2012 on inspiring Australians in marine sciences included Bringing Marine Science into the Community, with efforts to engage the public to include collaborative projects between scientists and artists (Inspiring Australia Expert Working Group, 2012). More recently in 2018, the Reef Restoration and Adaptation Program launched an ambitious joint project to be led by scientists and research institutions that included the Australian Institute of Marine Science and CSIRO in partnership with the Great Barrier Reef Marine Park Authority, the Great Barrier Reef Foundation, James Cook University, the University of Queensland and the Queensland University of Technology (Great Barrier Reef Marine Park Authority, 2018; Great Barrier Reef Restoration, 2018; Australian Institute of Marine Sciences, 2018; CSIRO, 2018). Based on the Social and Economic Long-Term Monitoring Program funded by the Australian Government, which gathers long term data specific to reef users, communities and industries, and providing new insights into relationships between people and the GBR natural resource, key findings revealed that all user groups of the GBR, value the aesthetic appeal of the reef above all other values – even economic values (CSIRO, 2016; Marshall, Bohensky, Curnock, Goldberg, Gooch, Nicotra, Pert, Scherl, Stone-Jovicich & Tobin, 2014)

To increase understanding of aesthetics in the context of science and bring the issue of coral bleaching to the greater public this research explores opportunities in architecture, public spaces and technology mediation that will enable various degrees of humanised engagement.

We explore and adapt Kolb's Experiential Learning Model (Kolb, 2014) to develop a language through a rhythm of tactile, visual, audible and ambient stimuli that will capitalise on these opportunities to restore participation of the body and emotion in a contemporary discourse.

Finally, the synthesis of the linguistic and the material is proposed as future work to enable a sensorial language for communicating aesthetics and abstract narratives in the GBR and coral bleaching. Computational strategies, biomimicry, spatial urban interventions, immersive and interactive capabilities will be utilised to develop embodied design to communicate and engage with the public in a humanised and emotional way.

1.1 Critical understanding of the Great Barrier Reef

Being home to over 25% of all marine biodiversity in the ocean, coral reefs are extremely important marine ecosystems. Coral reefs are under threat globally and climate change threaten valuable coral reef ecosystems (Hughes, Baird, Bellwood, Card, Connolly, Folke, & Lough, 2003). Global risks to coral reefs include mortality and reduced growth of the reef-building corals, ocean acidification, water pollution, destructive fishing, overfishing, and coastal development (Burke, Reytar, Spalding & Perry, 2011). Widespread coral bleaching events are becoming more frequent worldwide (Hoegh-Guldberg, Mumby, Hooten, Steneck, Greenfield, Gomez, & Knowlton, 2007). Disastrously, the Great Barrier Reef (GBR) has been subject to severe mass coral bleaching (Bruno & Selig, 2007; Hoegh-Guldberg Mumby, Hooten, Steneck, Greenfield, Gomez, & Knowlton, 2007; Sweatman, Delean, & Syms, 2011). As a result, the disappearance of coral reefs in the GBR has obliterated rich marine ecosystems.

1.2 Inspiring agents of change

Environmental intervention is of critical importance and active participation in ongoing discourses can increase advocacy and lessen and reduce destructive human impact on these valuable ecosystems. Engaging the public in a more personal and humanised way on the issue of coral bleaching may translate to actionable insights. Finding ways to inspire people to become agents of change and ways to promote pride and a sense of responsibility in protecting the GBR are central to this research. Therefore, ongoing discourse need lasting impressions which can facilitate emotional connections. As

such, marine scientists are looking for a language to talk about aesthetics and emotion in the context of science, to think about biodiversity not only in quantitative terms but also aesthetic value for sensation, perception and for all the things that lead on from that (Quigley, 2017).

2. Background

2.1 Data Visualisation and Communication in Science

Data visualisation is one of the important tools that is used to both analyse and communicate scientific research. Scientific Visualisation is the visualisation of data sensed from the real world that creates not only a visible representation of data, but also allows the user to construct a mental model of the data (Manovich, 2011). It is often used for analysis during scientific process. However, the graphs that scientists produce are often too abstract for most readers, requiring specialist knowledge to interpret graphical data (Duxbury, 2012). Artists, designers, animators and also scientists often help the reader by using aesthetic approaches to communicating science.

There are many creative communities of practitioners who visualise scientific data to inform the general public. These communities also include artistically inclined scientists, such as David Goodsell's paintings (Söderqvist, 2010), such as that shown Figure 1, among other creative practitioners. These models of collaboration emerge online or may be formalized in art-in-residence programs (Henschke, 2016), or by hiring animation experts, which is particularly useful for complex biomedical animation, such as the work of Christopher Hammang (O'Donoghue, 2014; Australian Life Scientist, 2014) or Drew Berry (2011).

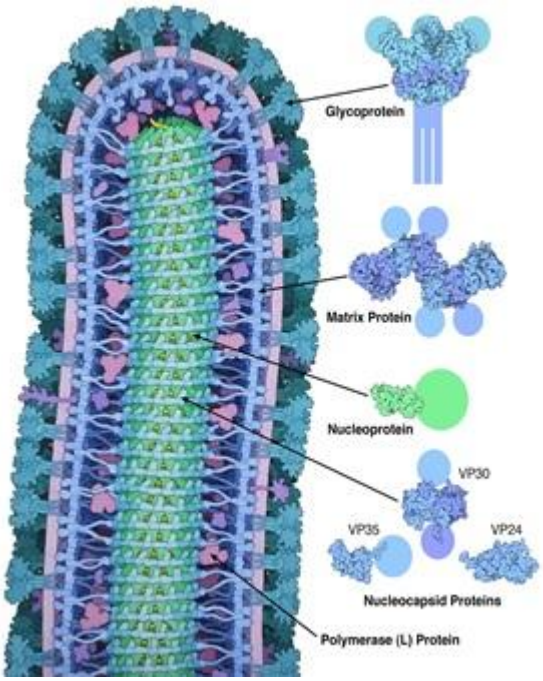

Figure 1: Ebola Virus. David Goodsell's composite watercolour and digital rendering of the Ebola protein created for the Molecule of the Month project. David Goodsell CC-BY-4.0.

Creative representations of data can contribute to comprehension of scientific data (Hohl, 2011), and transform quantitative data to new forms and ways of understanding that are meaningful to the viewer (Lupi, 2015). As such, complex environmental narratives such as climate change and coral bleaching require innovative ways to facilitate meaningful understanding of their critical and pressing urgency.

3. Methodology

Language and materiality have long been considered separate phenomena, but an increasing interest in their convergence suggests the productive potential of considering the linguistic and the material within the same analytic frame (Shankar & Cavanaugh, 2013). This research combines the linguistic and the material through embodiment to enable effective learning and provoke new understanding. Through this, emotional engagement become possible that would promote sustained commitment to the issue of coral bleaching.

"Kolb's Experiential Model" (Kolb, 2014) in Figure 2 underlines the four keystones of this research with principles adapted from the theoretical framework and human interaction model by John Zimmerman (Zimmerman, Forlizzi, & Evenson, 2007). The key elements in Kolb's model include: Active Experimentation, Concrete Experience, Reflective Observation, and Abstract Conceptualisation. In this model, according to Kolb, effective learning only occurs when a learner is able to execute all

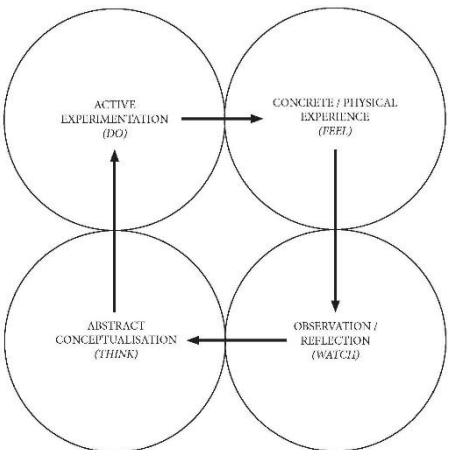

Figure 2: Kolb's Experiential Model An effective learning cycle (Kolb, 2014)

four stages of the model. Therefore, no one stage of the cycle is effective as a learning procedure on its own. Learning is the process whereby knowledge is created through the transformation of experience (Kolb, 2014).

3.1 Humanised approach in communicating scientific narratives - Keystone 1

In most cases, environmental and scientific data can remain impersonal to non-expert audiences resulting in audiences being emotionally disconnected. Much of non-experts' alienation can also be attributed to the 'foreign' nature of the language that constitutes science itself which estranges many and can be perceived as abstracted, disembodied or de-contextualised (Avraamidou & Osborne, 2009; Claxton, 1991).

Public art exhibitions that visualise scientific data for non-experts in novel ways can create emotional impact and meaningful engagement. Collaborations between artists and scientists that seek to visualise and communicate scientific research findings have become increasingly important (de Berigny, Gough, Faleh, & Woolsey, 2014). Artists can visualise scientific data in ways that make it more meaningful and visually sophisticated to large public audiences. Interactive installations can display scientific data through sight, sound and touch, via multi-modal engagement, that make scientific research findings more playful and engaging.

One such example of an art science collaboration is *Reefs on the Edge* (2012-2016) in Figure 3. Reefs on the Edge is an interactive artwork that explores how coral reef ecosystems are threatened by rises in sea temperature from the effects of climate change. The artwork is a collaboration with marine biologist, Dr Erica Woolsey, who researched the effects of rises in sea temperature on coral embryos, artists and designers, Caitilin de Berigny, Phil Gough, Adityo Pratomo, Ge Wu and Michael Bates. Public exhibitions like *Reefs on the Edge* provide evidence of their effectiveness in demystifying serious environmental topics to non-experts which increased their understanding and resulted in greater advocacy for climate change. Humanised approach in this research means inspiring estranged spectators to be active participants and enter into a dialogue, a dialogue where abstract conceptualisation and active engagement can promote emotional engagement.

Figure 3: Reefs on the Edge (2012-2016).

In this figure, the Installation designed and directed by Caitilin de Bérigny; Phillip Gough and Adityo Pratomo, who created the Tangible User Interface (TUI) objects and table; Ge Wu who created the multiple-channel video installation; and Michael Bates created the soundscape. (Left) Installation view with user moving the TUI objects. (Right) Background video installation and front, TUI table.

3.2 Public space and audience - Keystone 2

A multitude of opportunities for public engagement and dialogue presents itself in architecture and public spaces as they are direct, less formal and more accessible. Artists, urban planners and policy makers consider the role of public art and open spaces in facilitating dialogue, community activation and invigorating positive perception and attitudes. Their material and performative capacities provoke meaningful social interactions and learning moments (Ranciere, 2009). The public arena actualises multifaceted agencies for various possible degrees of engagement (Zebracki, 2013). As such, physical structures and objects in spaces that we move within in our daily lives play an important role in this research. Integrated in an urban setting, they can be designated to communicate and engage for the purpose of bringing environmental issues into sharp relief and providing a focus for reflection and observation, the second keystone. Non-traditional settings such as urban streets facilitate contemporary strategies and modalities for communication and engagement. Consequently, presenting and visualising

scientific data in novel ways that are embedded in a public context can contribute towards a less sterile to more humanised engagement.

3.3 Embodiment - Keystone 3

Embodiment is the realisation and materialisation of something abstract like an idea or a feeling into a tangible and visible form. The materialisation of communication in a public context as practiced in the arts and explored by many practitioners highlights the benefits and impact of intervention in public spaces (Guy, Henshaw, & Heidrich, 2013; Zebracki, 2013; Mmojieje, 2015; Moser, 2014). Evidently, our physical environment induces active tactile sensation and impacts the way we process and enrich our understanding through our sense of the physical. In this, the significance of the material to human cognition is recognised as materiality is envisioned to influence human behaviour and psychological processing and where materiality has agency (Overmann & Wynn, 2018).

As communication appeals to the emotion in an authentic way, discourse can be enriched and intuition enhanced through embodied sensorial experiences and perceptual cues that can promote deeper understanding of abstract and complex concepts. The challenge lies in developing conditions that create an influence on vision, audition and most importantly somatosensation or sense of the physical, to enable the third keystone of concrete and physical experience.

The design and creation of physical representations of abstract concepts can be highly complex and can be limited by design tools, building materials and structural considerations. Technology in design and building have advanced to enable realisation of highly intentional outcomes. Though often complex, objects and our physical environment can be designed and made to signify meaning and promote sentimental value.

The science of making in design and architecture involves tectonics as it relates to both aesthetics and function, elevating their materialisation into coherent structures. In developing a language that can enhance our understanding, we consider biomimicry and sensorial strategies to illustrate aesthetics in nature and their impact on emotion. Biomimetic sensorial designs can provide a coherent and enhanced communication strategy to facilitate meaningful humanised engagement through tactile, auditory and visual means.

3.3.1 Biomimicry

"Biomimicry" considered the practice of emulating natural systems and patterns can provide efficient and sustainable solutions to many challenges faced by humans (Benyus, 1997). The practice examines in detail natural occurring phenomena that can be tweaked, adopted and simulated for the purpose of solving issues especially those related to design and methods, thereby, abstracting principles from biological systems. The two approaches to biomimicry are described to be 'design looking to biology' and 'biology influencing design' (Biomimicry Guild, 2007). 'Design looking to biology' is an approach where designers identify human problems and look to the natural world for solutions and to organisms that have solved similar issues; whereas, 'biology influencing design' stems from having biological knowledge that can be adapted or that can influence human design.

According to the Biomimicry Guild, established in 2007, now known as Biomimicry 3.8 which is the world's leading consultancy group on biomimicry (Baumeister, 2014), there are three levels of biomimicry which apply to both approaches, categorised as form, process and ecosystem.

Form and process are aspects of an organism, plant or animal, that can be mimicked for their appearance, how they work and what they're able to do, while ecosystem is mimicking principles from whole ecosystems that allow them to function successfully. For architects and designers, this can mean that a whole or a feature of the organism or ecosystem is mimicked to provide solutions to design problems.

This research will use the biomimetic approach of 'biology influencing design' where aspects of corals in the GBR are mimicked for their aesthetics, structural efficiency and ambient qualities. The narrative of coral bleaching can be simulated through a rhythm of tactile, visual and ambient stimuli, as our built environment can be intrinsically persuasive and engages the consciousness in unique ways. As argued by Marcuse, art may not change the world but it works in changing the consciousness and attitudes of people who can change the world (Marcuse, 1978).

3.3.2 Computational design a paradigm of biomimicry

The potential of biomimicry and computational design as material language that will amplify expressions, enhance and visualise coral bleaching in the GBR is explored in this research. The biomimetic approach of 'biology influencing design' require understanding and a process of interrogation of natural systems. This process can be described as an oscillating process of simulation and design iterations, tweaking throughout the design phase to reach an optimal outcome. In design, fabrication and building, this process can be efficiently enabled through computation in digital environments, however often result in complex digital designs.

As technology and computer power advance, computational strategies leverage conventional methods and empower technology-mediated design development, providing a wide range of conceptual and fabrication techniques in object, structural, architectural, even systems design (Araullo & Haeusler, 2017). Computation becomes increasingly integral in the process of design creation, analysis, evaluation and aesthetic expression. As such, mimicking complex systems found in nature become possible through sophisticated computational techniques with deliberate and calculated iterative processes.

In the realisation of these complex designs, computation becomes a vital tool in the discretisation of the global form, defining finite elements, formal configurations and fabrication techniques (Araullo, 2018). Albeit, a greater knowledge and understanding of making and building is critical in this process.

Another important aspect of computational processes is that it has the potential to be generative presenting opportunities for diverse input parameters which can inform design at any stage of iteration (Araullo, 2018). As example, in our case studies sensor technologies provide data that result in transformative environments, creating a synthesis of form and media. These case studies feature embedded media and data that were simulated earlier in the design process and within the computational design environment so that their global forms can be described as reflecting and being informed by embedded data and media components.

3.4 Technology-mediated language - Keystone 4

In the same way technology is pervasive in design and making, the growing potential of technology has never been more apparent in the discipline of second-language acquisition due to its integration into everyday life. Language researchers have long recognised the potential of technology to amplify possibilities for expression, extend existing and enable new communication opportunities (Thorne & Smith, 2011). How hyper-personal dimensions of technology, language and cognition exploit ongoing technological advances is an ongoing field of inquiry and plays an increasingly important role in constructing messages to manage impressions and facilitate desired relationships (Walther, 2006). Through technological mediation active experimentation can be facilitated by means of interaction and immersion where one actively engages in a multitude of interactive sensory experiences, the fourth keystone.

3.4.1 Biomimetic approach to communication

In the last decade, interest in biomimetic approaches to problem-solving continue to grow in the areas of engineering, architecture and design (Hwang, Jeong, Park, Lee, Hong, & Choi, 2015). Some well-known examples include movement and growth found in nature (Benyus, 1997). Biomechanics of swimming is a good example of biomimicry that have inspired the design of highly efficient wind turbine blades and other types of airfoils making immense contribution critical to energy-harvesting technology. Another is evolutionary structural optimisation (ESO), inherent in the growth of trees and bones which is an approach for optimal structure by removing ineffective materials from the design domain, and which is a process that is now found in many finite element analysis software for engineering. Increasingly, biomimicry is evident in the design of many everyday objects as nature's beauty is a great source of inspiration (Baumeister, 2014). Patterns, textures, symmetry and simple natural logic are being explored through computer simulations and mapping.

These give insight into the abundant source of beauty and efficiency found in the natural world. As we continue to benefit however, these nature-inspired systems and designs, as they are integrated in our everyday lives can be leveraged to communicate meanings and narratives.

Plants and animals communicate all the time. In a local and micro level, biomimicry in communication is also another area of research that is a growing field of interest to scientists and

designers alike. Biomimetic communication mechanisms feature in the study of synthetic micro designs of autonomous motion and the self-assembly of biologically or artificially made nano or microscale entities (Baumeister, 2014). The prospect of extending this research into a macro-scale can be potentially beneficial in finding a way to communicate environmental narratives for clarity and better understanding.

In the same way the natural world communicates using signs and signals through motion, sense of smell, sound and other physiological sensorial perception, these same principles can be adapted with the use of computation. These communication methods can be simulated using sensor technology, light and sound technology, materiality and digital technologies to create hyper-personal conditions that provide a host of communicative and interactive advantages.

Mediacy is understood in this case as a contemporary means of communication using technology and media, and as such, what literacy is to print mediacy is to all media. Biomimicry in mediacy therefore facilitates a type of language that can offer dynamic engagement and expand one's understanding and emotional response.

4. Spatial intervention as case study

As examined in the following case studies, biomimetic and computational designs can create opportunities to deliver complex narratives in an intuitive and contemporary way. They were developed for spatial intervention and as tangible user interfaces for interactive media which transformed people and attitudes and transformed spaces into immersive tactile environments. As a means to increase public visibility, intervention of spaces in an urban setting can promote mental and emotional connections, and facilitate influence on vision, audition, and somatosensation through aesthetics of built forms and immersive tactile environments.

4.1 Spatial intervention: Euphonious mobius

"Euphonious Mobius" designed by Rebekah Araullo for Vivid Sydney in 2013 is an expressive piece of architecture that is site-specific and designed as a spatial intervention, Figure 4. This case study highlights the potential of computation in the design and realisation of complex structures. Through computational strategies, the design and its formal elements were informed by movement using digital dynamic simulations.

Figure 4: Euphonious Mobius installation in Campbell's Cove. A spatial intervention that is seven and a half meters long and stands at two meters high. The design is based on the mobius geometry. Sydney, 2013.

Media through LED technology and soundscapes were embedded as illustrated in Figure 5. Interactivity through sensors that were activated by movement and sound transformed the piece.

Figure 5: Interactivity is activated through movement and sound to create dynamic lighting. Sydney, 2013.

The simulation of this media during the design phase was critical in developing its design logic and its form.

Form and media in this case worked in conjunction to deliver intentional engagement and immersive experiences. Computation was a critical tool in facilitating its iterative design, structural engineering and dynamic simulations in a digital environment as well as enabling digital fabrication.

Euphonious Mobius is a seven and a half meter long self-supporting complex structure that was based on the mobius geometry and built as a reciprocal system. This structural

system uses small materials that are interdependent and can span a large area as loads are efficiently distributed throughout its global form. Reciprocity finds its structural efficiency under compression and tension. Small materials used were individually defined and unique that when assembled together produced an interesting and impressionable tactile form.

Through algorithmic computation, the design of the structure adapted to different input parameters such as the simulation of movement in the digital design environment which contributed to defining its final design outcome and expression. This was particularly critical as the global form enriched mediacy and enhanced public response.

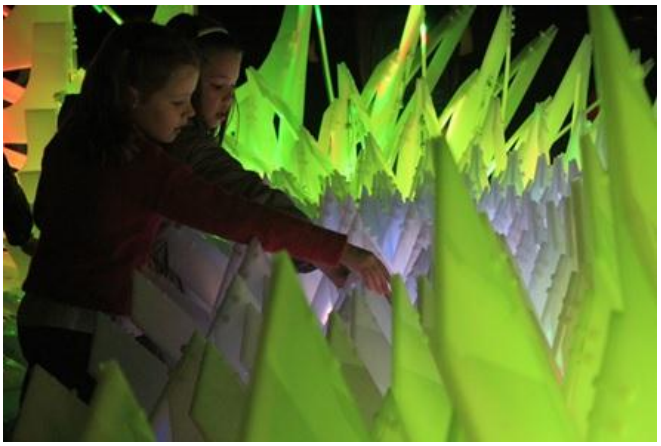

Figure 6: Euphonious Mobius' tactile texture which also functions as an interface is an active tool in engaging the public. Sydney, 2013.

Figure 7: Euphonious Mobius' form and function engaged in a unique and memorable way. Sydney, 2013.

4.2 Spatial intervention: Ptolemi

"Ptolemi" designed by Rebekah Araullo for Vivid Sydney in 2016 is an architectural installation that is site specific and designed as a spatial intervention on Campbell's Cove. This case study examines the potential of defined immersive open spaces and the digital fabrication of a complex structure. Ptolemi is made up of a pair of curved wall structures that defined a meandering walkway and engaged people in its unusual make and feel. The potential as well of computational design is illustrated in this case study. Interlocking panels developed through an algorithm stands at 3.8 meters high with a 6.4-meter diameter. Each unique piece is assembled together like a puzzle without fasteners such as nails or screws, as integrated into the design algorithm is a mechanism that interlocks the panels and contributes to its structural efficiency.

With embedded media, sensor technology and LED technology, the installation was transformed to engage the general public in a contemporary immersive and interactive experience, Figure 9. The installation made a profound impact on how the public stopped to observe, interact, reflect and move in this open defined space.

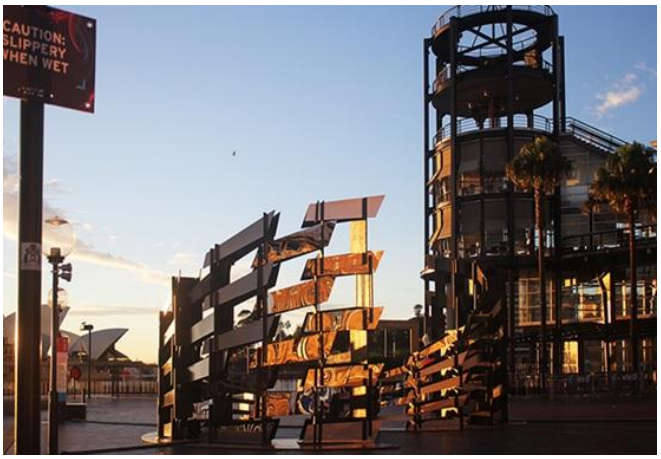

Figure 8: Ptolemi a reciprocal frame structure is made of timber and mirrored steel. Sydney 2016.

4.3 Spatial intervention: Mobi

"Mobi" designed by Rebekah Araullo in 2012 as a freestanding three dimensional media structure was built in collaboration with students from the University of New South Wales and installed at the forecourt of Customs House, Figure 10. The

Figure 9: Ptolemi's immersive engagement and interactive experience. Sydney, 2016.

development of this design offered insight into computational techniques that derived its final form through simulating media in the digital design environment to create expressive surfaces when built.

4.4 Spatial Intervention: Hextic

"Hextic" produced by Rebekah Araullo in collaboration with students from the University of New South Wales is a self-supporting archway developed for the Sydney Architecture Festival in 2014 and installed in a Sydney CBD laneway. The intention of this piece is to activate spaces that would otherwise be unused. This case study highlights the impact of dynamic and engaging experiences that activate spaces and transform people's attitudes. Interactive components were embedded and responded to facial detection and sounds which changed colour accordingly. Its transformative results enticed people within the space and engaged in a unique and memorable way.

Figure 10: Mobi at the forecourt of Customs House. Sydney, 2012

Figure 11: Hextic is a five and a half meter freestanding 3D media archway in a Sydney CBD laneway. Sydney, 2014.

5. Evaluation and future work

The case studies presented illustrate the potential of tactile mediacy that will be adopted to communicate the issue of coral bleaching to wide public audiences in an exhibition context in public spaces. The synthesis of form and media to develop a language through a rhythm of tactile, visual, audible and ambient stimuli has the potential to restore participation of the body and emotion in a contemporary discourse. Currently, there is an environmental urgency to help address the health of coral reef ecosystems globally. This research seeks to bring the issue of coral bleaching within the purview of the larger public, in a way that can have a high impact. Multi-sensory installation environments can provide new innovative ways to visualise and experience coral reef ecosystems, bringing new levels of understanding and emotional connection to the issue of coral bleaching.

5.1 Simulating environmental narratives

The communication and simulation of environmental narratives has never been more vital in the service of conservation. The Anthropocene, a geological epoch, defined by Paul Crutzen, the Dutch chemist Nobel prize-winner in 2000, argues that human activity has driven the Earth into a new geological epoch, by lasting effects of human activity on the environment (Crutzen, 2002). Increasingly, anthropogenic changes in the GBR have caused mass coral bleaching events. Reef ecosystems are crucial to worldwide ocean health as 25 % of diverse marine life resides in coral reefs and are continually in danger of extinction. Currently, over 60% of coral reefs have been lost, thus the communication of environmental narratives has never been more crucial. Multisensory applications in our built environment can visualise scientific data to non-expert audiences in ways that captivates audiences globally.

The first ever real-time photographic visualisation of a coral bleaching event was captured for a documentary called 'Chasing Coral' (Grobar, 2017). Chasing Coral reveals the tangible, devastating effects of warming sea temperatures. In the creation of the film, the team of scientists and film makers placed underwater time-lapse cameras to record coral bleaching in the GBR on Fraser Island. As a consequence of the documentary, the film engaged the audience as they witnessed the transformation of the corals through this photographic documentation. The film also served as scientific data that can be used for

further studies of coral bleaching around the world. It provided scientists the much needed insight into the global health of coral reefs worldwide, as well as communicating to audiences the immediate need to address climate change.

Simulating this coral bleaching event within an immersive but public space to bring greater public visibility may empower discourse and facilitate ongoing dialogue outside conventional places such as conferences, institutions and galleries onto a more immediate public platform.

5.2 Future work - Urban corals as sensorial language

Through form and media the narrative of the coral bleaching event in the GBR can be delivered and presented in a unique and contemporary way, one that will engage the public through tactile and mediated experience. "Urban Corals" will encompass a biomimetic architectural piece integrated with smart digital components and installed as a spatial intervention in a public setting. Through the biomimetic approach of 'biology influencing design', the levels of biomimicry of form and process where aspects of corals and their ecosystem, to do with appearance, how they work and what they're able to do will be mimicked. The spatial intervention piece will be embedded with media and sensor technology to inform and communicate the aesthetics and ambient qualities of corals and the GBR, and communicate the issue of coral bleaching in a meaningful and memorable way. Through this embodiment, a type of sensorial language will be developed to evoke new horizons of understanding and recognition of their value, a critical step towards promoting behavioural change on the issue of conservation of the GBR.

Figure 12: Urban Corals impression (own photo).

6. Conclusion

Finding ways to reach and inspire people to become agents of change on the issue of coral bleaching and climate change is challenging, layered with social, cultural and political obstacles. In the socio-spatial perspective, the people, their physical surrounding, architectural elements and objects in the space that influence and that can be altered, become active participants in a continuous dialogue that is transformative and one that generates new perspectives. The Reef Restoration and Adaptation Program launched in 2018 has as its goal a strategy for possibly recovering and developing protection of the reef beyond 2030, a direct response from a concerted effort that included inspiring Australians in marine sciences. It is imperative that the human dimension of the GBR and the findings of the Inspiring Australia Expert Working Group reported in 2012 on inspiring Australians in marine sciences will not take a back seat. Ongoing experiments and efforts must be encouraged, and opportunities developed and produced, to bring about a change in perspective and attitude. Developing a sense of pride and responsibility in protecting the GBR can be inspired during unique moments in such spaces, which may start through expanding one's understanding of their aesthetics and value to humanity, inspiring estranged spectators to become agents of change.

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