02

An investigation into the Architectural Agency of Air

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Tasenska Guilford

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ABSTRACT

Miyake Jima, an island off the East coast of Japan, was home to 3,600 residents until 2000 when an escalation in volcanic activity caused noxious gas to burst from the crater, sending twenty thousand tonnes of sulphur dioxide into the air each day. The noxious gasses forced a mass evacuation, leaving the island uninhabitable for five years. Since 2005, two thousand eight hundred residents have returned to the island but are at constant risk of gas eruptions. Residents' solution is to don gas masks when the sulphur dioxide levels become too high; however this does not ameliorate an ever-present, and real, danger from the air.

In this research, Miyake Jima Island is employed as a testing ground to explore how air can influence architecture. Miyake's problematic atmosphere is used as a starting point for a series of experiments that interrogate air's architectural agency. Design experiments explore the problem of noxious air across a range of scales, from the human body to the scale of landscape. These experiments have a twinned focus: combining scientific and aesthetic understandings of air, design explorations are informed by a rich mix of chemical and material dynamics, human dynamics, and intuition. The results of these experiments give insights into two research objectives: to understand air as an aesthetic and conceptual driver in architecture, and, to propose architectural solutions to Miyake's ever-present threat of noxious air.

The research draws on the work of Jane Bennett (2010) and N Katherine Hayles (2014), in the areas of New Materialism and OOI (Object-Oriented Inquiry), to develop a methodology of designing and physical modelling where material agency takes precedence. This is addressed through design research, by way of design experiments at three scales: an installation, at human scale, focusing on "making air visible"; an Air Safety Pod, at "mid" scale; and an Air Crisis Centre. The Crisis centre is at landscape scale and designed to accommodate the island's population in the event of a sulphurous air event. Critical analysis of site, theoretical contexts, and case studies are undertaken to aid the explorations. The thesis connects with key thinkers on the aesthetics and science of air, such as Sean Lally, Malte Wagner, Jonathan Hill and architect Phillip Rahm. This context is supported by specifically chosen case studies that relate to and support each scale of experiment.

The residents of Miyake Jima have shown resilience to continue living on the island, and this research contributes to helping them create a sustainable future. In doing so, the design research explores how air can be powerful in shaping architecture: how air, the primary component of architectural space, can influence architecture.

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INTRODUCTION

INTRODUCTION

The volcanic Island of Myiake Jima presents a problematic atmosphere, where its residents deal with the noxious gas sulphur dioxide. The residents have shown resilience to continue living on the island; however the lack of protection from the gas has left them with an overwhelming safety risk.

This research puts forward the question:
How can architecture be reoriented, through giving aesthetic agency to its primary component, air?

This question prompts investigations into how air can challenge architecture, in terms of its aesthetics, form, and the way in which it is designed. In this research, there has been a binary outcome wherein the aesthetic of architecture has been challenged through the design-through-research approach, which has produced a speculative solution for the residents of Myiake Jima.

The key theorists can be split into three sections and are discussed within Chapter Two. "Air as Architecture" discusses

immateriality in relation to Malte Wagnefield (2013), Jonathan Hill (2006), Philip Rahm (2009), and Sean Lally (2013). Sulphur dioxide is discussed in relation to its effect on the human body and existing methods to filter it from the air. Lastly the contemporary literary context of material agency is discussed in relation to Katherine N. Hayles (1999), Jane Bennett (2010) and Elizabeth Grosz (2010).

Through the design Chapters, Three to Five, the research investigates the principles of a design through research approach. Air as a material agent plays a crucial role in establishing a methodology where the focus is placed on the material's agency. These ideas are explored through three scales; an installation, at human scale, focusing on 'making air visible'; an Air Safety Pod, at 'mid' scale; and an Air Crisis Centre. The iterative process is carried out through model-making in a reflective process that provides an ever-increasing design loop of experimentation through modelling and reflection. The loop continues as new insights are found through the modelling process and continuing research presents new information.

METHOD

04

The research argues for a design through research approach. Rendell (2013) claims that “in much design research the process operates through generative modes, producing works at the outset that may then be reflected upon later” (p. 117). Murray echoes Rendell’s view “that designing is a way of knowing that is applied on the wider process of designing, rather than an enquiry directed towards a particular defined outcome” (p. 95). This methodology has been established through an iterative process of “making”, which develops methods to represent air as an aesthetic and the filtration of sulphur dioxide through three design investigations. Each project increases in complexity and the reflections from each are used to inform the following projects in a sequential manner. The research draws on the insights of Rendell (2013), Murray (2013), Kupler (2013), and Fraser (2013) in the realm of design as research.

The aim of the research is to investigate an “air like method” of making where the unpredictable nature of air is recreated by substituting air for alternative materials. This method allowed for unpredictable discoveries that would not have been possible through a traditional top down approach. Kupler (2013) supports this method saying, “Interests can be derived through graphic exploration and breeding latent and unpredictable opportunities, then visualised and capitalised upon towards design speculations” (p. 59). He also suggests, as this research follows, that the through the iterative process “ideas are augmented through an emerging visual field of study that is discovered in the act of constructing drawings”; however, within this research constructing drawings is replaced with constructing models (p. 59). Rendell (2013) suggests that “architecture and other built environment disciplines continue to be challenged by the idea that the aesthetic values might not only be object driven but also related to time, process, ethics and subjectivity” (p. 125).

Through the model iterations, this research picks up on two of these challenges; process and subjectivity. Subjectivity is approached through a relationship between human subjectivity and the power that materials themselves have to work as design actants. This is discussed in detail through the literary review (Chapter 2).

The focus was placed on the act of physical modelling or “making” with direct reference to site and its conditions in order to solve the climatic problem of sulphur dioxide. Models were constructed on site typographies, which then were reflected and analysed through a method of photography and drawing. Rendell (2013) suggests that “design research should be driven by the logic of ‘application’ and the need to solve problems,” which is exactly how this research operates by solving the issue of human inhabitation alongside the volcanic gas sulphur dioxide (p. 118).

The final outcomes, of the Air Safety Pod and the Air Crisis Centre, are presented through digital representation based upon the design insights gained through the iterative process of modelling. The three projects developed a method in which the iterative process of models were explored, enabling the investigation into the aesthetics of air and the integration of air filtration into architectural form.

THESIS STRUCTURE

2

LITERARY CONTEXT

Introduction

This context chapter presents the theoretical background to the work. Visual case studies are included, and further explored in design chapters where they directly relate to the work.

AIR AS ARCHITECTURE

Air is invisible yet at the same time physically present. It is, in essence, an invisible entity sensed through touch, smell, and taste. This literature review traverses air as a notion from, aesthetic, theoretical, and scientific points of view. It provides the context for a study in an immaterial, yet material, approach to architecture, a key objective of the design research. Architecture typically creates a physical boundary between exterior atmospheric conditions and interior, creating a fixed material boundary between two dynamic and gaseous states. The tradition of this defining boundary can be traced to Vitruvius, and to “man’s primitive need to take shelter from the external environment” (McWen, 2003). This places air in opposition to architecture as a static and material entity. In this research, the immateriality and unpredictability of air is brought to bear on the static nature of architecture. Air’s dynamic qualities are caused to redefine the boundedness and form of architecture, reshaping architecture as “airlike” rather than in opposition to its internal and external atmospheres. Four main theorists are discussed in support of this research direction: Wagnenfield illustrates the materiality of air through its unpredictability, Hill defines the immaterial, while Rahm and Lally present projects that use air as a material.

Wagenfield

Through his experiments discussed in his dissertation *Aesthetics of Air*, Wagenfield (2013) deals with the difficulties in visualising air. His physical experiments reveal air's movement, acting in eddies and swirls as it interacts with the interior environment and moving bodies (p. 17). His three main conclusions are: the air within a space is completely randomised; there is a dynamic relationship between our bodies, air, and the surrounding space; and the system of air is extremely delicate, easily affected by small external factors (p. 145). In this respect air itself becomes a material. Galileo and Giovanni Baliani were the first to claim that air had weight (Walker, 2007, p. 11). Through conducting simple experiments, they were able to show that air pushes and is ever-present in our surroundings, concluding that air has a physical substance. Walker notes that "not only is [air] vital for breathing, but it also touches us inside and out every day of our lives" (p. 22). Wagenfield's (2013) work establishes that air is a material that possesses its own characteristics and agency and that air's quality of unpredictability is ever-present.

Hill

Hill (2003), in his book *Immaterial Architecture*, suggests that there is a blurred line between the material and immaterial, terms that can be interchanged with "form and formless, real and virtual" (p. 176). He recognises that there are many ways that we can understand the immaterial; however, he is mainly concerned with the "perception of architecture as immaterial, which can be achieved either through the absence of physical material or physical material perceived as immaterial" (p. 176). He concludes that the immaterial "is not the absence of matter, but the perceived absence of matter." Therefore, he suggests that the immateriality of architecture relies on the individual's perception of space. Hill challenges the norms of architecture whereby "architecture is expected to be solid, stable and reassuring – physically, socially and psychologically", proposing that the "immaterial is as important to architecture as the material" (p. 177). He does not claim that the immaterial is the answer to moving away from the traditionally static forms of architecture. Instead, architecture must engage with "the material and the immaterial, the static and the fluid, the solid and the porous" to establish greater flexibility in the way that we design (p. 177).

Rahm

Rahm uses the idea of air as a material to redefine boundaries, believing that “invisible takes precedence over the visible” (Lally, 2009, p. 23). He explores newly-emerged meteorological architecture wherein the spaces he creates have “no meaning, no narrative; interpretable spaces in which margins disappear, structures dissolve and limits vanish” (p. 50). Pallasmaa (2012) suggest that the creation of space cannot only rely on form. Pallasmaa (1993) expands on this, stating that “We behold, touch, listen and measure the world with our entire bodily existence” (p. 35). While Rahm does not take on such a phenomenological approach, he challenges traditional buildings, in the sense that they are “frozen forms of social, political and moral conventions” (Lally, 2009, p. 26). His solution is to “re-appropriate the tools of the natural to generate cities and buildings” (p. 26). Rahm’s Interior Gulf Stream creates an external environment where the climate is constantly shifting (Fig 2.02). The spaces are divided through changes in temperature, which, therefore, is “creating a thermodynamic tension” (Rahm, 2009, p. 184). Rahm has taken air as a material to define internal space and, in turn, challenged the traditional approach to defining boundaries within an internal space.

Fig 2.02. Interior Gulf Stream by Rahm

Fig 2.03. Proof 101 by Lally

Lally

Lally (2009) defines the immaterial as “material energies” that include qualities of “thermal variation, air velocity, light spectra and electricity” which “all have potential roles beyond merely producing moods or effects along a surface” (p. 13). He believes that by looking at immateriality architects can start by “redefining the physical boundaries and edges that architect’s use as organisation strategies opens the potential for design innovation and the creation of new spatial and social constructs” (p. 14). PROOF 101 is Lally’s proposal for a public plaza works with air pushed from below ground through the sidewalk to create spatial boundaries that can be tacitly sensed (Fig 2.03) He establishes the point through this speculative project that “being able to identify the boundaries of these energy systems at any particular moment is important because those edges will come to define architectural space” (Lally, 2014, p. 210).

Summary

In conclusion, immateriality has seen some negativity towards its integration into design within architecture. While Rahm and Lally suggest an approach where we rely on our senses to establish these no visual boundaries, Hill recommends that the immaterial must work together with the material in order to make the first steps in moving away from a static architecture. While Wagenfield differs – looking specifically into what the aesthetics of air are through making air visible – like Lally, Rahm, and Hill, he challenges us to think of air as a material of its own right.

The research argues that immaterial materials, such as air, can provide new ways to design architectural form. Through the integration of the immaterial with the material a new method of design can be established. This is investigated through Chapter Three with the investigation into how to “make air visible”. The conclusions are used to aid the projects in Chapter Four and Five.

CONTEMPORARY LITERARY CONTEXT OF MATERIAL AGENCY

The contemporary literary context of material agency focuses on the theoretical background for the contemporary context of material agency. In terms of material agency, I discuss Katerine Hayles' Object Oriented Inquiry theory in relation to Jane Bennett's Vibrant Matter and conclude with Elizabeth Grosz' discussion on 'freedom to' versus 'freedom from.'

Hayles

Hayles' (2014) essay, *Speculative Aesthetics and Object-Oriented Inquiry (OOI)*, challenges the premise that human perception lies at the centre of aesthetics. She replaces this with "object-oriented philosophy," of Graham Harman (2007), wherein "humans, nonhuman biological creatures, inanimate objects, imaginary concepts—exists equally without privileging any viewpoint, especially the human, as the defining perspective for the others" (p. 273).

Hayle's presents her Object-Oriented Inquiry (OOI) by creating a middle ground between "speculative realism and speculative aesthetics" (p. 178). She discusses Flusser's explanation of the Vampire squid (2012) in conjunction with Bogost's assessment of speculative realism in *Alien Phenomenology: What it's like to be a thing?* (2012).

Over the past millennium, humans have struggled with attaching information to objects in order to inform them. Flusser (2011) attributes this struggle essentially to aesthetics:

Human art is the gesture through which man imprints his experience upon the object of his vocation in order to realize himself in it, to immortalize himself in it. Every object that is informed is therefore a 'work of art'.

Bogost (2012) develops a method of "metaphorism", which allows us to understand the objects' perception to each other through a metaphor:

Metaphorism offers a method for alien phenomenology that grasps at the way objects bask metaphorically in each others' "notes" [Harman's name for the sensual attributes of an object] by means of metaphor itself, rather than describing the effects of such interactions on the objects. It offers a critical process for characterizing object perceptions.

Hayle's OOI theory establishes a point of difference against Bogost and Harman in relation to "how objects manifest themselves" in reference to the objects' own "allure; the attraction it emanates for other objects" (p. 168). Instead she suggests that "in my experience it is the resistance objects offer to human manipulation and understanding" (p. 169). Hayle's scientific background leads her to this conclusion and draws her to the work of Andrew Pickering's *The Mangle of Practice* (1995). In the form of experimentation, "the object responds by resisting the human's inquiry, in a continuing dialectic in which the resistance forces the questions to be modified, and the modified questions uncover new forms of resistance" (p. 168).

She explains that this resistance of the objects is crucial to gain an understanding of them, as objects cannot let us know what they are but can tell us what they are not. Hayle concludes by positioning her work in the realm of the post-human “in which other species, objects, and artificial intelligences compete and cooperate to fashion the dynamic environments in which we all live” (p. 178). She goes as far as suggesting that designers’ “conscious thought does not operate at all” within this realm (p. 174). This research positions itself a step back from OOI and its realm of the post-human, while engaging with the idea that objects offer resistance to human manipulation; human agency still remains in the iterative process and the reflective loop of designing.

Bennett

Bennett’s (2010) book, *Vibrant Matter: A political Ecology of Things*, argues that there is “a vitality intrinsic to materiality; things too are vital players in the world” (p. 3). She explores the theory of New Materialisms, looking specifically towards what she calls “thing-power” where “man-made objects exceed their status as objects and manifest traces of independence or aliveness” (p. 16). Bennett’s work is positioned between political ontology, inspired by Deleuze (1991), and political ecology, inspired by Latour (1996); as well as drawing inspiration from 20th century vitalisms (Van Wyk, 2012, p. 130). The work is split into two; with a philosophical project and a political project. For the purpose of this research the philosophical project of how to “to think matter slowly, to think it so slowly that it becomes strange, and strangely vibrant,” is discussed (p. 130). Three points from the first five chapters Bennett’s book are touched on in relation to my research: insights into defining a “thing”, the association of actants, and the relationship of assemblages.

Bennett begins to define the “vibrancy of matter” through Hent de Vries’ theological approach of the notion of the absolute, establishing her definition of a “thing” and its power. She redefines the absolute as an “intangible and imponderable” recalcitrance” of things, whereby things seem to be unassociated with the human as they are “loosened off and on the loose” (p. 3). In other words, perfection of the thing is ascertained through its reluctance to be manipulated by the human, whereby it generates its own form. In this sense, the Absolute is a reference that is too simple. The “thing” transcends to become “some-thing that is not an object of knowledge that is detached or radically free from representation, and thus no-thing at all. Nothing but the force or effectivity of the detachment, that is” (3). The formation of the ‘no-thing’ presents as with “moment of independence possessed by things”; the moment that detaches them from human control. The moment of ‘things’ creating their own force can be described as “thing power” whereby objects then have “the curious ability of inanimate things to animate, to act, to produce effects dramatic and subtle” (p. 6).

“Thing power” challenges the “life-matter binary” that Bennett calls the “the dominant organisational principle of adult experience” (p. 20).

Bennett’s second point is the explanation of the actant. Van Wyk (2012) ascertains that if Bennett prefers “thing rather than object, she also prefers actant rather than thing” (p. 132). Actant is a term borrowed from Latour (1996) which he defines thus: “An actant is a source of action that can be either human or non-human; it is that which has efficacy, can do things, has sufficient coherence to make a difference, produce effects, alter the course of events” (p. 14). According to Bennett, actants never work by themselves. They are always a part of a larger assemblage. In her own interpretation of Nietzsche, Bennett suggests that there is not a singular actant, or doer, behind each action; instead there is an assemblage between the human and non-human (p. 28). Bennett’s ultimate aim is to establish that “materiality that is both force and entity, energy and matter” (Van Wyk, 2012, p. 131). It is the ability for an animate object to possess its own power outside of human action

Grosz

Elizabeth Grosz article titled *Feminism, Materialism, and Freedom* delves into the area of subjectivity through the three fields of autonomy, agency, and freedom that have been prominent concepts to aid our understanding through the 20th Century (Coole & Frost, 2010, p. 141). Grosz explores subjectivity by defining ‘freedom from’ in comparison to ‘freedom to’ which attempts to step away from the negative connotations associated with subjectivity and its elimination of constraints. The focus in relation to this research is Grosz’ establishment of ‘freedom to’. She attempts to reframe subjectivity “in a different context that may provide it with other, different political affiliations and associations and a different understanding of subjectivity” (p. 140).

Grosz uses Henri Bergson to help express understanding of subjectivity, agency, and freedom in terms of “rethink[ing] how subjectivity and freedom are always and only enacted within and through the materiality that life and the non-living share” (p. 142). She suggests that acts of freedom are “never the same, never self-identical” which, therefore, enables us incorporate these ever-changing actants into our processes and allow them the freedom to change design outcomes. She claims that with these acts’ starting points all changing, the outcomes of such acts can never be repeated in the exact same way again, stating that “Acts, having been undertaken, transform their agent so that the paths that the agent took to the act are no longer available to him or her except abstractly or in reconstruction” (p. 148). The materiality of the subject also plays an important role: she suggests that “if freedom is located in acts rather than in subjects, then the capacity to act and the effectivity of action is to a large extent structured by the

ability to harness and utilize matter for one's own purposes and interests" (p. 149). It is this notion of allowing freedom of the act to produce outcomes that are ever-changing and never repeatable that is used throughout the research process.

Summary

In conclusion, this research argues that Bennett's definition of new materialisms can be brought to the methodology of the process of designing in the architectural realm. Such methodology accepts that materials themselves have a 'thing power' that allows them to act of their own free will. This aligns with Grosz's claims that the freedom lies in the act itself rather than the object, and also acknowledges Hayles' contribution, through the OOI theory, that objects themselves have a resistance to human inquiry. A collaboration of these theories provides the methodological focus for the design of the Air Crisis Centre.

SULPHUR DIOXIDE RISKS AND FILTRATION METHODS

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Sulphur Dioxide presents an ever-present danger to human habitation; however, there are methods by which it can be filtered from the air. This literature review provides a theoretical background to sulphur dioxide gas in relation to volcanoes, its risk to human health, and its current methods of filtration.

Risks

Sulphur dioxide (SO₂) is a heavy, colourless, poisonous volcanic gas that is produced at points of fumaroles and craters on volcanoes. The gas exits these vents at high temperatures between 1000C-8000C (Cole, Nairn, & Houghton, 2005). In the atmosphere SO₂ reacts with water to create sulphuric acid, which is one of the main components in acid rain (Encyclopaedia Britannica, 2016). It can also easily react with other substances to form harmful compounds such as sulphurous acid and sulfate particles. SO₂ has a distinctly strong odour and in large quantities is extremely dangerous to humans' respiratory system. SO₂ will "irritate the nose, throat and airways to cause coughing, wheezing, shortness of breath, or a tight feeling around the chest" (Department of the Environment and Heritage, 2005). The Australian standard for acceptable levels of Sulphur dioxide in the air is 0.20ppm (parts per million) average over a one-hour period. A life-threatening level of SO₂ is 100 ppm for a short time period (Fig 2.04).

Pilot studies conducted on White Island through "time-averaged measurements of personal exposure to SO₂ for a 20-minute period spent downwind of fumaroles of 6 – 75ppm" (IVHN, 2011) validate the need for refuge when it reaches these high levels that would cause harm to humans. The current solution for areas with high levels of sulphur dioxide is for individuals to carry gas masks for protection.

Filtration Methods

To filter SO₂, acid gas filters are required to be fitted within the gas mask (Cole, Nairn, & Houghton, 2005). Acid gas filters fall within the chemical filters family which work through two processes of absorption of chemicals and chemisorption. All chemical filters consist of a container filled with sorbent, typically a granular porous material that interacts with gas to remove it from the air. The most commonly-used material used is activated carbon or charcoal. The carbon is activated by heating it to 800-900oC with heat or steam, which creates a porous internal structure. Absorption of chemicals method relies on the vapour molecules adhering to the surface of the activated carbon. The process relies on the strength of attraction produced by the adhering chemical; thus, the difference in strength varies. Chemisorption works in a similar manner; however, in order to make the filter selective to particular chemicals, sorbents are impregnated onto the activated carbon. The binding of these specific chemicals is much stronger than absorption of chemicals and, therefore, reuse is limited by the surface area of the carbon (3M, 2016).

Chemicals that are used to impregnate filters are rated from A-C class for their effectiveness. Chemicals that have been proven to filter SO₂ are triethylenediamine, sodium hydroxide, potassium iodide, and potassium hydroxide (Li-Chun Wu et al., 2012), listed respectively from least effective to most effective (James & Lodge, 1959, p. 59).

Another form of SO₂ filtration involves the use of nylon filters; however, this is rated as a B-grade filter for the absorption of SO₂ (CPLabSafety, 2017). The nylon filter is essential like gauze fabric that has a level of transparency and complete flexibility. Nylon filters are also used as a sampling method for ambient air over short time periods for SO₂ (Sickles & Hodson, 1999, p. 2423).

Exposure Limits (ppm)	Health Effects
1-5	Threshold for respiratory response in healthy individuals upon exercise or deep breathing
3-5	Gas is easily noticeable. Fall in lung function at rest and increased airway resistance
5	Increased airway resistance in healthy individuals
6	Immediate irritation of eyes, nose and throat
10	Worsening irritation of eyes, nose and throat
10-15	Threshold of toxicity for prolonged exposure
20+	Paralysis or death occurs after extended exposure
150	Maximum concentration that can be withstood for a few minutes by healthy individuals

Fig 2.04. Table showing the exposure limits of sulphur dioxide and there effects on health.

Summary

Human exposure to high levels of SO₂ poses severe health risks to the respiratory system. The only protection against the gas is to wear acid-filtering gas masks containing chemicals of varying effectivity impregnated into activated charcoal. An alternative method of filtration is to impregnate nylon fabric with chemicals that attract SO₂.

The research explores ways in which these methods of filtration can be used within an architectural form in order to provide humans an area of safe, breathable air. This is explored through the Air Safety Pod and extended into the project of the Air Crisis Centre.

Conclusion

The three areas of the aesthetic, theoretical, and scientific have been investigated in relation to the notion of air: the aesthetic was derived from the contextual background of immateriality; the theory of the contemporary context of material agency encapsulated Bennett's *Vibrant Matter* and Hayles' OOI theory; and the scientific research uncovered detailed information related to SO₂. The wealth of information comes together through the design process to enable an informed speculative solution to be produced.

3

MAKING AIR
VISIBLE

INTRODUCTION

The installation stage explores how air can be made present or visible within a space, as air becomes the focus of designing. Three air experiments were undertaken investigating the patterns created by artificial air, the movement of air in an external environment and the ability to manipulate the shape of air.

ARTIFICIAL AIR MOVEMENT

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Introduction

Making air visible is an installation that investigates how air can be made present space, as air becomes the focus of the design. Three air experiments were undertaken to investigate the patterns created by artificial air, the movement of air in an external environment, and the ability to manipulate the shape of air.

Aim

To investigate and analyse air movement patterns through the suspension of fabric in a stream of air inside a cylinder shape.

Method

Using a fan laid flat on the ground and a cylinder made from plastic sheeting, the patterns from pieces of fabric made by the movement of the air were documented via a photographic series.

Fig 3.05.

Fabric fluctuation series

Fig 3.06. *Fabric fluctuation in motion.*

MAKING AIR VISIBLE

Fig 3.07. Fabric fluctuation in motion.

Fig 3.08. Spherical vessel testing series.

Fig 3.09. Close up series of air movement.

Results

The fabric circulation patterns were highly unpredictable as each trial saw the fabric react in a slightly different way (Fig 3.06).). However, some reoccurring patterns were established where the fabric was stuck flowing in a circle at a set level. At some stage, the fabric would float out of the top of the cylinder and the fabric would rise up and down through the cylinder in a rotational pattern. There was no way to predict how long the fabric would stay in the cylinder, what forms were created by it, and when the air flow would fluctuate to allow the fabric to rise and lower through the cylinder. The main factor that never changed was the rotation of the fabric in an anti-clockwise direction as it swirled through the cylinder in a convection current created by the fan (Fig 3.07).

Reflection

The experiment was successful in regards to making the patterns of air visible, enabling forms in the fabric to be photographed. The reoccurring factor was that the air flow behaved in an unpredictable manner. The artificial air circulation experiment is useful for creating space in interior environments; however, investigation of exterior forms of air circulation was also needed; hence, the following experiment.

ARTIFICIAL VS. NATURAL

Aim

To observe and analyse the currents and patterns of air in an external environment versus those of the artificial circulation of a fan.

Method

External air circulation was observed by releasing fog from a smoke machine and documenting the patterns of the smoke via photographs. Artificial airflow was observed releasing fog from a smoke machine at the base of a fan and documenting the patterns of the air via photographs.

Fig 3.10. Series tracking smoke movement in fan circulation.

MAKING AIR VISIBLE

Fig 3.11. Series tracking smoke movement in external environment.

Fig 3.12. Tracking smoke movement in external environment series.

Fig 3.13. Tracking smoke movement in external environment series no. 2.

Fig 3.14. Tracking smoke movement in external environment series no. 3.

Results

The day and night photo series were taken on the same day when the wind speed was not strong (approximately 12km/hr) and the smoke panned out over the car park without any swirling motion until it finally disappeared above the buildings. The area that the smoke was released into was surrounded on three sides by buildings of equal heights, therefore the smoke was not affected by an external wind patterns.

Through the series of photographs of the smoke movement at night, some regular patterns were established. The smoke travelled along the wall and gradually barrel rolled while drifting upwards. The air dispersed evenly until reaching the end of the wall where it was picked up by a small breeze and drifted out. Some variation was seen in the final photos when the wind changed direction and pushed the smoke back towards the smoke machine along the wall.

Reflection

The first experiment using fabric to show air circulation of the fan was a greater success than illustrating the movement with smoke. However, testing the fan circulation with smoke was imperative to the comparison of external air circulation. The day and night photographic series achieved the aim of documenting air patterns in an external environment. On reflection, I realised that the air within or around an architectural space needs a control mechanism or artificial source. Therefore, exploration was needed into how air can be manipulated either around an object or within it. The third experiment explores this.

MANIPULATION OF AIR

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Aim

To explore and observe how air can be manipulated inside geometric shapes through compression and contraction.

To explore the effects geometric shapes have on a stream of airflow.

To explore how the bodies' influence on current of air influences the air's natural pathways.

Method

When smoke has a higher density than air, it will settle on a surface. To increase the air's density, glass vessels were frozen and then used to capture the smoke. Cooling the smoke down increased the density. The higher-density smoke was then used in three processes:

- A) Smoke was poured into a prism or cube and manipulated by contracting or compressing the shape with hands.
- B) Smoke was poured from a jar around a cube, cylinder, and prism.
- C) Smoke was poured onto a flat surface and photographed observing the movement of a hand.

All processes were photographed.

Fig 3.15. Trapping smoke inside cube and manipulating form by hand.

Results

A) Compression and contraction

Because the heat of the smoke caused the walls of the plastic to condensate, making it impossible to see how the smoke was performing inside the vessel (Fig 3.15), this technique was quickly abandoned.

MAKING AIR VISIBLE

Fig 3.16. Series tracking smoke movement within prism shape.

Fig 3.17. Close up series of tracking smoke movement within prism shape.

MAKING AIR VISIBLE

Fig 3.18. Series of tracking smoke movement within prism shape.

Fig 3.19. Tracking smoke movement within cube.

Results

B) Air manipulation

Air manipulation proved successful due to the fact that smoke trapped within a vessel is easily manipulated (Fig 3.18). A swirling effect was easily achieved through manipulating the sides of the vessel; however, controlling the smoke after this point was more difficult. Comparison of the triangular form with the cube shows that the volumetric form of the object depicts how the smoke will react within the vessel (Fig 3.19).

Fig 3.20. Tracking smoke movement around cube.

MAKING AIR VISIBLE

Fig 3.21. Tracking smoke movement around cylinder.

Fig 3.22. Tracking smoke movement around prism.

Conclusion

C) Stream of Air

The effect that the geometric shapes had on the stream of air was dependent on the shape itself. The smoke deflects away from the shape following the same angles or curves. As can be seen in the imagery, the cube (Fig 3.20) and prism (Fig 3.22) provide a deflection point where the smoke splits into opposite directions, while in the cylinder shape (Fig 3.21) the smoke tracks right around the circumference of the circle before dispersing. The images prove that the air flow will mimic the shape that it is travelling around before deflecting off at angles dictated by the shape itself.

Fig 3.24. Tracking smoke movement in relation to the deflection made by my hand.

Conclusion

The effect that the geometric shapes had on the stream of air was dependent on the shape itself. The smoke deflects away from the shape following the same angles or curves. As can be seen in the imagery, the cube (Fig 3.19) and prism (Fig 3.21) provide a deflection point where the smoke splits into opposite directions, while in the cylinder shape (Fig 3.20) the smoke tracks right around the circumference of the circle before dispersing. The images prove that the air flow will mimic the shape that it is travelling around before deflecting off at angles dictated by the shape itself.

Hand movement within the smoke disrupts the natural fluid flow and transitions the smoke into ebbs and flows drawing towards the direction of the movement. The smoke is highly reactive to the movement of the hand with instant visible results (Fig 3.23). Each process shows an effective way to manipulate smoke; however, the most control was achieved through flowing the smoke around an object or directly interacting with the smoke through body movement.

Reflection

The experimentation through installation raises questions: how do we design for air? how do we design space to provide containment of air? What happens to the space when there is movement through it? And how does the space react to the environment and its inhabitants?

The overwhelming insight from this series of investigations is that air's natural movement through a space cannot be predicted as it acts in uncontrolled and unrepeatable patterns. Further exploration is needed on how to architecturalise these notions of air movement and fluctuation that can transition from the intangible experience of air to a literal translation in architecture. The notion of air's unpredictable characteristic links to the next project of the Air Safety Pod.

4

AIR SAFETY
POD

Fig 4.01. Perspective of White Island from 2012 with high water levels within the crater.

INTRODUCTION

The Air Safety Pod used White Island, off the Bay of Plenty, as a local testing ground to investigate how air can challenge architecture, with specific focus on the filtration of the noxious volcanic gas SO₂. White Island provides an architectural testing ground with the same atmospheric issues as Miyake-Jima. The characteristics of movement, manipulation, immediate response, and unpredictability of air realised through the installation stage have been applied to this project. The final outcome for this stage is a speculative architecture intervention to provide protection from SO₂ for scientists and visitors.

Aim

The aim of the Air Safety Pod is to use air filtration to create a protective refuge for scientist and tourist groups visiting the island. The project interacts with the site through the scope of a landscape scale. The exploration focuses on providing shelter in a crisis where extreme levels of SO₂ are released from the volcano's inner crater.

Method

The characteristics of air that were realised in the installation stage were movement, manipulation, immediate response, and unpredictability. These character traits have been developed into a modelling method wherein the relationship between human and material agency has been explored. This methodology has been used to generate physical models which will enable digital model representations to be formed. Physical models will be the focus with an iterative process based on relationship between human and material agency.

CASE STUDY

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Aim

The acid filtering gas mask provides a metaphor for the conceptualisation of how to integrate air filtration into the aesthetics of the building.

Gas mask filters the air through a number of layers. As a generalisation, when you inhale air flows through the inlet, through a particulate filter, through an activated charcoal filter, through another particulate filter and through the outlet into the mask. The activated charcoal is impregnated with chemicals that attract the SO_2 . The SO_2 is absorbed by the activated charcoal by attaching to its

surface. Due to this the charcoal reaches a maximum absorbing point where it is no longer effective. Therefore these filters must be replaced (Brian, 2017).

It is the build-up of layers using different filtration methods that allows for effective filtration of SO_2 . It is the notion of this layering system that has enabled the conceptualisation of a building designed for its aesthetic qualities and its functionality of filtering air.

3M

6200mask

7pcs of dustproof
anti - virus

Anti acid gases, chlorine,
hydrogen chloride, sulfur
dioxide, hydrogen sulfide,
chlorine dioxide

6002Filter

zian.aliexpress.com

Fig 4.02. 3M half facepiece respirator with reusable 6002 filters.

SITE CONTEXT

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White Island (Whakari) is New Zealand's most active andesite stratovolcano submarine volcano, believed to be 150,000-200,000 years old. Seventy percent of the volcano lies under water with only 321m above sea level. The total height of the volcano from the sea floor is 760m. The island itself measures 2.4km by 2km above sea level, but the total breadth of the volcano is 16km by 18km.

Located 49 kilometres north of Whakatane in the Bay of Plenty (Fig 4.02), White Island is privately owned by the Buttle family who have allowed the island to be classed as a scenic reserve since 1953 (GeoNet). Daily tours via boat, charter plane, or helicopter allow over 10,000 people to visit White Island annually. Since 1967, scientists have closely monitored activity on the island; this monitoring is now undertaken by GeoNet who visit the island around 10 times a year.

Sulphur mining has been a prominent part of White Island's history and began on the island in 1855. In 1914, disaster abruptly stopped the mining when the western rim of the volcano's crater collapsed causing a volcanic landslide, or lahar. The collapse destroyed the sulphur mine and village, killing 10 men working on the island. Mining resumed in 1923 when the island was sold to Archibald Mercer who re-established the factory buildings by 1925 in the inner crater. Eventually, mining ceased in 1933 due to the reduced demand for fertiliser brought on by the Depression (Tait & Tait, 2001, p. 11). The factory buildings were left to decay and have become part of the tourist attraction.

Fig 4.03. Map locating White Island within the North Island, New Zealand

Fig 4.03 Photo of the inner crater of White Island from the dock

Fig 4.04 Photo of the inner crater of White Island from the eastern wall

SITE ANALYSIS

Introduction

Due to the literature not showing the current configuration and layout of the inner crater, the physical site visit provided insight towards the design process. The following maps and analysis look into the dynamic elements of the site, particularly focusing on the changing layout of the inner crater over the years and what happens in the event of an eruption.

Site Analysis

White Island poses varying levels of hazards to those visiting the inner crater. The eruption types can be classified into five categories: Explosive activity, Lava Flows, Debris Avalanches, Volcanic Gases, and Tsunami. Although all of these pose a constant threat to people on White Island, the air safety pod focuses on issues

surrounding volcanic gases. Daily tours of White Island, including 90minute inner crater walks, cater for up to 104 people at any time.

Fig 4.07. Inner Crater series walking along the SW wall of the inner crater.

Fig 4.08. Photo of the inner crater lake

Fig 4.10. Illustrates the potential fallout areas from a volcanic eruption on White Island during a 100 year event. A central blue zone is at risk from debris avalanches, pyroclastic flows and surges. The second zone (diagonal hatch) shows that area that bomb and block falls could reach from the main crater. An outer zone (dotted) extends further offshore, at risk from pyroclastic surges. Block falls could occur up to 4 km from the active vents. The crater shape sends most ballistic blocks to the east. Heavy ash falls will be dispersed mostly downwind. The most common wind directions are shown in figure Fig 4.13 (Cole, Nairn & Houghton, 2005).

1913

1913

Lakes on Crater floor permanently drained to enable Sulphur desposits on crater floor to be mined

1914

Lahar on Southwest Wall of crater, which also destroyed buildings at eastern end of crater.

1933

1933 Crater was formed during an explosive ash eruption

1947

Noisy Neillie Crater formed prior to January 1947

1966

Gilliver Crater formed during the eruption in Novemeber. The crater was 60m in diameter and 120m deep

1962 - 1965

Big John Crater grew to 50m diameter during the eruptions between these years

Fig 4.12. Timeline illustrating significant events on White Island from 1913 to 2017

Prevailing Winds

The map of wind directions (Fig 4.13) illustrates the “mean annual wind frequencies of the surface wind directions from hourly observations at selected Bay of Plenty stations” (Chappell, 2013, p. 15). For White Island, data from Whakatane, the closest geographical point, is used. It can be seen that the prevailing winds for Whakatane come from the north-west and south-west, which do not pose a threat to those on White Island in a crisis situation. However, in the event that the wind comes from the south-east, the high SO₂ levels will cause a catastrophic whiteout. The term whiteout in this environment refers to large amounts of SO₂ gas being trapped in a swirling motion inside the inner crater, causing zero visibility on the island.

SITE LOCATION POINTS

Fig 4.14. Map illustrating three site location points

DESIGN PROCESS

Introduction

The design process was carried out in three phases of 2-D studies, 3-D form finding, and an enclosure study.

TWO—DIMENSIONAL STUDIES

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Aim

To extract patterns and details from site conditions on White Island and analyse the effects created when these abstractions are layered up against the island's contour lines.

Method

The modelling process started by abstracting patterns created by SO₂ deposits and dominant wind patterns of the SO₂ clouds emitted from the inner crater of the island. The abstractions of SO₂ were created in two forms; the first as close up images printed on transparent paper and the second as black and white patterns etched into acrylic. The SO₂ wind patterns were cut from 6mm thick MDF and again from 0.6mm thick frosted plastic. These four sets of abstractions were layered against the contours of White Island as an exploration of the aesthetic qualities that these could produce in different lighting conditions.

Fig 4.16. Volcanic gas time lapse photograph series and series of sulphur dioxide deposits.

Fig 4.15. Iterative series of layering up the abstracted patterns of sulphur dioxide deposits and wind patterns against the contour map of White Island.

Results

The layering effect of the abstracted patterns created the desired aesthetic but also created unexpected results through the experimentation with lighting techniques. The experimentation of backlighting the model had some successful results and allowed the use of 6mm MDF, which I had previously thought to be too chunky and aesthetically displeasing. The most effective results came from the layering of the acrylic etched SO₂ deposit patterns combined with the closeup coloured shots of the deposits (Fig 4.15).

Reflection

The two-dimensionality of the model became a limiting factor when analysing its potential for architectural qualities. The challenge for the next stage of modelling would be to create 3-D form from these layers of abstractions. The build-up of layers in the model triggered the idea of using a gas mask as a metaphor for how the air could be filtered through the building. The walls of the building could function in the same way as gas masks made from multiple layers.

THREE—DIMENSIONAL FORM FINDING

Aim

To create a form from using the abstracted SO₂ patterns etched onto surfaces that would allow for the functionality of filtration. The material must have its own agency that provides influence over the physical modelling process.

Method

The abstracted SO₂ deposits patterns were used to create a catalogue of modelling materials with the patterns etched or cut into the material. These materials included transparent and translucent 0.3mm plastic, polystyrene strips and 0.5mm white card. The metaphor of the gas mask was used as an underlying driver during the modelling process for these forms. The photographic catalogue was used to experiment with form and the aesthetic quality of air.

Fig 4.17. First set of iterations of form generation on a 2m grid at 1:100.

Fig 4.18. Second set of iterations of form generation 2m grid at 1:50.

Fig 4.19. Close up images of the iterative series on a 2m grid at 1:50.

Results

The first set of four, set on a 2m grid at 1:50 scale, were purely focused on experimenting how the materiality would perform, and creating an aesthetic (Fig 4.17). The second set of two, set on a 2m grid at 1:100 scale, focused on singular and dual pod systems that would be part of a greater system or scheme (Fig 4.18). The full series of models achieved the aim of experimenting with form to create an aesthetic for air and enabled testing of the limitations of the material qualities itself. The following forms and curvatures depict the style of aesthetic which can be carried through to the final model.

Reflection

These models still do not form a clear form of enclosure, and simply putting a flat roof on these flowing forms would not be a viable architectural solution. Therefore, the following model series looks into how an enclosure could be created.

ENCLOSURE STUDY

Aim

To find a material that would present an element of unpredictability through resisting manipulation. The aim is to create a form that is enclosed to provide protection against SO2. The hunch was that materials such as foil, mesh, and aluminium sheeting would present this quality.

Method

Aluminium foil, wire mesh, and aluminium sheeting were tested by pinching the material at a single point and allowing it to transform itself into a form. Each was tested in isolation and then placed together to see if combining elements would create a desirable enclosure form. These forms were documented through a photographic series.

Fig 4.20. Iterative model series of enclosure with aluminium foil and wire mesh

Fig 4.21. Iterative model series of enclosure with aluminium sheet

Results

From the three materials that were tested, the only successful outcomes came from the aluminium sheeting (Fig 4.21). The foil and wire showed some qualities of unpredictability; however, they were, in essence, too malleable to provide the material agency needed for uncontrolled formation (Fig 4.20). The final series of aluminium forms provided plentiful source material to create an enclosure form.

Reflection

The lack of material agency that the aluminium foil and wire possess could have been predicted before starting the modelling. This would have allowed more time to experiment with the aluminium sheet material. The next step will be to digitally model the selected enclosure form with the surrounding filtration layers in order to create the final physical model.

FINAL DESIGN: Air Safety Pod

Introduction

The final design is presented in plans, sections, elevation, and photographs of the final physical model. It has been created with four levels of filtration, each level using a more effective method to filter out the SO₂. The whole scheme, situated on site at 45 degrees, is designed to protect from the prevailing wind from the north-west and the south-east which would cause a catastrophic whiteout.

Fig 4.22. Site plan with building in the context of White Island.

Fig 4.23. Master plan of building illustrating the functionality of sulphur dioxide filtration.

Fig 4.24. Level one of filtration:
Charcoal carbon filter poles

Fig 4.25. Level Two of filtration:
Nylon fabric filter panels on a curved
frame structure

Level One

The first layer of filtration is high tensile carbon poles coated with activated charcoal wrapped in a porous membrane (Fig 4.24). The poles are scattered throughout the landscape surrounding the main structures and have LED lights fixed to the top. The LED lights are activated when the Sulphur levels become higher than 10ppm. Their ability to sway in the wind allows them to become beacons to direct people towards the central enclosure and safest point of the building.

Level two

The second layer comprises the proposed sulphur catchers which essentially work like fog catchers (Fig 4.25). Sulphur catchers utilise SO_2 's ability to instantly combine with water to form sulphuric acid. The mesh is attached to the outward facing curved frames which have water misters situated on the ground in front of them. The sulphur reacts with the water vapour and either immediately drops to ground or condensates on the mesh and then pools on the ground. These are illustrated in the plan, section, and elevation with a grey circular mesh texture.

Fig 4.26. Level three of filtration:
Water misting sulphur dioxide
catchers

Level Three

The third layer of filtration utilises nylon filters impregnated with the three lesser effective chemicals – triethylenediamine, sodium hydroxide and potassium iodide (Fig 4.26). The nylon filter is stretched over the inward facing curved frames creating small sheltering spaces along the pathways towards the main enclosure. These are illustrated in the plan, section, and elevation in a grey hatch.

Fig 4.27. Level four of filtration: Modular
panels on space frame structure with
impregnated potassium hydroxide filter.

Level Four

The fourth layer is the main structure in the centre of the scheme and is made from a plastic space frame structure (Fig 4.27). The material was selected as it will not corrode in this volatile environment. The lattice structure, infilled with a porous membrane impregnated with potassium hydroxide, was created so that after an extreme event of high SO₂ levels the panels could be replaced to ensure optimum filtration. The structure is made from two forms; the smaller underneath structure acts as a ramp to allow occupants to access the enclosed level sheltered by the larger form.

Fig 4.28. Section A

Fig 4.29. Section B

Fig 4.30. Exploded elevation of the four layers of filtration

Fig 4.31. Photographic series of final model

CONCLUSION

The air safety pod developed a methodology, through initial site analysis and research with physically modelling, in order to explore ideas of material agency and experiment with aesthetic qualities. Using digital modelling at the end of the iterative process was a successful way to finalise the design outcome and enabled ease of translation into architectural drawings and elements to physically model. The whole modelling process was driven by the research into how gas masks filter SO₂. The design methodology was used in the third phase, the Air Crisis Centre. The final design utilised all the research on SO₂ filtration and intertwined this into the building scheme. It can be seen through the final model that the final design (Fig 4.31) was a simplified version of the second phase of iterations (Fig 4.20); however, I did not bring the detail of the sulphur patterns or the complexity of the curving forms into the final design. The methods used to produce the final model were successful.

Reflection

From the beginning of the design process I had a preconceived notion of what I wanted the overall form to look like in plan. On reflection, this preconception hindered my ability to see the potential in the iterative models. I feel this notion lead me to distil the iterations down too much without realising the true value they were bringing to the design process and aesthetic. For the next stage of design, it will be important to reflect on

designs after each phase so that important design aesthetics or opportunities are not lost.

The final design became a simplified almost diagrammatic version of what the architecture would truly be. The issue arose with how the model and drawings were represented. The model itself did not possess enough detail to truly get an idea of how each stage of filtration functioned (Fig 4.30). The endeavour was to illustrate this function through the architectural drawings; however, the lack of line weights and tonal qualities rendered these drawings back to diagrammatic images and failed to convey the full sense or scope of the architecture. The model could be improved by constructing the main enclosure form, or fourth level of filtration, at a larger scale of 1:50 so that the complexity of the design can be completely understood.

Because of the extreme scenario of a crisis event on White Island, the focus on the functionality of creating breathable air became the forefront of the design problem. The design, moving forward, aims to look at the juxtaposition between the aesthetics of air and the functionality of the scientific filtration systems.

5

AIR CRISIS
CENTRE

Fig 5.01. Miyake Jima during the 2000 eruption

INTRODUCTION

The Air Crisis Centre exploration used the site of Miyake Jima, off the south-east coast of Japan, as a testing ground where air has been explored as an aesthetic agent and speculative solutions for Miyake Jima's problem have been proposed.

The notion of level of control between human and material agency was developed from the installation and Air Safety Pod. Through this investigation the difference between these two agencies was established through the design process. The materials agency can be seen as a parallel to air's own agency.

The final outcome of this stage is a speculative architecture intervention to provide protection from SO₂ in an event of a crisis, providing a facility for a civil defence centre and a growing facility for the local residents.

Aim

The aim of the Air Crisis Centre is to provide protection for the whole community against SO₂, and disaster relief in a crisis event, while providing facilities to grow produce. The duality of program will allow the building to have functionality on a daily basis and in the event where extreme levels of SO₂ are released from the volcano.

Method

The notion of human and material agency and their differing level of influence on the process of modelling underlines the design process. While physical modelling is the chosen method, digital modelling works as an additional tool to allow for detailed designing of the intervention. The aim is to allow bias towards material agency and allow human agency to intervene when seen necessary.

CASE STUDY

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Eden Project - 2017 - Cornwall, U.K.

The Eden project is a tourist attraction, a social enterprise and a charity.

The project inhabits an abandoned china-clay quarry where it sprawls out within the vast landscape. The ethos of the project is to highlight how we depend on the environment and its aim is to challenge the way we think about the world we inhabit (Eden Project 2017). The project relates to the research in two ways; its community focus, which engages people with idea's of sustainability and the nature in which the building is constructed.

Two geodesic domes, with hexagonal pneumatic pockets supported by steel structures, are home to the largest artificial rainforest and Mediterranean gardens (Fig 5.02). The pneumatic structure has provided inspiration to conceptualise how the growing facility could function and be formed.

The project is focused on sustainability through water conservation, composting, buying plants ethical and producing energy through a geothermal power plant. The project also engages the community through providing jobs and educational facilities. The Air Crisis Centre must be self-sustaining in the event of an eruption, therefore the sustainable attributes of the project have provided a background from which to design from.

Fig 5.02. Photograph of outside of Eden Project

Fig 5.03. Eden Project inside one of the biomes

SITE CONTEXT

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Miyake Jima is one of Japan's most active basalt-andesite stratovolcano submarine volcanos located in the Pacific Ocean about 180km SSW of Tokyo (Miyagi, 2007). Volcanic activity dates back to 1085 when the start of former hatchodaira caldera was formed. The volcano erupts periodically at approximately 10-year intervals; however, the last eruption started in 2000. This eruption was unprecedented due to the concentration of SO₂ gas exceeding the environmental standards of 5.0 ppm (parts per million) average over a 5-minute period (Geological Survey of Japan, 2005). The dangerous levels of SO₂ caused the mass evacuation of approximately 3,800 people and it wasn't until February 2005 that residents were allowed to return. The current population now sits at 2,415 as recorded in 2016 (Miyake Village Official, 2017). Before the 2000 eruption, the emission level of SO₂ from the crater was approximately 2000 tons a day. In 2000 it increased to about 20,000 tons/day and peaked in November at

80,000 tons/day. The rate of SO₂ emissions gradually slowed until it reached a stable level of 1,000-3,000 tons/day in 2005.

While residents could return to the Miyake Jima in 2005, 20% of the island remained off-limits due to the high density of volcanic gases (Fig 5.08).

Between 2005 and 2011 these off-limits parts of the island have gradually been reinstated as habitable. It was not until 2011 that residents could return to the eastern flank of the island. (Joyce, 2011).

The total size of the volcano, including areas that are submarine, in the north/south direction is 25km and east/west is 15km; however; the diameter above sea levels is 8km. The full height of the volcano is 1183 m with the highest point above sea level reaching 738m at the Oyama crater (Geological Survey of Japan,

Fig 5.04. Location map illustrating Miyake Jima's location in relation to Japan

Fig 5.05. Series of Miyake Jima during the 1983 eruption.

2005). Miyake Jima's climate is mild and humid due to the Japan Current flowing around the island. The predominant wind comes from the south-west, blowing across the island between April and September. During the months of October to March the predominant wind direction is westerly. The mean annual temperature is 7.4 0C; however, it ranges from 9.4 0C in February to 25.8 0C in August (Wild Bird Society of Japan, 2016).

Miyake Jima has a strong tourism industry with the main attraction being the volcanic activity. There are several sites on the island where tourist can see the traces of previous eruptions. The whole island is, in fact, registered as part of the Fuji-Hakone-Izu National Park. Other prominent tourism activities on the island include bird watching, diving, snorkelling, and dolphin swimming (Japan National Tourism Org., 2016).

Residents live a self-sufficient lifestyle with many choosing to live completely of the land, growing vegetables and crops in the open air and in greenhouses in the winter, and fishing off the coast and from local wharfs. Their main diet consists of fish, vegetables, and rice.

SITE ANALYSIS

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Miike Village is the chosen site on the Island of Miyake Jima. Miike village was abandoned after the 2000 eruption as it was classed as an off-limits zone due to the dense levels of volcanic gas (Fig 5.08). Miike is located on the east side of the island so is therefore directly downwind of the volcano during the months of October to March (Wild Bird Society of Japan, 2016). The village sits within a dormant crater and lies in the hazard area classed as dense volcanic gas. Residents have only been allowed back into this area since 2011 and, due to the risk of high levels of SO₂, only those over the age of 19 are permitted by the Japanese government to live in the area (Joyce, 2011). Many of the housing plots remain vacant after the buildings were stripped away (Fig 5.13). Much vegetation and plant life was greatly affected by the release of SO₂ gas. Previous to the eruption Miike village was abundant with vegetation including Laurel forests of Live Oak and Tabunoki (Wild Bird Society of Japan, 2016). Directly through the site lies a mudslide dam that

continues right to the water's edge.

As Miyake Jima is an active volcano there are many extreme potential site hazards, which include earthquakes, tsunami, lava flows, rock falls, mudslides, volcanic gas, and more. SO₂ is the greatest hazard that the architectural intervention is engaging with. Details on the effects of SO₂ to humans are included in Chapter 2.

Fig 5.06. Location map illustrating Miike village's location in relation to Miyake Jima Island

Fig 5.07. Hand-drawn illustrations of prominent plant life on Miyake Jima

Fig 5.08. Map of Miyake Jima illustrating the infrastructure, main villages and hazard zones of the island

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Fig 5.09: Panoramic photograph of the crater of Miike Village taken from the South end of the beach (authors own photo).

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Fig 5.10. Panoramic photograph of the crater of Miike Village taken from the South end of the beach (authors own photo)

Fig 5.11. Panoramic photograph of the crater of Miike Village taken from the west side of the crater (authors own photo).

Fig 5.12. Panoramic photograph of the crater of Miike Village taken from the west side of the crater

SULPHUR DIOXIDE ALERT LEVEL AND RESPONSE

Warning 5.0ppm/5min average

Advisory Information 2.0ppm/5min average

Warning for Sensitive Group 0.6ppm/5min average

Advisory Information for Sensitive Group 0.2ppm/5min average

S02 Warning Lights and Speakers

At 14 sites around the island village officials measure the concentration of S02 twenty-four seven. The information is relayed to the residents through 44 outdoor speakers, 14 warning lights, home receivers, and mobile phones.

The 14 warning lights have four alert levels, which correspond to the advised levels of response. Depending on the level of alert, officials can advise to wear gas mask, evacuate into a desulfurisation facility, or ultimately evacuate the island (Ishimine, Yasuhrio, 2007).

Fig 5.14. Photograph of the one of the power poles that houses the warning system for sulphur dioxide levels.

Fig 5.15. Wind Rose recorded from Miyake Jima airport

MAP ILLUSTRATING HISTORICAL AND RECENT GEOLOGICAL PHASES

Fig 5.16. Map illustrating the historical and recent geological phases of Oyama volcano, including lava flows craters and fissures

Fig 5.17. Map series illustrating the prominent eruptions and there effects on the island between 1962 and 2000

1811

1811

27th January, earthquakes occurred through the night and a column of could be seen at the summit. Earthquakes continued till February 1st.

1835

10th November, Strong earthquakes were felt from lunch time and continued till the 19th Novemeber. On the western side of the island smoke and magama were visible. 13 craters opened releasing lava flows down to Kasaji Kannon. Ash falll was experienced at Nakayama Kannon.

1874

3rd July, sudden high intensity earthquakes felt causing a fissure to open on th NNE side of the volcano. Smoke travelled East from craters and felt a coarse grained ash fall affecting areas from Tosa to Hodai. Lava flowed and reached the sea via Higashigo, which existed east of were kanitsuki currently stands. 30 houses of Higashigo were buried under debris.

Fig 4.18. Timeline illustrating significant volcanic events on Miyake Jima from 1811 to 2017

DESIGN PROCESS

Introduction

The notion of level of control between human and material agency has been explored through four design stages whereby the main method of investigation has been carried out through physical modelling. These stages include massing models, 1:200 scale form finding iterations, 1:500 scale crystallisation, and final designing through the creation of the final model. The first two stages have been carried out before physical visiting the site and then reflected upon and regenerated. Initially two proposed sites were selected to start the modelling process; however, based on knowledge and new information acquired from visiting the site, the site was reselected. The level of control between the human and material agency has been reflected upon before moving into the next mode of modelling to ensure that the key aesthetic qualities are not discarded

MASSING MODELS

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Aim

To find a generalised shape or form of the building, or buildings, in relation to the typography and conditions by allowing the material agency to have control or sway over the designing of the building's mass.

Method

The typography of two selected sites were laser cut from cardboard then placed on a 100mm diameter magnet. Iron filings were arranged in different formations to test out possible solutions for the configuration of the buildings mass. Three were then selected, for their qualities of being the most aesthetically pleasing, and analysed in section and plan.

Fig 5.19. Map locating the potential sites within Milke village

Fig 5.20. Photograph illustrating the construction of the massing models

AIR CRISIS CENTRE

SITE OPTION A

Fig 5.21. Iteration series one on site option A of iron fillings on magnetic base to create massing forms.

Fig 5.22. Iteration series no.2 on site option A of iron fillings on magnetic base to create massing forms

SITE OPTION A

AIR CRISIS CENTRE

SITE OPTION B

Fig 5.23. Iteration series on site option B of iron fillings on magnetic base to create massing forms

Fig 5.24. Three selected iterations from site option A analysed in plan and section

Results

The massing models were successful in generating quick iterations of building masses that had a strong material agency. The magnetism provided a force to design against that resulted in particular patterns occurring. The curved nature in plan and height of the mass was a direct correlation to the circular shape of the magnet (Fig 5.20). The two variations of lead filings gave differing aesthetic results but both behaved in the same manner against the force of the magnetism. The iterations from site option A (Fig 5.21) using the larger iron filings were the most aesthetically pleasing in their form in plan and section. Three were analysed using line drawings to establish a building footprint (Fig 5.24).

The plans varied between one building, two separate, and two connecting buildings. Each was orientated differently on the site, but all followed the contours of the typography and engaged with the elevation of the hill.

Reflection

The selection method of three massing models to analyse was based on my own subjective choice. To move away from the aesthetic bias, more thought could have been given to the building's orientation on the site in relation to the effects of wind, sun, existing buildings, and infrastructure. It can be seen in the location plan (Fig 5.19) that the buildings would overlap existing buildings, roads, and the mudslide dam. These three building footprints have been used as a starting point for the next stage of modelling, form finding.

FORM FINDING MODELS

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Aim

To create a three-dimensional form, in relation to site typography, from the three proposed building footprints. The form has been created using the two materials, tracing paper and OHP film, where rigidity creates the material agency. The material agency has been worked with to create a superstructure for the building.

Method

The three successful massing models were used for their basic outline of building footprints. Site option A was scaled up to 1:2000 and CNC cut out of goldfoam. OHP film and tracing paper were etched on the laser cutter with abstracted SO2 patterns. Thin strips of the papers were twisted in and around each other and pinned onto the 1:2000 site model to generate a building form.

Fig 5.25. 1:2000 series of form finding models

Fig 4.26. Analysed 1:2000 scale models for their scale and aesthetic effects.

Results

The material agency of the tracing paper and OHP film directed the creation of a sweeping, overlapping form that created visualisation of an architectural aesthetic of air. The models A, B, and C were created from the building footprints established from the massing models. These sweeping forms have created an overarching structural system to support the filtration systems of the building (Fig 5.25).

The overlapping of the paper creates different densities and coverage over the expanse of the building. The addition of the etching gives an aesthetic quality through the shadows cast onto the ground surface, which would provide a shifting atmosphere when inhabiting the building (Fig 4.23). Model A was the most successful in relation to appropriate scale of the building in relation to the proposed program. Options B and C worked aesthetically; however, the building form was out of scale to the site model.

Reflection

Analysis showed models B and C to be too high for the programmes. Model A is closer to an appropriate scale; however, interest was sparked to explore the building's relationship with the vast landscape scale to be explored through decreasing the height of the building. It can be seen from the scale bars and scaled people on the model photos that these explorations were 30-40m tall at a 1:1000 scale.

The use of these paper types through modelling presents a design which is rather two-dimensionality when isolating the individual elements. Therefore, a solution to give more three-dimensionality to the individual forms is needed so they can be represented accurately in a model form. Material agency was explored to an extent, but the bias was on human agency through this model stage. While the materials provided some rigidity, they were easily manipulated and provided little resistance. In the next stage of modelling more bias has been given to material agency to achieve the essence of unpredictability, which provides the parallel to the aesthetic of air. The scale of 1:2000 became limiting to the design process, so it was realised that in order to get detail into the design the model would need to continue at a larger scale of 1:500.

SITE VISIT

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By physically visiting the site, new information and insights were gained in relation to the position of the building site and the existing and proposed buildings that deal with the filtration of SO₂. The first major discovery was that there is currently a desulphurisation building located in the village of Izu that acts as a safety bunker sealed underground. However, this bunker can only hold up to 300 people. Secondly, the Government of Miyake Jima has proposed a government building in the same place proposed for site option A in the massing models stage. Thirdly, the water way, previously thought to be man-made, is in fact a mudslide dam system. Based on this information, the major change was to reposition the proposed site to higher in the crater, making it also clear from the threat of tsunamis.

Protection Methods against Sulphur Dioxide

For the approximately 2,500 residents inhabiting the island, current protection methods against high levels of SO₂ are to don gas masks, or to evacuate to a local desulphurisation chamber or to the large desulphurisation bunker in the village of Izu (Fig 5.29).

Fig 5.28. Hand drawn illustrations of Miike village area.

Fig 5.29. Perspective view of Miyake Jima showing the two government buildings designed to protect residents from sulphur dioxide, in relation to Miike village

MASSING MODELS

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Aim

To find a generalised shape or form of the building, or buildings, in relation to the typography and conditions of the site by allowing the material agency to provide resistance over the human agency in the design process.

Method

While at Miike village, the already modelled site typography of option A was used to start to create new massing forms for the new proposed site, option C. While at the site, iterations were made with lead filings and then photographed. These iterations were then analysed in plan for their aesthetic qualities and their orientation on the site. A laser cut model was then made of the actual typography of option C allowing more massing models to be made. The focus was on creating a building mass that had separate elements that were interconnected. These iterations were again analysed in plan. Four of these iterations, outlined in black in Fig 5.32, were then traced over in plan, by hand drawing then digitally tracing, to form smaller building footprints that would house the greenhouse program. The greenhouse tracings were then applied to three alternative building footprints until a final resolution was found and finalised as the proposed building footprint.

AIR CRISIS CENTRE

Fig 5.30. Iterative model series no.1 of massing models created on site and analysed in plan

Fig 5.31. Iterative model series no.2 of massing models created on site and analysed in plan.

Fig 5.33. Analysing 4 of the models in plan created in the iterative series of Fig 5.32 outlined in black. These plans were drawn over by hand, and then digitised, to establish smaller building footprints for the green houses.

Fig 5.34. Two selected building footprints analysed for their spatial qualities, followed by the rearrangement of the green houses within these building footprints.

Fig 5.35. Final arrangement of building footprint and green houses

Results

While modelling at the site, the typography of site option A was used as a stand-in for the purpose of creating massing model iterations for site option C (Fig 5.30). The difference in typography was that on site option A the hill was convex in shape, whereas option C was a concave. The massing models created on site were a great starting point to then create accurate representations of how the mass would sit on the typography of site option C (Fig 5.30 & Fig 5.31).

Once the second iteration series were made on site option C typography (Fig 5.32), the massing models allowed for a successful transition into abstracting and manipulating the proposed building footprints to find a resolution. Being able to abstract and manipulate the forms digitally was a quick way to refine the building footprints, which put human agency at the forefront of the design process (Fig 5.30).

Reflection

Being able to create the massing models on-site allowed for a greater understanding of the wider context. The quick generation of building footprints allowed for human agency to take over from the initial method of the building mass being developed from the material agency between the lead filings and magnet. The sole method of human agency took over the designing process as soon as the iterative models were made. The established building footprint of the overall building and greenhouses have been used as a guide to create the next 1:500 model.

CRYSTAL MATERIAL AND PROCCESS TRIALS

Aim

To establish a method in which to grow uniform and aesthetically pleasing crystals on a materials surface.

Method

Five materials were tested for the best surface for crystals to grow on. These included: pipe cleaners, aluminium sheeting, etched tracing paper, aluminium wire, and twinge. Each material was submerged for 6 hours in heated water saturated in borax powder, and then removed and left to dry. Each was then photographed to establish which provided the best surface for crystal growth

Fig 5.36. Initial material and process tests of pipe cleaners tracing paper, aluminium sheet, wire and string for the method of crystallisation.

Fig 5.37. Results from the material testing with the crystallisation process where pipe cleaners, tracing paper, aluminium sheet, wire and string were tested. Close up images of crystallisation results on each material.

Results

Etched tracing paper and pipe cleaners were the most successful surfaces for the crystals to grow on (Fig 5.37). They also provided the material agency that is desired when constructing the overarching form of the building. Pipe cleaners do not require a surface to be attached to in order to maintain their form, whereas the tracing paper must be stuck down to a surface in order for it to sustain its shape.

Reflection

Etching the tracing paper appears to provide a rough surface for the crystals to attach to, much like the pipe cleaners. The aluminium was too smooth and therefore the crystals were unable to form. The previous 1:2000 model was constructed from etched tracing paper and OHP film, so to provide consistency in the aesthetic quality and performance of material agency, this has been used to construct the structure of the models.

1:500 CRYSTALISED MODEL

Aim

To create an overarching structure through the bias of human agency that the can then be completed through the material agency of crystal growth.

Method

Using etched tracing paper and OHP film, the overarching structure was created by cutting thin strips and attaching them to a temporary PETG plastic base. The PETG plastic was heat moulded to the shape of the 1:500 CNC gold foam typography. The building footprint established in the second series of massing models was used. Once the overarching structure was created on the site model, it was removed and submerged for four hours in heated water saturated in borax powder, then taken out of the solution and left to dry for two hours. Then the crystal structure was removed from the plastic base and glued onto the gold foam site model.

Fig 5.38. 1:500 scale model testing the process of using etched tracing paper and OHP film glues to a plastic base.

Fig 5.39. Series showing a close up of the build-up of crystals over a 4 hour time period.

Fig 5.40. 1:500 model preparing to be submerged

Fig 5.41. 1:500 model submerged in borax solution

Fig 5.42. 1:500 model submerged in glass fish tank

Fig 5.43. 1:500 model removed from borax solution and left to dry

Fig 5.44. 1:500 completed model with crystal structure removed from plastic base and glued on to goldfoam typography

Results

The crystalline process was successful for the modelling scale of 1:500. The crystals were easy to remove from the base and remained intact during positioning onto the site model. The crystalline process established a method wherein the material agency of the crystal took over the design process, filling in and around the structure, providing an unpredictable design that could not be identically replicated (Fig 5.43). One issue in the modelling process was that the glue appeared to melt or break away from the plastic base as it was heated in the borax solution. This has presented a problem for the final model process. Due to the nature of modelling by hand, each time the overarching structure is created the form of the building will alter (Fig 5.44). However, the building footprint will not change through the iterations.

Reflection

The process of creating the overarching structure on a plastic base in order to remove it to submerge it in the crystal solution will not be possible when transitioning into a 1:200 scale. Therefore, a new method will be needed in order to create the crystalline structure. The material agency of the tracing paper will need to be maintained; however, it will be easier if the material can hold its form and does not need to be glued to another surface. Therefore, pipe cleaners are the obvious choice for the final model.

There is also a restriction the bed size of the vacuum former of 600mm x 600mm, which was used to form the plastic to the shape of the typography. The building footprint of a model at the scale of 1:200 would exceed the dimensions of 600mm x 600mm.

PROGRAM PLANNING

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Introduction

The greenhouse typology has been established due to Miyake Jima experiencing snow in the winter months, and SO₂ deteriorating plants (Wild Bird Society of Japan, 2016). The greenhouses will be grouped in clusters and use a hydroponic growing system. This requires a three-stage water filtration system: rainwater collection, fish nutrient ponds, and water treatment stations. The hydroponic system is best utilised when fed by gravity.

The Air Crisis Centre program requirements are based upon the New Zealand standard set out in the Civil Defence Centre toolkit (Civil defence, 2016). The essential programs can be broken down into eight spaces: accommodation, crush space, catering, medical centre, living space, toilets and ablutions, child friendly space, and isolation area within the medical centre (Civil defence, 2016).

Aim

To investigate how the program of the Air Crisis Centre and the plant-growing facilities will be situated within the building footprint and how the programs might alter this building footprint. The process has been undertaken through the control of human agency where the results from the massing models' building footprint have been used as a starting point.

Method

The first challenge was to situate the Air Crisis Centre program in the building alongside the growing facility. Sketch iterations were carried out in section to analyse the possible solutions.

The layout of the hydroponic system was then explored in relation to the established positions of the greenhouses.

From here, it was established that the Air Crisis Centre could be situated within the overarching structure so that the growing facility would have the full use of the total footprint of the building at ground level. The hydroponic pond system was established alongside a terracing system. The overarching system was then planned out over top of the now established ground level master plan. Positioning of the program of the Air Crisis Centre within the overarching system was then developed by drawing over top of photographs of the 1:500 model.

Hydroponic system ideas

Green House Concepts

Civil defense underground with light wells through gardens above

Civil defense underground with light wells through gardens above

Hydroponic gardens suspended from canopy

Civil defense buildings suspended from canopy

Civil defense buildings underground with greens roofs

Civil defense buildings constructed on poles above ground

Fig 5.45. Sectional sketch drawings of possible solutions for the placement of the two programmatic schemes.

INITIAL IDEAS OF HOW THE HYDROPONIC SYSTEM WILL WORK WITHIN THE BUILDING FOOTPRINT

CIVIL DEFENSE BUILDINGS

INITIAL IDEAS OF HOW THE CIVIL DEFENCE PROGRAM WILL WORK WITHIN THE BUILDING FOOTPRINT

GREEN HOUSES

- 1) SLEEPING
- 2) LIVING
- 3) CATERING
- 4) CHILD ZONE
- 5) HEALTH

Ground level raised over water

AIR CRISIS CENTRE

INITIAL IDEAS OF HOW THE HYDROPONIC SYSTEM WILL WORK WITHIN THE BUILDING FOOTPRINT AND AROUND THE GLASS HOUSES

POCKET FISH PONDS

CIVIL DEFENSE BUILDINGS

INITIAL IDEAS OF HOW THE CIVIL DEFENCE PROGRAM WILL WORK WITHIN THE BUILDING FOOTPRINT AND HOW THE HYDROPONIC SYSTEM WILL WORK WITHIN THE SCHEME.

GREEN HOUSES ARE HYDROPONIC

CIVIL DEFENCE
-underneath green house
-closed in from the weather

PLAN VIEW

break-out spaces

Terraces down to a lower level at center

Fig 5.46. Exploration sketches of possible solutions for program placement and initial mapping of hydroponic pond systems within the established building footprint.

IDEAS OF HOW TO ZONE THE SEPERATE CIVIL DEFENCE FACILITY PROGRAM WITHIN THE BUILDING FOOTPRINT

INITIAL SKETCH OF POSITIONING OF HYDROPONIC PONDS IN RELATION TO THE GREEN HOUSES

FINALISED DIGITAL DRAWING OF HYDROPONIC POND SYSTEM AND THEIR RELATIONSHIP TO THE GREEN HOUSES

INITIAL SKETCH OF TERRACING LAYOUT IN RELATION TO PONDS

FINALISED DIGITAL DRAWING OF CONTOURS FOR GARDEN TERRACES

FINAL DRAWING OF TERRACING AND PONDS WITH THEIR RELATIONSHIP TO THE OVERALL BUILDING FOOTPRINT AND GLASS HOUSES

Fig 5.47. Continued series of exploration sketches to establish positioning of hydroponic pond system and establishing the contour lines for the garden terraces.

Fig 5.48. Exploration sketches of the layout of the overarching structure in relation to the positions of the green houses.

Fig 5.49. Initial program planning drawn over top of a photograph of the 1:500 model

Results

The process of establishing the positioning of the various programs within the building footprint wasn't straightforward. It was made easier through the use of hand drawing quick iterations (Fig 5.45). The iterations were able to challenge the established building footprint, created through the massing model stage, to come to a refined solution allowing the Air Crisis Centre program and growing facility to remain separate entities.

Reflection

The planning of the placement of overarching scheme and the program within it will not be the final resolution as each time the model is made the positioning of these forms changes and adapts. It will not be until the final model that the program will be able to be refined in its placement within the overarching elements. Since the plan at the ground plane is now established, the final model can begin to be made.

FINAL MODEL

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Aim

To produce a physical model of the developed design, through the notion of the level of control between human and material agency.

Method

The final model was constructed using the same method as the 1:500 crystalline model, except that pipe cleaners were used to construct the overarching structure on the tracing paper and OHP film. This enabled the overarching structure to be built directly on the CNC model instead of using a plastic base. The overarching structure could then be easily removed to submerge in the borax solution. The greenhouses were also made using this method. The hydroponic ponds were cut out of the gold foam during the CNC process and then later infilled with coloured resin. The overarching scheme was dyed with yellow resin dye to create a visual differentiation between them and the greenhouses underneath.

Fig 5.50. Photographic series of the process of the final model being constructed

Fig 5.51. Final model photographed with ground level growing facilities followed by the air crisis centre.

Results

The model was successful as it was an accurate representation of the design established through the model process at a 1:200 scale. The only issue arose in the process of growing the crystals on the overarching structure as there was no way to control the size of the crystals between the different batches of solution (Fig 5.51). The overarching structure was separated between each building; however, at the scale of 1:200 they did not fit in one vessel to carry out the crystallisation process. The size of the crystals also altered the position of the overarching structure in relation to their position within the building footprint and around the greenhouses.

Reflection

The physical model was executed to a high standard, which allowed for the visualisation of the aesthetics of the building and illustrated the whole scheme as a master plan. The model can now be used as a tool to design the core area in detail and plan out the Air Crisis Centre program within the overarching scheme. If the model were to be remade, more tolerance would be allowed for around the greenhouses to ensure that when the crystals grow on the pipe cleaners the overarching structure has enough space to be placed back onto the model. The current model exceeded the initial estimation, based on the previous crystallisation trials of how large the crystals would grow.

The method of crystallisation was slightly changed, resulting in bigger, clearer crystals. The unpredictability of the crystal growth is part of the design process of allowing a bias towards material agency. While the crystal sizes exceeded the initial expectations, more interesting results were created.

Fig 5.52. Photograph of the work presented at the second review.

DESIGN DEVELOPMENT

Introduction

The design development stage is a record of progress that was reached by the second review. The second review acts as a milestone where critical feedback is gained from external reviewers to enable the design to move into its final stages of detailing. The current design is not fully resolved, but was illustrated in plan section and perspectives to describe the building visually for the benefit of the reviewers

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Fig. 5.53. Aerial view of the building located in the site context of Milke Village.

N

- PROGRAM PLAN
- 1 RAIN WATER COLLECTION POND
 - 2 FISH PONDS
 - 3 WASTE WATER COLLECTION AND TREATMENT POND
 - 4 GREEN HOUSE
 - 5 ORCHARD
 - 6 OPEN AIR GARDENS

Fig 5.54. Masterplan at ground level illustrating the program within the growing facility and the core area that is designed in detail

AIR CRISIS CENTRE

Structure and Filtration:

The overarching scheme is shaped as a hexagon with internal and external skins. The external skin provides structural support with a steel tubal network set up in connecting pods. A panelling system that filters SO₂ attaches on the outside of this steel structure. The filtering system is made from a porous 3D printed glass that is impregnated with potassium hydroxide. The system is an imitation of the functionality of the volcanic rock scoria, where air is able to pass through small air channels; however, the potassium hydroxide impregnated in the porous glass channels will filter out the SO₂ in the air.

The greenhouses have a roof system that is constructed from curved wooden beams connected by wooden triangular cross bracing. The skin of the roof works in the same fashion as the panels of the overarching structure. The walls are made from curved glass panels with mullions at a spacing of 1500mm.

The second level of protection against SO₂ is the kinetic system which attaches to the overarching structure and activates in the event of a crisis when the SO₂ levels exceed the recommended health standard of 5ppm. On a daily basis the system will sit flat against the overarching structure. When it is activated the dual-fabric membrane impregnated with sodium hydroxide and potassium iodide fans out to cover the open space between the overarching structures. The fanning action is controlled through a pneumatic system where a thin plastic pocket is woven between the fanning membranes. The fan will expand when air is pumped into the plastic pocket. The pneumatic system has been adapted from the precedent P.A.D.S. designed by Andrea Springer and Jeremy Luebker (Luebker, 2013). The kinetic system overlaps one another to form a fully enclosed building, as can be seen in Fig 5.62.

CIVIL DEFENCE EMERGENCY
CENTRE PROGRAM

ACCOMODATION
LIVING
CHILD FRIENDLY
ZONE
CATERING
CIVIL DEFENCE
OFFICES
+ HELP CENTRE
MEDICAL CENTRE

AIR CRISIS CENTRE

GARDENS PROGRAM

Fig 1.55. Exploded perspective illustrating the two programs of the building

Fig 5.56. Diagram illustrating the placement of the individual programs within the Air Crisis Centre, drawn over a photograph of the final model.

Fig 5.57. Plan of core area design detail with surrounding site context

Fig 5.58. Section of core area

Fig 5.59. Rendered perspective view from inside a glasshouse

Fig 5.60. Rendered perspective view from outside the greenhouses.

Fig 5.61. Rendered perspective view from the main entrance to the buildings

Fig 5.62. Initial sketches of the design and functionality of the kinetic system used to filter sulphur dioxide in a crisis event.

Results

The developed design, illustrated in the previous pages, provides a broad overview of the aesthetics and functionality of the building. The positioning of the two programs in the building are shown in the ground plan of the growing facility and the above overarching scheme. The placement of the programs is finalised but the detail and functionality of the spaces has not been completed. The core area of the building is illustrated in plan and section in Fig 5.57 and Fig 5.58 ; however, these areas have not been designed to a high level of detail. The plan and section do illustrate the functionality and current proposed construction methods.

The concept of proposed structure with the filtration will work in theory. The design of main filtration system which activates in event of a crisis is not complete, so this will need to be developed. The perspective drawings give a sense of the scale and aesthetic of the building as it would be inhabited, and mainly focuses on the greenhouse spaces. The habitation of the Air Crisis Centre in the overarching scheme has not been illustrated.

Reflection

The review provided a new perspective in how to make progress with the detailing of the building. The potential changes and suggestions are discussed below.

The methodology driving the physical modelling process has set up strong principals to design by; therefore, this method will be continued through to the final stages of designing.

A difference in design language needs to be established between the overarching scheme of the Air Crisis Centre and the greenhouses, which currently seem to visually merge as one. Alternatively, the glasshouses could create a contrast between the overarching systems. The glasshouse do not necessarily need to be fixed structures as they could adapt and change as the crystals grow. An investigation into pneumatic architecture could help to create a resolution for the form and construction methods of the greenhouses.

The presentation images need to clearly communicate complex information in one image. Plans and sections can illustrate the complex process in a single image rather than splitting up the different building process. The section will be a key drawing as it will show all the structural detail and how you truly inhabit the space.

The next stage of design involves designing the building in more detail in regards to its aesthetic and functionality. The detail

design doesn't need to be constructed as a replica of the final physical model, but can use this model as a basis/masterplan to design from. Starting to model at a larger scale will be helpful to get a sense of inhabitance.

BUBBLE MASSING

Introduction

After the reflecting on the developed design, the aesthetic of the greenhouses has been investigated so that they have their own aesthetic in juxtaposition to the overarching scheme of the Air Crisis Centre.

Aim

To establish an aesthetic based upon a material's agency for the design of the greenhouse structures as a pneumatic system.

Method

Using the building footprint established for the greenhouses, bubbles were blown on to a plastic surface within this outline.

Fig 5.63. Initial trial of bubble formation

1:300 WEST BUILDING

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Fig 5.65 West cluster B iteration series

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Fig 5.67. West cluster A iteration series

Fig 5.68. Collaged west cluster A final forms

AIR CRISIS CENTRE

Fig 5.70. Collaged east cluster final forms

Fig 5.72. Collaged south cluster final forms

Results

The unpredictable manner in which the bubbles formed, repositioned themselves, and popped created the forms of the greenhouse using the materials of agency. The amount of air blown into the bubble controlled the size; however, the order in which they popped or repositioned was completely uncontrolled.

Reflection

The bubble forms created a new aesthetic that could not be completely controlled through the design process. It enabled the design of the forms of each of the greenhouses that could then be modelled digitally to inform the final design.

Fig 5.73. Photograph of the work presented at the Visual Assessment.

FINAL DESIGN OUTCOME

Introduction

The final design outcome is situated in the village of Miike, on the northern face of the crater in close proximity to Myiake Jima's main port, airport, and high school. The following work was presented for review at the Visual Assessment, review three. The building has a duality within its program: firstly, it acts as an Air Crisis Centre in the event of the volcano releasing dangerous amounts of SO₂; and secondly, as a growing facility with hydroponic greenhouses, open gardens, and orchards. The site takes advantage of the predominant westerly winds so that in a crisis event the building, with its three stages of air filtration, is perpendicular to the volcano and its noxious gas clouds. The angle of the building allows for the most effective filtration. The design is presented in master plans, section, axonometric diagrams, perspectives, and a sectional 1:200 model.

Program

The building is split into two separate layers that also separates the program. At ground level, illustrated in Fig 5.77, the clusters of greenhouses can be seen alongside the gravity feed water system that provides them with water. The uppermost ponds collect rainwater, followed by a fish nutrient pond, and lastly a wastewater treatment pond. The areas surrounding the greenhouses are orchards and open-air garden spaces. The garden terraces are clearly illustrated on this ground level master plan.

The above overarching structures provide the inhabitable space for the Air Crisis Centre. Fig 5.76 shows the layout of the crisis centre's provisions and amenities

Fig 5.74. Site map illustrating the building in context in relation to the volcano and sea

AIR CRISIS CENTRE

Fig 5.75. Site section illustrating the building in context in relation to the volcano and sea

AIR CRISIS CENTRE

Fig 5.77. Masterplan illustrating the program of the growing facility

Fig 5.78. Masterplan of ground level growing facility

AIR CRISIS CENTRE

Fig 5.79. Masterplan of Air Crisis Centre

Fig 5.80. Exploded axonometric of growing facility and air crisis centre

Structure and Filtration

The structure and filtration system of the building is explained in relation to the two building types: the overarching Air Crisis Centre and the greenhouses. Three levels of filtration are each associated with the building typologies.

Air Crisis Centre

The Air Crisis Centre is a hexagonal modular steel structure, inlaid with a glass and wood panelling system (Fig 5.80). Crystalline filter panels fixed to the exterior of the building provide the first stage of filtration (Fig 5.86). These panels have the same crystalline structure of microscopic holes as the volcanic rock, scoria. These holes are impregnated with potassium hydroxide in order to filter the air from SO_2 . The

Fig 5.81. Exploded axonometric of growing facility and air crisis centre structure in relation to the filtration methods within the building

crystalline panels create a double skin on the building, allowing the internal layer to have openable windows. The crystalline material is reactive to the SO₂ as it deposits on its surface. The build-up of SO₂ in the exterior of the building helps to grow and form more crystals for filtration, and also begins to colour the crystals with a yellow tinge.

Greenhouses

The greenhouses are split into three structural systems (see Fig 5.81). The main structure is a pneumatic double layer skin, which acts as air pockets, shaped in a spherical manner. This skin is supported by a pneumatic structure inlaid between the spherical skins. The pneumatic structure's flexibility allows for the growth of the crystalline skin which is able to flex or contract to accommodate new growth. Above this pneumatic system sits a nylon fabric canopy stretched in tension over a

high tensile plastic rod frame. The pneumatic structure underneath helps to support the fabric canopy. The canopy provides the second level of filtration as the fabric is impregnated with potassium iodide.

Fans

The third level of filtration comprises pneumatically activated fans that seal off the spaces between the overarching scheme of the Air Crisis Centre. The system is only activated when SO₂ levels become too dangerous for human habitation. The fans allow for the protection of the growing facility below and for inhabitants to freely move between the Air Crisis Centre buildings.

The fans are constructed from nylon fabric impregnated with potassium hydroxide that sits over a steel frame, and expand when a tubular air pocket running along the fan structure is filled with air, fully extending the fan (Fig 5.82).

Fig 5.82. Image series illustrating the fan filtration system expanding.

ACCOMMODATION SPACES SERIES

A

GREEN HOUSE SPACES SERIES

D

CAFE SPACES SERIES

G

CIVIL DEFENCE SPACES SERIES

J

LIVING SPACES SERIES

M

B

E

H

K

N

C

F

I

L

O

Fig 5.83. Perspective series of the air crisis centre. The letters correspond to the detailed core masterplan.

Fig 5.84. Detailed core masterplan

Fig 5.85. Section of core area designed in detail

Fig 5.86. *Rendered perspective of the initial approach to the building*

Fig 5.87. Sectional model photographed in plan and elevation

AIR CRISIS CENTRE

Fig 5.88. Series of close-up photos of sectional model

6

CONCLUSION

Summary

Chapters Two, Three, and Four review the literary context, providing an understanding of the relevance of air as architecture, the risks and filtration methods of SO₂, and the contemporary literary context of material agency. Air as architecture provided a starting point for Chapter 3, “making air visible”; research into SO₂ provided insight into how to begin to design with the issue of a problematic atmosphere; and the research into material agency set up a framework in which the method of design was carried out. Chapter 3 uncovered the notion of air having its own agency, which was developed into a method of “making” through Chapter 4 and 5. Using the site of White Island, Chapter 4, Air Safety Pod focused on incorporating air filtration methods into the aesthetic of the architecture. The case study of a gas mask was used as a driver for the design through the three iterative stages of modelling. The Air Crisis Centre, Chapter 5, drew on the case study “The Eden Project” and developed the methodology of physical modelling with a feedback and forward between the material’s own agency and the human agency acting upon it. The project went through five stages of iterative modelling, leading to a speculative outcome to solve Myiake Jima’s atmospheric issues.

Critical Reflection

The final design outcome of this research has been successful in using material agency with human agency to drive the process of designing. The push and pull between human and material agency has been investigated through all three projects. The final design, of the Air Crisis Centre, has produced a successful speculative solution for Myiake Jima's problematic atmosphere. The research question, "How can architecture be reoriented, through giving aesthetic agency to its primary component, air", has been successfully investigated and answered.

This was achieved by taking the initial notion of the unpredictable nature of air, gained from Chapter 3, "making air visible", and establishing that air has its own specific agency. This unpredictable quality was sought out in alternative materials and then used to inform the process of designing. The method used to design was used to achieve the aesthetic quality of the building. The functionality of air filtration methods was incorporated into this aesthetic throughout the design process to produce a resolved system of filtration.

The materials provided their own force, enabling unexpected and unusual solutions in terms of the form and aesthetics of the design. While the process posed a strong element of design through human agency, or aesthetics, it was the materials' unpredictable nature that allowed for the control of the design to be taken over by the materials themselves. In this sense, the project becomes unrepeatable and only abstractions or representations can be derived from the original. By allowing materials to reveal their own agency, I have gone beyond the aesthetic through rigorous investigation into how SO₂ can be filtered out of the air. The outcome is a co-authorship between the materials themselves and myself as a designer. The research shows that human agency and material agency are only successful when both are used together to form design outcomes.

In accepting that air can reorient the focus of architecture, I have been able to establish a specific way of designing that has allowed air to affect the architecture itself. This research challenges the premise that air is an infinite resource and argues that we are taking air for granted. By accepting this, the research has investigated what happens if air becomes the pivotal driver for architecture. The functionality of air filtration technologies has been integrated into the form of the design in a way that challenges the aesthetic norms of traditional air filtration design in buildings. By establishing an alternative approach to incorporating filtration into buildings, I have blurred the line between the aesthetic and the functionality of design. I have been able to challenge that these two things do not

need to be designed as separate entities in order to achieve the same functionality. I have done so by challenging the boundaries of the architectural form.

Traditionally, any new design aesthetic has been perceived as “ugly” or not beautiful to the wider public. It is not until it becomes a mainstream approach that the public become accepting and perhaps at some point deem it as something of beauty. Similarly, in this research, the design outcomes have produced their own aesthetic that, had I been designing using my own preferences, I would not have preconceived. I would previously have perceived this aesthetic to be unpleasing; however, through the process of designing this displeasure has been overcome. Through the process of designing this displeasure has been overcome, through allowing materiality, analogous to air’s indeterminate possibility, to have aesthetic agency.

The speculative solution for Miyake Jima has been successfully achieved through the creation of the Air Crisis Centre. The duality of program has allowed the building to have a daily use of growing produce while the infrastructure required for a crisis event is lying in wait. The building is capable of providing shelter for the island’s whole population, for an extended amount of time, until the crisis is over. With the building’s ability to protect the growing facility at ground level, during a crisis event, the residents are able to live sustainably with the produce and rain water collection ponds. The building continually filters the air and has the extra resource of the pneumatic driven fans to enclose the building when SO₂ reaches harmful levels. The building creates a sustainable solution to allow the residents of Miyake Jima to remain living on the island. The Air Crisis Centre gives the residents peace of mind that there is now a facility that is fully equipped to provide them a safe haven, in the event of a crisis.

Concluding Statements

If the architecture discipline and the wider public can come to terms with the practical design process of allowing materials to have their own agency, new innovative aesthetics can be developed that are truly unique. This means that the design is particular to the materials used and the designer who has used them. The new approach to designing creates architecture that is unrepeatable as it is so specific to the agency of the materials used.

The incorporation of the functionality of filtration with the aesthetics of architecture has established new possibilities for filtration methods. It has influenced the form and challenged the way in which I have designed. Designing with a problem-solving approach

has allowed innovation to the ways that buildings are formed.

White Island and Myiake Jima have provided extreme environments with problematic atmospheres, enabling speculative designs to be created. These designs, while specific to each particular site, can be adapted and reused in other environments that have issues with air quality. The residents of Myiake Jima now have a speculative solution that provides them safe haven during and after a crisis event.

7

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Figure List

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Tasenska Guilford