

Wasted Opportunities

Developing resiliency in architecture through ecosystem Biomimicry

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This document and the accompanying design are dedicated to Jennifer Annette Balle, my much-loved and missed mother. You were, and continue to be, my motivation in everything I do. Rest in peace mum.

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Abstract

As architects we conceive of our buildings as finished products, our labours forever immortalised in them. But buildings are never finished; they are subject to multiple changes in occupation, repair and replacement as a result of wear-and-tear, renovation and replanning, the ‘finishes’ weathering constructs and cosmetic alterations. When buildings are stubborn to adapt they are at risk of demolition, with their materials becoming waste.

Architecture does not have to resist change, and does not have to be wasteful. We can instead rethink a building as a long duration ‘work-in-progress’, constantly developing and changing incrementally under changing conditions of context; designed to be readily susceptible – not resistant – to adaptation and growth.

This research collates a set of architectural strategies derived from attributes common within biological ecosystems to aid the design, construction and maintenance of a resilient, adaptive, built environment. These strategies include increasing adaptability through incremental construction; designing capacity for future

development; establishing lifespan hierarchies of building layers to aid maintenance and repair; design for disassembly and framing the programme to welcome change. Waste reduction strategies include the adaptive reuse of existing buildings; reinvestment of surplus materials and components of the existing building in its adaptation; use of natural and artificial waste materials and components ‘harvested’ from sources local to the site.

The focus on the energy-conservative re-use of existing buildings and materials represents a positive response to the environmental sustainability imperative. Yet, whilst gently adding layers and texture over time through gradual, incremental growth, this re-use paradigm also ensures a continuing social familiarity with the urban landscape and the sustainability of associated memory.

The following body of research is grounded in the premise that change is inevitable and that buildings should reflect this. It critically examines each attribute of an ecosystem; surveys current writings and precedents; and appraises the application of re-use strategies. The research is applied and tested in the adaptive re-use of an existing electricity substation building and site in the city-fringe suburb of Kingsland in Auckland, New Zealand.

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Key Definitions

‘Down-cycling’, ‘Reuse’ and ‘recycling’ have all been defined within a construction context. All other definitions are included in the body of the text when the terms first occur.

Down-cycling The complete reprocessing of a building element producing a different and lower grade building element.¹

Food web Many food chains linked together to show a more accurate model of all possible reeding relationships of organisms in an ecosystem.²

Reuse When elements are minimally reprocessed and reinstalled in a building without having to be remanufactured.³

Recycling The complete remanufacturing of a used building element to produce the same type of building element [or one of equal quality.]⁴

Organism An individual living thing that can react to stimuli, reproduce, grow, and maintain homeostasis. It can be a virus, bacterium, protist, fungus, plant or an animal.⁵

Species An individual belonging to a group of organisms (or the entire group itself) having common characteristics and (usually) are capable of mating with one another.

1 Paola Sassi, *Study of current building methods that enable the dismantling of building structures and their classifications according to their ability to be reused, recycled or downcycled.* , Unknown, School of the Built Environment, University of Nottingham (United Kingdom : University of Nottingham). 2

2 Biology Online, Food Web, <http://www.biology-online.org> (accessed 05 17, 2010).

3 Sassi, *Study of current building methods that enable the dismantling of building structures and their classifications according to their ability to be reused, recycled or downcycled.* 2

4 Ibid.

5 Biology Online, Food Web, <http://www.biology-online.org> (accessed 05 17, 2010).

7 Ibid.

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1 Introduction

1.1 The Problem

The effects of Man's existence on Earth are more evident today than ever. Of all living things on Earth, we have the largest impact on our environment, constantly and often radically modifying it to suit our social and economic desires.

We mine and harvest our planet for its precious resources, we use them, and then we waste them. We leave our planet, in many cases, scarred from our activities. Once limited to the raw materials of Mother Nature's palette, we now know how to manipulate her bounty and manufacture foreign materials, most of which are not easily absorbed back into natural systems and can be detrimental when disposed of.

Since the advent of mass-production society has succumbed to the insatiable desire to own, use and retire products. This phenomenon, known as 'Consumerism', is encouraged by constantly changing fashions and planned product obsolescence, where products are designed to be out-of-date or useless within a defined period of

time.⁶ Many of our everyday products are made this way and as a result require regular replacement. In turn, this ultimately leads to growing amounts of waste and increased use of virgin materials.

The Modern Movement in architecture has seen buildings become increasingly viewed as mass-produced products. Le Corbusier, a pioneer of Modernism, believed that housing should embrace mass-production, stating that the house should be viewed as a tool; cheap, available to everyone and disposable.⁷

This put architecture in a vulnerable position, as it gave architects licence to design 'throw-away buildings' and influenced the culling of buildings worldwide that no longer work for their original purpose. This attitude continues to result in the generation of vast amounts of construction and demolition waste.

The Netherlands is at the forefront of reuse recycling, with more than ninety five percent of construction and demolition waste

⁶ Investopedia, *Planned Obsolescence*,

http://www.investopedia.com/terms/p/planned_obsolescence.asp (accessed 04 03, 2010).

⁷ Le Corbusier, *Towards a New Architecture*, Translated from the thirteenth French edition, trans. Frederick Etchells (New York: Dover Publications Inc., 1986). 237-263

reused or recycled.⁸ This is due the high landfill taxes imposed by the government that almost tripled in the 1980's as a result of the increased scarcity of suitable new landfill sites. Subsequently there are over two hundred thriving companies that deal with the collection of waste material and their reuse or recycling in the Netherlands.⁹

In New Zealand construction and demolition waste accounts for fifty percent of total waste entering our landfills, ten percent higher than the global average.¹⁰ Waste materials that are recycled are more often done so overseas closer to where most manufacturing takes place, such as plastics and steel that are exported to Asia and parts of Australia.¹¹

Our waste situation needs re-evaluating. We should be striving to reduce our building related waste in the first instance, and complement this by developing a reuse and recycling industry

⁸ Michael Willoughby, *Time to go Dutch?*, 11 14, 2008,

<http://www.building.co.uk/story.asp?storycode=3127653> (accessed 07 05, 2009).

⁹ Ibid.

¹⁰ Maibritt Pedersen Zari, *Towards a Sustainable Future: Adopting a Regenerative approach to Development*, Ministry for the Environment (Wellington: Ministry for the Environment, 2009). 4

¹¹ Plastics New Zealand, *Recycling Plastics in New Zealand*, 2003,

<http://www.plastics.org.nz/page.asp?section=recycling> (accessed 05 01, 2010).

similar to the Netherlands. We should be using our waste as a resource to locally manufacture new goods, rather than sending it to landfill, or shipping it overseas for recycling. This would help address our waste problems, create employment, show the world we are truly committed to our aims of Zero Waste by 2015¹² and reinforce our tourism marketing of a “100% Pure New Zealand.”

Developing building resilience can, therefore, be seen as fundamental to reducing construction waste. The promotion of material reuse can significantly extend the life of a material or building part in its existing state, and hence is preferable than recycling.

1.2 The Architectural Question

How can the fundamentals of an ecosystem be applied in architecture to develop more resilient constructions?

¹² In 1999 twenty five New Zealand councils agreed to adopt Zero Waste policies, with a target of Zero Waste to landfill by 2015.

1.3 Key Objectives

- Define problems associated with existing construction methods that hinder resilient buildings.
- Collate existing design strategies applied in architecture that express similarities to ecological ideologies and match them to ecosystem-based principles.
- Apply and evaluate a number of these principles and their ensuing architectural strategies to an existing building and its site.
- Develop a building program that benefits the community on multiple levels.

1.4 Project Outline

What began as simply an investigation into the adaptive reuse of a building quickly escalated into something very challenging, and much more complex, after the question was asked - *How can a building adapt to a new use not just once, but many times over?*

This question led to the research of existing systems that are dynamic and display resiliency, and so nature became the main focus of studies. In the book *Construction Ecology*, the writers state:

Ecosystems are the source of important lessons and models for transitioning human activities onto a sustainable path. Natural processes are predominantly cyclic rather than linear; operate off solar energy flux and organic storages; promote resilience within each range of scales by diversifying the execution of functions redundantly over different range of scale; promote efficient use of materials by developing cooperative webs of interactions between members of complex communities; and sustain sufficient diversity of information and function to adapt and evolve in response to changes in their external environments.¹³

The research develops and expands some of the above ideas as refined by Maibritt Pedersen Zari and John Storey in their paper “*An ecosystem based biomimetic theory for a regenerative built*

¹³ Jan Sendzimir, G. Bradley Guy Charles J. Kibert, *Construction Ecology - Nature as the basis for green buildings* (New York: Spon Press, 2002). 7

*environment*¹⁴. They summarise these ideas in six key attributes common among all ecosystems:

1. Ecosystems are attuned to and dependent on local conditions.
2. Ecosystems are diverse in components, relationships and information.
3. Ecosystems optimise the system rather than its components.
4. Ecosystems adapt and evolve at different levels and at different rates.
5. Ecosystems create conditions favorable to sustained life.
6. Ecosystems are dependant on contemporary sunlight

My research has focused on the first four attributes, which will be discussed, developed and applied in detail in this document and resulting design. The last two attributes have been omitted from the research, as they are believed to already have common argument in their support, while the other four remain less developed and deserving of attention.

¹⁴ John B. Storey and Maibritt Pedersen Zari, *A Ecosystem based Biomimetic Theory for a Regenerative Built Environment*, Lisbon Sustainable Building Conference, School of Architecture, Victoria University of Wellington (Wellington: Unknown, 2007).

Fundamentally there are a number of variables involved in altering and adding to an existing building, as well as building with reused materials including their quality, locating and coordinating their sourcing from multiple sites, storage and handling and satisfying Building Codes of Compliance. The understanding of some of these realities will only come when the strategies outlined in this document are applied to a built structure, and are, therefore, beyond the scope of research.

2 Methodological Approach

The methodological approach can be broken into three distinct parts: research through literature, research through multiple site investigations and research through design.

2.1 Research through literature

In order to develop an understanding of the attributes that make an Ecosystem resilient much research was conducted by reading and analysing information in books, web articles and conference papers. As the topic is relatively unexplored, there is no built precedent known to the writer that embraces all attributes, although there are some that could be considered to make use of one or two through different architectural strategies. A mix of both national and international precedents were analysed with some of their strategies outlined and expanded upon in the Current Review of Knowledge. These have been critical in developing my thinking and have informed the design development. (See appendix 'A' for a selection of precedents.)

2.2 Research through site investigation

Intensive site investigations and documentation was required in order to develop a thorough understanding of the site and its wider context. This involved spending considerable time on the existing site, within the wider Kingsland area and its neighbouring industrial areas to understand who lived and worked in the area and what the community might collectively benefit from. The Auckland City Archives furnished a history of the substation and the area of Kingsland. Collectively this research set the scene for my proposal and was fundamental to developing a fitting program and integrating the proposed design in its environment.

2.3 Research through design

The design itself is perhaps the most crucial part of the research, as it involves my own interpretation and translation of theories developed into something a step closer to a realised building. It involves not only the application of the strategies derived from precedent, but also the solving of general problems faced in any architectural design, including suitable planning, integration of services, material selection, massing and scale to name a few.

Additional to these problems, an architectural language needed to be developed that considered the ‘existing’ and the ‘imported’, the old and its interaction with the new.

The design process was markedly different from that of a typical building, as much of the design work involved working with an existing building and materials. Taeke de Jong, Professor of Ecology at the Architecture Faculty of the University of Technology in Delft, refers to this as ‘means-oriented design’, as opposed to the ‘goal-orientated design’ commonly used in architecture.¹⁵

Goal-orientated design involves setting out a clearly defined goal with every design decision made devoted to reaching that goal. However, a ‘means-orientated’ process begins with the limited resources available and these become informants that lead the design towards a typically less pre-determined goal.¹⁶ The approach I have taken considers a mixture of ‘goal-orientated’ and ‘means-orientated’ design and therefore a ‘give-and-take’ approach has been adopted and applied subjectively throughout the process.

¹⁵ van Hinte, Peeren and Jongert, *Superuse - Constructing new architecture by shortcutting material flows*. 78

¹⁶ Ibid.

The design and its preliminary experiments have been explored through a mix of physical and digital modelling, drawing and 1:1 scale explorations. The 1:1 scale explorations are an integral part of the project due to their focus on materiality. By doing these explorations a true understanding of each materials limitations can be developed, and in turn allow their integration into the design to be informed and more successful. One set of these explorations – the rehabilitation of furniture – has allowed the testing of ideas of prolonging product lifespans and the results have been translated into the architectural design.

3 Review of current knowledge

3.1 Ecosystem Biomimicry

Biomimicry is the investigation of nature’s methods of solving common problems, then mimicking and applying these methods to solve human-related problems. The scale and level of mimicking can vary from the characteristics of a single organism to the mimicking of a collective of organisms acting as an ecosystem.¹⁷

An example of organism-based mimicry is a self-cleaning paint, developed after it was noted that the Lotus plant’s leaves emerge from muddy waters completely clean. Scientific analysis determined that the leaves have a microscopically rough surface, so when water comes in contact with them, it floats atop the air trapped in the crevices of the leaf’s texture and water beads straight off, taking any dirt particles with it. The paint’s additives

create a similar surface texture when dry, allowing water to remove dirt with ease.¹⁸



Figure 1 – Water beading on Lotus leaf and self cleaning Lotusan Paint

The mimicry of ecosystems has little, if any, precedent but is outlined by Zari and Storey as an important area of research. They believe the application of the fundamentals of ecosystems to architecture could drastically alter the way humans live, allowing

17 Storey and Zari, *A Ecosystem based Biometric Theory for a Regenerative Built Environment*. 1

18 Biomimicry Institute, *Learning from Lotus Plants How to Clean without Cleaners*, 2007, <http://www.biomimicryinstitute.org/case-studies/case-studies/toxics.html> (accessed 05 04, 2010).

us to become reconnected with nature and live more responsibly on Earth.¹⁹

An ecosystem can be defined as a system consisting of a diversity of living organisms, or biotic factors, of various scales interacting with their physical environment, or abiotic factors, to function collectively within a given area.²⁰ Ecosystems are efficient and resilient, capable of persisting as a whole in situations of adversity. This is largely due to six common attributes that can be found in almost all ecosystems, as mentioned in the Project Outline. These attributes can be “mimicked” by pairing them with design and construction strategies, in turn allowing the concepts ecosystems employ to be more easily applied in architecture.

19 Storey and Zari, *A Ecosystem based Biometric Theory for a Regenerative Built Environment*. 1

20 Eugene P. Odum, *Fundamentals of Ecology* (Philadelphia: W.B. Saunders Company, 1971). 8

3.2 Ecosystems are attuned to and dependant on local conditions

In the conference paper *An Architectural Love of the Living*, Zari states: “The immediate or local context an organism lives in, generally provides the resources and information it needs.”²¹ Michael Braungart and William Mc Donough agree, and suggest some organisms within an ecosystem are more attuned to their environment than others. These are the thriving species, and are considered those that are the most ‘fitting-est’ for their environment due to their strong “energetic and material engagement with place, and an interdependent relationship to it.”²²

The interdependence established between one or more species in an environment would suggest that mutually beneficial activities or ‘working together’ can be associated with resilience and that locality is a key factor in creating these long lasting interdependent relationships between an environment and its inhabitants.

21 Maibritt Pedersen Zari, *An architectural love of the living*, Conference Paper (Wessex: Sustainable Development, 2009). 6

22 Michael Braungart and William McDonough, *Cradle to Cradle -Remaking the way we make things* (London: Vintage , 2009) 120.

3.2.1 Architectural Application

For a building to be the most fitting-est for its environment, Zari and Storey suggest “a thorough understanding of a particular place would be required of the design team.”²³ With this understanding a design solution can be developed that does not fight its surroundings, but instead complements and enhances it.

A building should be environmentally, economically and culturally connected with its surroundings. It should become one of many nodes within a system of material and energy exchanges that are beneficial to all involved parties.²⁴ Construction materials should be sourced as locally as possible and local energy sources should be explored. In return for the materials and energy it receives, the building should offer products and services that benefit others within the area. The building’s function should capitalise on the characteristics of its environment, complementing other local businesses rather than directly competing with them.

3.2.2 Harvest Mapping

23 Storey and Zari, *An Ecosystem based Biomimetic Theory for a Regenerative Built Environment*. 5

24 Ibid. 7

The sourcing of local materials is seen as one of many sustainable design initiatives that can be employed in construction, due to the reduced energy and carbon emissions involved in transporting them from source to site. ‘2012 Architecten,’ a small architecture practice in The Netherlands, developed what they refer to as a ‘harvest map’ as a means of locating and mapping potential sources of waste or surplus materials from within a given area around a building site.²⁵

These materials are sourced due to their abundance, variation and local availability. Before any design work begins, the architects scout the area to find sources of waste or surplus materials to integrate into, and inform the design. The location of each material is then plotted on the map, along with a description of each material and quantities.

The map acts as a design tool to help generate ideas based on the materials found, as well as inform the architects of the materials transport requirements.²⁶ The use of locally sourced surplus materials minimises the distance of materials flow from one place

25 van Hinte, Peeren and Jongert, *Superuse - Constructing new architecture by shortcutting material flows*. 17

26 Ibid.

to the next. It is usually beneficial to both the provider and recipient of materials, as the provider saves on the cost of disposal, while the recipient is supplied with free or discounted materials.

Harvest maps seem to be most useful in densely built areas such as cities and around city fringes where there is generally a large variety of development and industry occurring. Suburban areas therefore pose a more difficult task in terms of locating materials useful for construction.

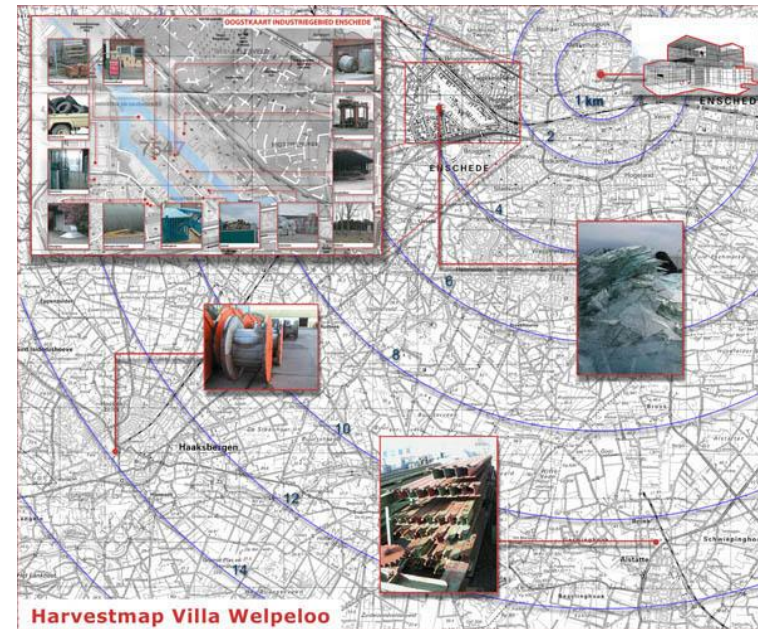


Figure 2 – 2012 Architecten's Villa Welpeloo Harvest Map locating project materials.

make more informed decisions regarding matching building programme to site.

3.2.3 Matching Programme to Site

The success of a development or a new business entering an existing area can be influenced by its appropriateness to that area and the relationships it develops with others already operating in the local vicinity. It is logical that thorough research is conducted to understand the areas existing identity in order to establish a market. Research should include understanding zoning regulations, products and services already offered within the area, the people living and working within an area, and what they might benefit from. This is especially the case if the provided product or service is targeted at the local market, rather than the wider national or international markets.

This can be likened to the ‘niche finding’ of organisms competing within the same area. Organisms will often limit competition with others for resources by defining territories, or staggering feeding times.²⁷ This ‘niche finding’ seems to allow those competing to coexist. Although in the built environment it does involve a degree of foresight, prior research allows the designer or developer to

²⁷ Storey and Zari, *A Ecosystem based Biomimetic Theory for a Regenerative Built Environment*. 5

3.3 Ecosystems are diverse in components, relationships and information

Ecosystems are sustained by a diversity of organisms, their varied functions and the multiple relationships existing between one another.²⁸ Each organism has a specific role to play in the processing of energy, matter and information. Odum points out that the more diverse an ecosystem, the more intricate the food webs among species and greater chance for mutual relationships to develop.²⁹

Zari and Storey add to this by suggesting that it is not specifically the number of species that is attributed to the stability of an ecosystem, rather the strength and number of these relationships between them.³⁰ They believe that “through this kind of

cooperative networking, one organism can fail without disrupting the whole system.”³¹

Niche finding, as referred to in Section 3.2.3, is directly correlated with the diversity of functions in organisms. Organisms rely on differing resources from multiple locations, in order to avoid direct competition with other.³² In most cases this is the result of specific characteristics that allow an organism to occupy a niche.

For example, there are a number of food niches present in a grove of trees, with a variety of bird, mammal and insect life that focus on different food sources. Different birds focus on food sources at different levels between the canopy and forest floor. These include a range of fruits, seeds and insects within each level. Evolution has allowed them to develop their functions to better suit their source, such as the Kiwi,³³ with its long bill and sensitive smell that allows it to find insects deeper beneath leaf litter than most other birds in the same area.

28 Kilbert, Sendzimir and Guy, *Construction Ecology - Nature as the basis for Green Buildings*. 18

29 Odum, *Fundamentals of Ecology*. 149

30 Storey and Zari, *A Ecosystem based Biomimetic Theory for a Regenerative Built Environment*. 7

31 Ibid.

32 Kilbert, Sendzimir and Guy, *Construction Ecology - Nature as the basis for green buildings*. 18

33 A small, flightless bird indigenous to New Zealand.

3.3.1 Architectural Application

In nature there is biodiversity, the diversity of species, each with a different role in the working of the system. In the built environment, diversity can be represented by a wide range of built structures housing different functions.³⁴

Mixed-use developments consist of a diversity of compatible building functions grouped within one building, or multiple buildings in close proximity.³⁵ This helps foster relationships among local businesses, and creates vibrancy and variation within an area due to the diverse range of activities taking place.

Although diverse relationships are considered more important than the diversity of the buildings themselves, a consistent yet varied streetscape is still considered vital to the vibrancy of an area.³⁶ As mixed-use developments typically amalgamate multiple functions into one or two buildings it could be argued that there is a loss in what would have otherwise been a collection of varied building types, and subsequently a loss in diversity within the street. This,

34 Howard T. Odum, *Construction Ecology - Nature as the Basis for Green Buildings*. 59

35 North Shore City Council, *Good Solutions Guide for Mixed Use Development in Town Centres* (Auckland, 06 2005). 5

36 Ibid. 23

however, can be somewhat balanced by integrating existing character buildings into a mixed-use development. Developments should therefore seek to find a balance between building diversity and the diversity of relationships among their users.

3.3.2 Building Diversity

Anne Vernez Moudon suggests diversity can be established simply by dividing the site into many small lots:

*Small lots will support resilience because they allow many people to attend directly to their needs by designing, building, and maintaining their own environment. By ensuring that property remains in many hands, small lots bring important results: many people make many different decisions, thereby ensuring variety in the resulting environment.*³⁷

Putting the decisions of how a group of buildings develop in the hands of many, rather than one, will result in variation, but may not result in a 'cohesive whole' within the streetscape. Cohesion can be attained through good design, where scale, proportion and material

37 Stewart Brand, *How Buildings Learn - What happens after they're built*, (London: Phoenix Illustrated, 1997). 18

section become crucial factors in designing a building and its street-facing facades. A common method of creating diversity and cohesion is by borrowing proportions and scale from the facade neighbouring buildings from making street faces read continuous. This effect is illustrated in a building designed by RTA Studios on Richmond Road, Auckland.



Figure 3 – RTA building illustrating borrowed proportions from neighbouring buildings

3.3.3 Relationship Diversity

Interdependence among local business and industry should be encouraged in order to maximise efficient material and energy use, and minimise waste.

In Kalundborg, Denmark there are a group of companies working together as an ‘Industrial Ecosystem’, where resources and energy are shared in an interdependent network³⁸. A coal-fired power station, oil refinery, a pharmaceutical plant, a plasterboard manufacturer, and fish and pig farms all operate within a local area. Waste steam and materials such as sulphur, fly ash and sludge are exchanged from one business to another, where they become fuel or raw material for use in another production process. Such relationships include the use of waste steam produced by the power plant to power the oil refinery, the pharmaceutical plant and heat thirty five hundred local homes.³⁹The Kalundborg industrial, commercial and residential areas are essentially all connected in a ‘food web’ similar to an ecosystem. The full extent of these relationships is demonstrated in Figure 4.

38 Janine Benyus, *Biomimicry - Innovation Inspired by Nature* (New York: William Morrow and Company, 1997). 255

39 Ibid.

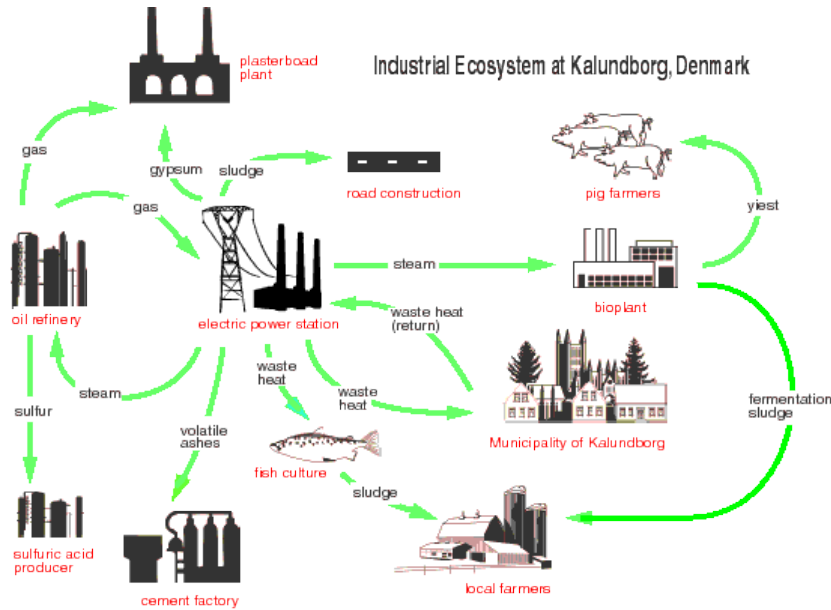


Figure 4 – Diagram illustrating relationships in Industrial Ecosystem at Kalundborg

Although these relationships may not be developed to the same extent in every development, similar relationships should be encouraged among the three categories mentioned in the form of business relationships, and material and energy exchanges. Similar initiatives can also exist on a much smaller scale simply by collecting and exchanging waste heat and rooftop collected water between neighbouring buildings. Repeated within a neighbourhood, this would see each building become one of many

nodes, connected with other local buildings within a system of exchanged resources.⁴⁰

⁴⁰ Storey and Zari, *An Ecosystem Based Biomimetic Theory for a Regenerative Built Environment*. 7

3.4 Ecosystems optimise the system rather than its components

In nature waste does not exist. Organisms in an ecosystem acquire matter and energy from their local surroundings as nourishment for growth. They use only what they require then discard the excess back into their immediate environment. The discarded waste of one organism then becomes nourishment for the growth of another, cycling perpetually through connected food webs of many different species.⁴¹ The exchange of this material and energy is what formulates interdependence among species, where coexistence becomes beneficial to all parties within the system. This is fundamental to the working of an ecosystem.⁴²

The releasing of excess material and energy would be regarded as inefficient on the organism's behalf if it were not reliant on the excess or waste of another. As humans we rely little on the waste of others to provide for us and the waste we produce is non-beneficial to other species, in fact, it is increasingly detrimental to them. Essentially, we fail to participate as a part of an ecosystem.

41 Eugene P. Odum, *The Strategy of Ecosystem Development*, Science 164, no. 3877 (04 1969). 262 - 270

42 Braungart and McDonough, *Cradle to Cradle -Remaking the way we Make Things*. 122

3.4.1 Architectural Application

Chemist Michael Braungart and Architect William McDonough, authors of *Cradle to Cradle – Remaking the Way we Make Things*, believe we do not have to cease producing waste to reconnect ourselves with active ecosystems. Instead, they suggest we need to imitate nature's cradle-to-cradle metabolism, where detritus becomes the food for the growth of another and essentially eliminate the very concept of 'waste' altogether.⁴³ They believe that man-made materials, similarly to biological materials, can be seen as nutrients able to feed new growth as they become surplus. While some can aid natural growth, others can be broken down and used as nutrient for artificial growth: the growth of industry. Hence, they separate the material stream into two distinct categories, biological nutrients and technical nutrients.⁴⁴

Biological nutrients are materials that can be returned to the earth to become part of a biological cycle, where microorganisms and other animals can safely consume them.⁴⁵ Braungart and

43 Ibid.103-104

44 Ibid. 93

45 Ibid. 105

McDonough use the example of a compostable fabric they were asked to develop for textile company DesignTex. This fabric uses no harmful substances in its creation, allowing it to be tossed onto the garden at the end of its useful life where it safely breaks down. It is, in fact, so safe that it is claimed to be edible by humans.⁴⁶ As the process of making it involves no carcinogens, mutagens or pesticides, the water coming out of the factory that produces the textile was found to be cleaner than the water entering it.⁴⁷ This example suggests that re-evaluating the way things are made could not only lead to safer, healthier products that can be disposed of in a manner beneficial to the environment, but the processes that make them could also become beneficial.

Technical nutrients are described as materials or products that can be returned to an industrial metabolism, where they become the nourishment for artificial growth.⁴⁸ Through the act of recycling Braungart and McDonough believe that material flows can become closed loop systems, with technical nutrients reused perpetually. This would entail the disassembly of products or components to break them down into a more usable state so that they can be easily

46 Ibid. 107

47 Ibid. 108

48 Ibid. 92-93

absorbed into different technical processes, similar to the metabolism of an organism. The reality of ‘technical nutrients’ is that they are not all recycled, even if they are intended to be. Impurities, coatings and alloys are common barriers that complicate even the most recyclable materials, aluminium and steel.⁴⁹

The theory of developing products and materials as biological nutrients could radically change the global industry, as industrial growth would have the potential to improve the quality of its environment, rather than damage it. However, as manufactured products fitting into the ‘biological nutrient’ category are still in their infancy the reuse and recycling of non-biodegradable materials or ‘technical nutrients’ is a pressing problem globally that needs to be addressed.

Reuse, in a construction sense, is defined by Paola Sassi, as “when elements are minimally reprocessed and reinstalled in a building

49 Sassi Paola, *Defining closed-loop material cycle construction*, Informaworld, 09 2008, <http://www.informaworld.com/smpp/section~db=all~fulltext=713240928~dontcount=true~content=a901651390> (accessed 08 03, 2009).

without having to be remanufactured.”⁵⁰ Reuse is a commonly confused and overlooked approach to dealing with waste that is, in fact, ranked higher than recycling within the Waste Management Hierarchy.⁵¹ This is due to the little or no loss in quality and minimal reprocessing involved, which in turn means less energy is used and fewer emissions are made.⁵²

Many of today’s buildings have the capacity to exist in a usable state for as long as fifty to one hundred years⁵³, but few reach this age before they enter the waste stream. Put simply, our buildings and their components do not last long enough in one given state before they are torn down. Each time we recycle a material or product rather than reuse it, it is subject to additional energy, material and chemical inputs.⁵⁴ These inputs are usually less than

50 Sassi, *Study of Current Building Methods that enable the Dismantling of Building Structures and their Classifications according to their ability to be Reused, Recycled or Downcycled*. 2

51 The waste Management Hierarchy is a guideline used by the Ministry for the Environment. The following strategies are ranked from most beneficial to least beneficial: Reduce, Reuse, Recycle, Energy Recovery and Residual Management

52 Sassi, *Study of Current Building Methods that enable the Dismantling of Building Structures and their Classifications according to their ability to be Reused, Recycled or Downcycled*. 1

53 Brand, *How Buildings Learn - What happens after they're built*. 11

54 Bill Addis, *Building with Reclaimed Components and Materials : A Design Handbook for Reuse and Recycling* (London: Serling, VA : Earthscan, 2006). 6-7

what is required to produce it from virgin materials, but are still considerably more than reusing it in its existing state. The other consequence is that often materials cannot be recycled to create a product equal in quality to the original. This loss of quality is referred to as “down-cycling.”⁵⁵

Nature has the advantage of a vast multitude of organisms working locally disassembling her biological products with the motive of turning them into their own food. The application of Braungart and McDonough’s theory of recycling ‘technical nutrients’ is fundamentally flawed as it discounts the location of reprocessing in relation to the materials location, the energy required for transport and reprocessing, and the range and availability of materials that are infinitely recyclable. It could therefore be argued it is better to reuse than recycle ‘technical nutrients’ until these issues are properly addressed.

55 Sassi, *Study of Current Building Methods that enable the dismantling of Building Structures and their Classifications according to their ability to be Reused, Recycled or Downcycled*. 2

3.4.2 Adaptive Reuse

Adaptive Reuse is most commonly defined as the reuse of a building or buildings involving a level of adaptation or change in character of the building fabric and its spaces, to suit a new program.

Luis Fernandez-Galiano helps us to see an existing building from an unusual point of view. He suggests that a building essentially represents a bank of stored material and energy already expended.⁵⁶ Therefore the greater the amount of an existing building retained and reused, the more that energy remains locked in its most useful state.⁵⁷ A helpful addition to the definition of Adaptive Reuse could therefore be defined as ‘the prolonging of the cradle-to-grave lifecycle of the building⁵⁸, its associated materials and the energy costs involved in the materials manufacture and the buildings construction.’

56 Luis Fernandez-Galiano, L. *Fire and Memory - On Architecture and Energy*. (G. Carino, Trans.) Cambridge, Massachusetts, United States of America: The MIT Press, 2000, 64

57 van Hinte, Peeren and Jongert, *Superuse - Constructing New Architecture by Shortcutting Material Flows*. 6

58 Prof. Dara O'Rourke, D. G. (2002). *Adaptive Reuse*. Retrieved 07 11, 2009 from MIT - Greening East Campus, Industrial Ecology & Life Cycle Assessment : <http://www.archinode.com/lcaadapt.html>

Demolition, on the other hand, requires additional energy to break the building into smaller, less useful pieces. As a high proportion of this demolished building becomes waste, the stored material and energy is essentially dissipated and lost. By limiting or avoiding demolition or disassembly in the first instance, there are monetary and energy savings to be made through a reduced dismantling process and the reduced transport, sorting and disposal of the resultant wastes.⁵⁹ To replace the building also entails additional energy and the use of virgin materials inherent in new construction. It is for these reasons that in situ adaptive reuse of buildings can be seen as the most efficient form of reuse.⁶⁰

Lynch believes that the change in program of a building is a “significant test of its quality”⁶¹ and could be argued as fundamental to its survival and continued evolution, as it demonstrates the building has the capacity to perform a function other than for which it may have been specifically designed. It is

59 Ibid.

60 John Storey, Morten Gjerde, Andrew Charleson & Maibritt Pedersen Zari, *The State of Deconstruction in New Zealand*. Victoria University Wellington, Centre of Building Performance Research, Wellington. 22

61 Kevin Lynch, *Wasting Away - An Exploration of Waste: what it is, how it happens, why we fear it, how to do it well*, ed. Michael Southworth (San Francisco: Sierra Club, 1981). 178

not uncommon with adaptive reuse for the building to be reformatted to perform a less specific function or set of functions, and as a result becomes ‘loose-fitting’. The alterations that adaptive reuse involves bring spaces to an acceptable state of useability, but by no means makes them the most efficient for a particular use. Some ambiguity remains. This ambiguity adds a certain idiosyncrasy to the building and often can become a feature. It is also what makes future reuse easier, as less effort is required to reformat the building and its spaces for a new function.

Fernandez-Galiano also suggests that buildings not only retain material and energy, but also valuable information worth conserving.⁶² This information includes the continued familiarity and identity of the urban environment, the conservation of the history associated with the building’s inhabitancy and the retained knowledge of past construction methods. He suggests that a building becomes a complex story of recorded events and traces of human inhabitation, with information stored through matter in the same way as in nature.

*The earth’s layers remember geological ages, the rings of a tree recall past springs and autumns, and the archaeological mound is a reminder of the passage of cultures. The built structure remembers living habits and processes, contains information about historic vicissitudes, and forms the material basis of collective memory.*⁶³

Brand agrees and suggests the complexity that develops through this succession of interventions makes a building more interesting. He writes: “the continuing changes in function turn into a colourful story, which becomes valued in its own right.”⁶⁴ Through sequential changes in use and their subsequent alterations the buildings collective memory becomes an intricate tapestry of information. This information is recorded at a variety of scales, from an evolving building form, down to the developing patina on some materials as a result of wear and weathering.

The adaptive reuse of buildings faces many barriers including the need to maximise the rentable floor area on a site in order to maximise profits, costs associated with remedial work and the general belief it is cheaper to demolish and start again than to retrofit. Some developers are beginning to understand the character

62 Fernandez-Galiano, *Fire and Memory - On Architecture and Energy*. 66

63 Ibid.

64 Brand. *How Buildings Learn - What happens after they're built*. 104

and value associated with old buildings, and hence modifying and refitting them for small-scale office and commercial use.

3.4.3 *Building part, component and element reuse*

Pieces of old buildings including dressed stones and columns have historically been reused a number of times in Egyptian, Greek and Roman construction, usually from damaged or redundant buildings.⁶⁵ While some might have considered this undignified and vandalism at the time, it would have been a sensible and efficient method of sourcing materials for a required construction, as much of the hard work of quarrying virgin stone and its processing had already been done.

The same principle is relevant today with our buildings and the parts that constitute them. These pieces of a building can be divided into groups based on their level of processing and combination, and are referred to as a ‘building part’, ‘component’ or ‘element’. A material processed into its final shape is considered an ‘element’. When two or more elements are combined, they form

65 Addis, *Building with Reclaimed Components and Materials: A design handbook for Reuse and Recycling*. 9

a ‘component’. A ‘building part’ consists of a number of components, which make it a functional whole.⁶⁶ To distinguish the three, the following example is given. A working door unit including its frame is considered a building part. It is made up of many components including the locking mechanism, the handles and hinges. The barrel hinge is typically made up of two ‘leaves’ and a pin, which are all considered elements.



Figure 5 – Scavenged columns and capitals, Santa Maria in Cosmedin, Rome

66 van Hinte, Peeren and Jongert, *Superuse - Constructing New Architecture by Shortcutting Material Flows*. 6

The reuse of these pieces is subject to a number of conditions including the market for second-hand goods, their quality after their reclamation from the past construction, their price compared to a similar new item and regulatory issues.⁶⁷ It is, nevertheless, a common occurrence in domestic timber construction in New Zealand. This is due to the character and charm associated with old timbers and their often durable, crafted nature,⁶⁸ rather than an exercise in efficient material use and waste reduction. It is less commonly seen in commercial and industrial buildings, possibly because of liability and regulatory barriers concerned with reliable performance.⁶⁹ There are also issues inherently involved in the reliable sourcing of second-hand building pieces, and their integration into a building's design. Strong relationships with salvaged material dealers are required to know what is available and in what quantities.

When designing with a large percentage of reused building parts and components both client and architect need to be accepting and embracing of the eclectic aesthetic that results. Their use could

67 Storey, Gjerde, Charleson and Zari, *The State of Deconstruction in New Zealand*. 26-27

68 Ibid. 26

69 Ibid. 28

otherwise seem cumbersome and mistaken, rather than a feature of the building.

3.4.4 Superuse – Waste Material reuse

Superuse can be defined as the action of removing materials from a scenario where their maximum value is dissipated through storage, potential 'down-cycling' or dumping, and reusing them in a similar state for a purpose of equal or greater value than its original use.⁷⁰

The term was coined by 2012 Architecten and is regularly applied in the buildings they design.

It is an efficient and creative way of dealing with a number of waste products and materials, as often little additional energy is required to make them useful again. Superuse does not discriminate against recyclable materials as it generally requires less energy than recycling.

In a similar way that the adaptive reuse of a building demonstrates its resiliency by showing it can carry out a different function, the

70 van Hinte, Peeren and Jongert, *Superuse - Constructing New Architecture by Shortcutting Material Flows*. 5

superuse of a product or material also displays its resiliency through its capacity to be repurposed. Superuse not only prolongs the life of a material in a given state, but also promotes awareness of waste materials and their creative applications in architecture and other design fields.

Working with these unconventional materials poses many challenges and in some cases is not practical. They face the same issues as the reuse of building parts, components and elements, including quality, reliable sourcing and cost, but with added extras. They face additional scrutiny as many were not intended to be used in building construction. Some products, such as industrial liquid containers have also been exposed to hazardous chemicals, making them unfit for superuse.



Figure 6 – 2012 Architecten's 'Miele Space Station', now a coffee house, clad in washing machine panels

3.4.5 Design-for-Disassembly

Design-for-disassembly is a method of designing a product or appliance with consideration for the future need to disassemble it for repair, refurbishment or recycling.⁷¹ Disassembly facilitates an easy and high yielding reclamation and separation of materials for reuse or recycling, but it can be seen as uneconomic in common products due to their materials and fixing methods used. By designing with disassembly in mind it becomes far more economical. Fisher and Paykel, New Zealand's only appliance manufacturer, embraces disassembly with a profitable take-back scheme where appliances are collected and dismantled for reuse and recycling.⁷²

Design for disassembly is a topic beginning to gain interest in the field of architecture, but faces many barriers. The additional time required for disassembly, the costs incurred as a result of this extra

71 Alex Diener, *Afterlife: An essential guide to Design for Disassembly*, 02 01, 2010, http://www.core77.com/blog/featured_items/afterlife_an_essential_guide_to_design_for_disassembly_by_alex_diener__15799.asp (accessed 03 17, 2010).

72 Ministry for the Environment, *The New Zealand Waste Strategy*, Ministry for the Environment, 03 2002, <http://www.mfe.govt.nz/publications/waste/waste-strategy-mar02/> (accessed 04 16, 2009). 12

time and the limited market for reclaimed materials have hindered its widespread adoption.

Bill Addis believes that buildings should be designed in a manner that allows easy separation and reclamation or recycling of their constituents at the end of their useful life.⁷³ Sassi Paola, author of a number of publications related to design-for-disassembly, agrees suggesting their disassembly should be as quick and effortless as possible in order to compete with the cost of standard demolition.⁷⁴ By doing so there would be less waste associated with building removal and greater opportunities for the sourcing and reuse or recycling of building materials.

Five main methods – also supported by Paola⁷⁵ – of facilitating designing-for-disassembly and reuse are derived from the document, '*The state of deconstruction in New Zealand*'. These are as listed:

73 Addis, *Building with Reclaimed Components and Materials: A Design handbook for Reuse and Recycling*.19

74 Sassi, *Study of Current Building Methods that enable the Dismantling of Building Structures and their Classifications according to their ability to be Reused, Recycled or Downcycled*. 2

75 Ibid. 4

1. Provide sufficient information on the buildings disassembly sequence as well as its construction process.
2. Use accessible mechanical fixings over chemical fixings.
3. Design components and building parts to be disassembled in manageable sections
4. Avoid composite materials.
5. Avoid interlinking elements

Older buildings are generally considered easier to disassemble for reclamation than new ones due to the quality of materials and the methods used to joint them.⁷⁶ The change in use of lime-based to cement-based mortar to join bricks is a prime example. Lime mortar does not bond as strong as cement, but can easily be knocked off the brick, allowing easy reuse. Cement mortar makes the separation of bricks almost impossible, causing them to fracture during removal.⁷⁷ Other common methods of joining today's materials such as welded steel joints, multiple nailed joints, and the extensive use of glues are generally very durable, but are possibly

⁷⁶ Storey, Gjerde, Charleson and Zari, *The state of deconstruction in New Zealand*, 27

⁷⁷ Ibid. 33

the biggest hindrance to disassembly,⁷⁸ as they make it near impossible to separate a building into reusable parts.

A flaw in the concept of designing-for-disassembly is that it may end up encouraging the disassembly of buildings over retaining and adapting them. Perhaps a balance needs to be found where the less durable parts of the building are easily disassembled allowing their easier maintenance and replacement, with a long lasting structure that is retained.

⁷⁸ Ibid. 60

3.5 Ecosystems adapt and evolve at different levels and at different rates

Adaptation and evolution are two methods by which organisms and whole ecosystems respond physically and behaviourally to the dynamic environment in which they exist. The time scale over which this response occurs differentiates the two, with adaptation occurring during the organism's lifetime and evolution occurring over successive generations of a species.⁷⁹ Both types of change can be seen as an act of learning from the environment and adjusting to better suit it.

Biologist Stephen Jay Gould points out that evolution can occur in all biological structures, from genetic material to organs, as they all have a built in 'capacity for massive redundancy' allowing organisms to develop new features or functions, while still maintaining their regular ones.⁸⁰

The ability of organisms within an ecosystem to adapt and evolve at different rates over different scales is fundamental to the stability

⁷⁹ Storey and Zari, *A Ecosystem Based Biomimetic Theory for a Regenerative Built Environment*. 7

⁸⁰ Braungart and McDonough, *Cradle to Cradle - Remaking the way we make things*. 185

of the system.⁸¹ Small organisms typically have short lifespans whilst the larger ones usually have long ones. "In any shock to the ecosystem, the fast parts respond quickly, allowing the slow parts to ignore the shock and maintain the continuity of the system."⁸² This keeps the system in a constant state of flux and allows it to persist as a whole through adversity.

3.5.1 Architectural Application

Architecture is often seen as permanent and unchanging⁸³, but similarly to a living organism, our buildings are positioned in a dynamic environment and, therefore, should have the capacity to adapt and change to better suit the changing environment in a similar manner.

Brand suggests that some buildings are more accepting of change, distinguishing the common 'building' from 'architecture':

⁸¹ Storey and Zari, *A Ecosystem Based Biomimetic Theory for a Regenerative Built Environment*. 6

⁸² Ann Thorpe, *Eternally yours - Time in Design*, trans. Peter-Paul Verbeek (Rotterdam: OIO Publishers, 2004). 219-220

⁸³ Brand, *How Buildings Learn - What happens after they're built*. 2

*The word 'building' contains the double reality. It means both 'the action of the verb BUILD' and 'that which is built'- both verb and noun, both action and result. Whereas 'architecture' may strive to be permanent, a 'building' is always building and rebuilding.*⁸⁴

He argues that 'architecture' often differs from a standard 'building' due to its focus on construction as an art rather than a craft. If the art prevails over the practicality of the building, it can become victim of the consumerist tendencies mentioned in the Introduction, failing as soon as new fashion comes along.⁸⁵

Along similar lines as Brand, Fernandez-Galiano refers to:

*...the need for the irremediable catabolic degradation of the built work to be complemented by the indispensable anabolic constructive action that restores, in a never-concluded process, the permanently transforming form of architecture.*⁸⁶

This can be interpreted as not the need for complete demolition and reconstruction, but more the removal of the defunct parts of a building and the addition of new parts that restore the building to a

84 Ibid. 2

85 Ibid. 54

86 Fernandez-Galiano, *Fire and Memory - On Architecture and Energy*. 94

useful state. David Leatherbarrow actually believes that some buildings "...may be realised perfectly in time through a series of sequential interventions."⁸⁷

The application of this in architecture could involve designing in a manner that welcomes adaptation and change, rather than resisting it. A building would then become a long duration 'work-in-progress', constantly developing and adapting incrementally over time through changing conditions of context. This gradual adaptation and evolution of the built environment that results is fulfilling of society's psychological need for urban familiarity, as opposed to the abrupt demolition and replacement of the built environment.⁸⁸

87 Moshen Mostafavi and David Leatherbarrow, *On Weathering - The Life of Buildings in Time*, 2nd Printing (Cambridge, Massachusetts: The MIT Press, 1997). 109

88 Dr. Gregory A. Norris Prof. Dara O'Rourke, *Adaptive Reuse*, 2002, <http://www.archinode.com/lcaadapt.html> (accessed 07 11, 2009).

3.5.2 Material Lifespan Hierarchies

Kevin Lynch proposes that a building should be split into two categories of parts in order to minimise future waste: those that remain for the life of the building and, therefore, have long life spans, and those replaced more frequently.⁸⁹

Brand addresses a similar concept, instead separating a building into six distinct layers that form a hierarchy based on their typical life spans.⁹⁰ From longest to shortest lasting, these are:

SITE – The buildings geographical location

STRUCTURE – Any load bearing part of the building

SKIN – The exterior surfaces

SERVICES – All systems within the building.

SPACE PLAN – The interior fit out

STUFF – Furniture and appliances

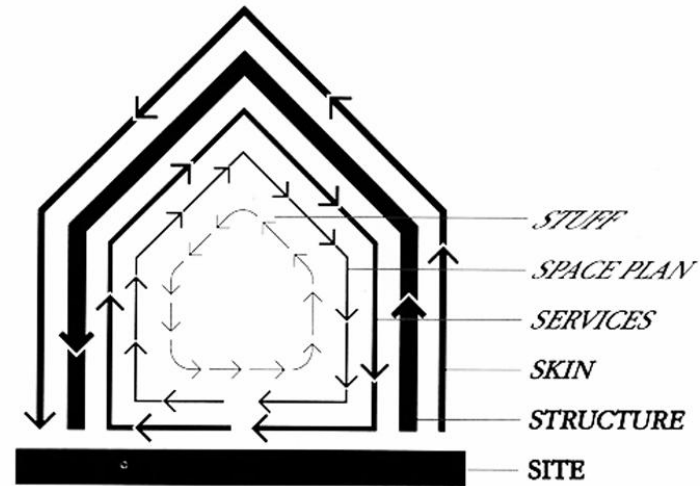


Figure 7 – Stewart Brand's diagram describing the layers of lifespans in a building

He points out that in the same way that the large and slow organisms control an ecosystem, a building is controlled by its large and slow changing components.⁹¹ When multiple layers are too heavily integrated or connected with one another, all layers fail

⁸⁹ Lynch, *Wasting Away - An Exploration of Waste: What it is, how it happens, why we fear it, how to do it well.* 174

⁹⁰ Brand, *How Buildings Learn - What happens after they're built.* 12-13

⁹¹ Ibid. 17

when one fails. The most common example of this is when services are too deeply integrated with the structure and/or skin of a building. When one tries to maintain or upgrade these services, it is a struggle, if not impossible to do so. Thinking of a building in these layers supports the processes of design, construction, maintenance and eventual disassembly of the building.

This strategy opposes the idea of a ‘maintenance-free’ building, instead promoting the ritualistic renewal of certain parts of a building as they wear and require replacement over time, keeping it as a useful whole. The building essentially becomes a *process* rather than the product it is currently deemed.

3.5.3 Incremental Development

Incremental development is the act of staggering the construction and/or design sequence of a development. By staggering the construction, each new building, addition or alteration is informed by the prior one. Gary Peterson believes:

Leaving portions of a building unfinished, or not completely finished, allows the occupants to learn and develop effective ways of using space. It is unrealistic to

*expect an architect or designer to anticipate all the possible future uses of a structure. The needs and requirements of a building’s users change over time as a result of social and technological change, as well as shifts in who owns and occupies the building.*⁹²

Stewart Brand agrees, suggesting that “first we shape our buildings, then they shape us, then we reshape them again – ad infinitum. Function reforms form, perpetually.”⁹³ Ian Athfield’s house in Wellington could be considered an example of this iterative process, as referred to in Appendix A.

The benefit of this strategy to the client is that the cost of the overall design is split into stages, allowing them to develop the building as money allows them to. Conversely, depending on the proposed additions, the building’s use may be hampered while construction occurs, and could mean a loss of income.

92 Gary Peterson, *Construction Ecology - Nature as the Basis for Green Buildings* (New York: Spon Press, 2002). 143

93 Brand, *How Buildings Learn - What happens after they're built*. 3

3.5.4 Included redundancy for adaptation – Building capacity not things

In order for a building to cater for future additions with little disturbance to the existing building fabric, it could be designed with a percentage of redundancy included in its structure. This would allow for future additions, such as floors or lean-tos, to be added to satisfy growing needs for extra space. Braungart and McDonough acknowledge the idea of redundancy, suggesting:

You may not even know today what it is that you need to grow in the future, but if all of your resources are tied up in basic operations, there won't be anything extra to allow for innovation and experimentation. The ability to adapt and innovate requires a "loose fit" – room for growing in a new way.⁹⁴

This strategy is typically hampered by the fact that much of the world's real estate is not owned by those who occupy it. Tenants simply move into a bigger building as they require more space, rather than adjusting their existing one. This type of development would more likely suit a user/owner scenario, where those that use

the building are the ones that own it and, therefore, would make sense for them to consider future additions in its development. Changing attitudes in developers might also allow them to see the positives in future-proofing their investment by spending a little extra on an over structured building that will accommodate future additions.

⁹⁴ Braungart and McDonough, *Cradle to Cradle -Remaking the way we Make Things*. 185

3.6 Site Description

Kingsland is a small bohemian suburb in Auckland New Zealand on the fringe of the CBD. Historically, Kingsland developed around a popular trade route, now known as New North Road. Much of its original shopping precinct consisting of diverse building styles and scales remains largely intact.

The chosen site is located at 1a Central Road, on the corner of Central Road and Kingsland Terrace. The site runs parallel to New North Road approximately twenty metres away, in close proximity to Kingsland’s shopping precinct, train station and bus route.

Vector Electricity currently occupies the site with an electricity distribution substation. The substation consists of two buildings housing switchgear, open spaces acting as transformer bays and a service lane that runs through the site. The switchgear controls the supply of electricity to different neighbourhoods and the five transformers lower the voltage of incoming electricity from around

33,000 volts to 11,000 volts, before being distributed to various street side transformers.⁹⁵



Figure 8 – Drawings locating Kingsland Site

⁹⁵ Substations, 2003, <http://www.vectorelectricity.co.nz/projects/substations> (accessed 04 07, 2009).

The older of the two buildings, dating from the 1930's, is a concrete monolithic structure, with all walls, columns, beams and floor cast in-situ. It was remodelled in 1948 in an Art Deco style. It houses the Ripple-Plant, the part of the substation that moderates loads during times of peak electricity use, as well as a number of lockers containing the switchgear. On one side of the building timber floorboards conceal a service trench that contains the incoming electricity cable, whilst allowing easy access. This metre-deep trench continues out of the building, across the service lane and through the 1960's building to the transformers on the other side.



Figure 8 – Interior of 1930's Building, showing switchgear (left)



Figure 9 – Exterior of 1930's Building (right)

The second building, dating from the 1960's, consists of a steel portal frame, non-structural concrete and brick walls, a profiled steel roof and a concrete floor. It also houses switchgear along with a small control room. The cable trench under this building is accessed at a lower level and is deep enough to stand in comfortably. Two large transformers sit in concrete bays between this building and Kingsland Terrace, bordered by six concrete columns holding isolators in place. The site is screened with tall fences to keep the public out, for obvious safety reasons, but also to mask the activities that occur on the site, as it is deemed an undesirable thing to have in the area.



Figure 10 – Interior of 1960's Building, showing switchgear (left)

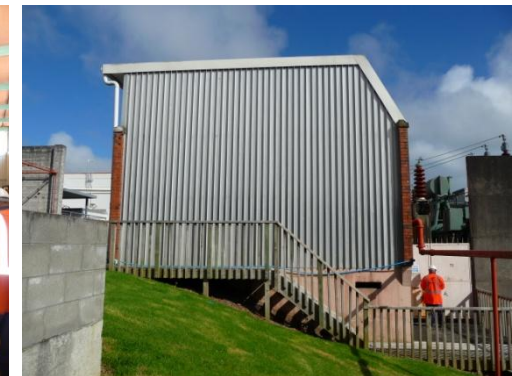


Figure 11 – Exterior of 1960's Buildings

The substation was accessed on three occasions, May 19th 2009, August 25th 2009 and October 5th 2009. Barry Kopua of Vector Electricity guided me each time, explaining the role of each part of the substation as it was documented through photography.

The site is identified as containing ‘character defining’ buildings that should remain embedded within Kingsland and adapted for continued use.⁹⁶ Further investigation at Auckland City archives and talking to Vector revealed that the transformers and switchgear are over fifty years old and essentially running inefficiently.

The Department of Architecture’s resident services specialist, Max Hynds, brought to my attention that although the size of transformers has not changed drastically in the last fifty years, the switchgear had the potential to decrease in size by at least sixty percent if replaced with new digital switchgear and the ripple-plant could be shrunk by at least ninety percent.⁹⁷ It was recognised that stacking the transformers into a tower would free more of the ground plane for another use, and allow the site to be optimised more efficiently.

⁹⁶ Kingsland Character & Heritage Study prepared by Boffa Miskell, Matthew + Matthew Architects, R.A. Skidmore Urban Design Ltd. And Salmond Reed Architects, 2004.

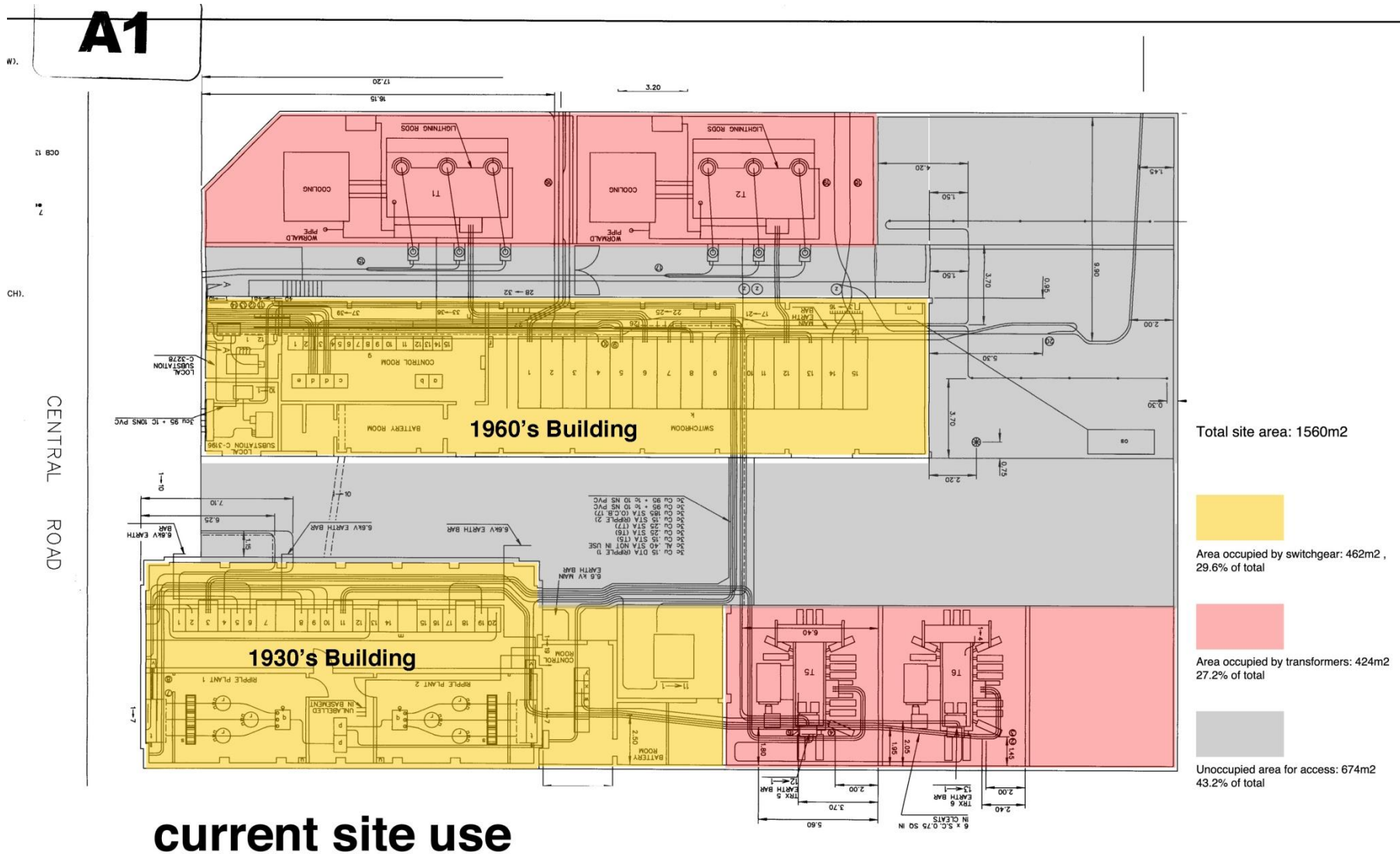
Accessed at Auckland City Archives April 2009

⁹⁷ Max Hynds, Personal Communication, 27.04.10

By offering a design solution that acknowledges all parties – Vector, the residents and workers of Kingsland – the site could be developed to host a more efficient substation, while freeing space that could provide a number of beneficial amenities to the community.



Figure 11 – View of site from Kingsland Terrace



current site use

Figure 12 – Plan of existing site describing area usage, Not to scale

4 Project Development

The Project Development is broken down into six sections. These sections are not strictly in chronological order, as multiple investigations and explorations in each section took place over the entire course of the project. The order presented was seen as the easiest and most comprehensible manner to describe the project to others.

The first section addresses the early explorations that took place, which informed my thinking and were drivers of the shift in research. The following five sections address general design issues as well as the investigation and application of each attribute outlined in the Review of Current Knowledge.

4.1 Early Explorations – Furniture Rehabilitation

As mentioned in the introduction, since Modernity, buildings have been increasingly viewed as products, so I decided as a starting point it would be interesting to test ideas applicable to architecture on furniture. Many architects are famous for experimenting with furniture, Mies van der Rohe, Frank Lloyd Wright, Le Corbusier, Frank Gehry and Zaha Hadid, to name but a few.

The explorations included the rehabilitation of a set of discarded drawers, and two computer desk chairs. (See Appendix C for detailed descriptions from each experiment) The process of rehabilitation involved *disassembly, removal of components, stripping of surfaces, repairing and crafting*, all of which are affiliated with the process of reusing an existing building.

I found the rehabilitation of discarded furniture a useful way of engaging with ‘the existing’, experimenting with form, understanding materials and finishes, and detailing at a 1:1 scale. Many lessons were learned from these explorations, but the three major conclusions drawn are as follows:

- Additions/alterations seem most fitting when applied in a manner that considers the proportions and scale of the existing, without copying, or pretending to be it.
- Exposed and expressed fixings provide the user with an understanding of furniture's assembly, making it easier to maintain and fix than when they are concealed.
- Furniture can become valuable through the expression of time, iteration and intervention. The passage of time is most clearly illustrated when alterations, patina and wear are evident. This also involves *selective* maintenance.



Figure 13 – Found desk chair before rehabilitation (left)



Figure 14 – Chair after rehabilitation (right)



Figure 15 – Drawers found in inorganics before rehabilitation (left)



Figure 16 – Drawers after rehabilitation (right)

4.2 Ecosystems are attuned to and dependant on local conditions

In order to develop a design proposal that embraces ‘the local’, many site investigations took place over a variety of scales. These studies are the foundation upon which the building’s programme and design are formed and have influenced the choice of functions combined in the site, and many of the materials used in the design. These take the form of Urban and Site Scans, and Harvest Mapping.

4.2.1 Urban Scan

Urban scanning involved looking at the Kingsland area for information to develop a building programme and aesthetic consistent with the identity of Kingsland. This was executed by analysing the existing buildings, their uses and the people living in the area. (Refer to Appendix for these studies)

Kingsland is sandwiched between two semi-industrial areas, Morningside and Eden Terrace, and hence contains a mix of industrial, commercial and residential buildings. Its main set of shops on New North Road consists of a number of different

buildings of different eras, styles, colours and proportions that contribute to its eclectic “vibe”. Over half of these buildings were built between 1890 and 1950 and very few new buildings have been built in the last thirty years. Many have instead been subject to a change in function, including an old service station now occupied by Handmade Burgers, Mac’s Neighbourhood Bar, which was previously a mechanics workshop, and the AW Page General Store buildings, which are now mixed retail, bars and cafés.

The people living and working in Kingsland form its creative culture, as is evident in the twenty art and design-oriented businesses present, many of whose owners live locally. These businesses include architects, graphic designers, jewellery designers and fashion retailers to name just a few. Despite this creative culture, Kingsland seems to lack a formal gallery space for designers and artists to display and sell their work.

Karangahape Road is widely known as an area that “embraces the diversity of individuals, cultures and communities”⁹⁸ and “encourages freedom of expression.”⁹⁹ Kingsland is perhaps the

98 Karangahape Road Business Association, *Our Values*, 2000, <http://www.roadworks.co.nz/kroad/values/default.asp> (accessed 04 16, 2009).

99 Ibid.

‘younger brother’ of K Road, sharing similar values installed by its creative community and should aim to retain and develop these values. Development should refrain from ‘sterilising’ the street and glossing over the area, as this would mean a significant loss in its existing character. Rather than standardisation and uniformity, diversity and eclecticism should be encouraged in future developments.

After spending considerable time in Kingsland, it was noted that there were few spaces for public use in close proximity to the heart of Kingsland, the only two being the local church and a small urban space situated between the AW Page Building and Old Windsor Dairy Building.



Figure 17 – View along railway line showing graffiti on weathered warehouse building (top left)

Figure 18 – View of 1930’s Art Deco building showing its weathered nature (top right)

Figure 19 – Wall on New North Road used for posting bills (bottom left)

Figure 20 – Bridge displaying the gritty nature of Kingsland (bottom right)

4.2.2 Site Scan

Site scanning involved gaining an in-depth understanding of the site's history, construction and workings to inform future design decisions. This entailed many site visits and the sourcing and understanding of building and service drawings.

The site contains some immensely unusual and tectonically striking features, most of which could be useful in the new construction. Some of these key parts included the concrete isolator columns, concrete transformer bays, steel tracks within the building, switchgear lockers, the network of service tunnels within the site and the decommissioned sprinkler system.

These were identified as some of the things that contained history and made the site distinctive in Kingsland, other than the buildings themselves. These components should therefore play a part in the redevelopment by being reused and integrated as useful components of the proposed construction, as well as acting as relics of its previous use. I therefore approached the building with the following propositions:

1. Remove as little as possible to minimise the creation of waste and retain site history.
2. When parts are removed, try to reinvest them elsewhere on site rather than let them enter the waste stream.

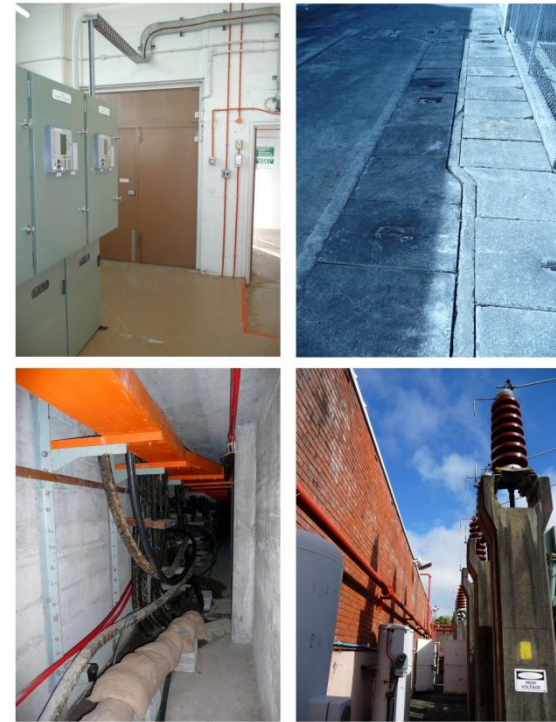


Figure 21 – Showing Switchgear housing (top left)

Figure 22 – Shows removable concrete panels for service trench access (top right)

Figure 23 – View Inside service trench below 1960's building (bottom left)

Figure 24 –View of concrete structures supporting isolators (bottom right)

4.2.3 Harvest Mapping

A harvest map was conducted to locate locally found surplus and second hand materials that could be reused and inform the proposed development. Materials include those removed from the buildings on the substation site, those found from three local demolition sites, and surplus and dead stock materials found in some retailers shops.

This process involved much communication with local businesses about their common waste or surplus products. In a number of cases managers were reluctant to describe what these were and how they dispose of them. This suggested their waste management strategies might have been insufficient or non-existent and restricted sourcing materials somewhat.

Construction materials are sourced from within the substation site, from three demolition sites that Ward Demolition worked on and two semi-industrial areas.

Kingsland Substation - 0 Km from site

Although a large percentage of the original buildings are kept intact, some materials are sourced from within the site when freed up by the proposed alterations. These materials include, crushed

concrete, brick, profiled sheet aluminium and the steel switch-gear housing.

Eden Park South Stand – 0.4Km from site

Eden Park, Auckland’s major sports ground has been undergoing renovation to accommodate the 2011 Rugby World Cup, including a new three tier south stand. The site has generated a large amount of waste material during the demolition process, mainly in the form of concrete rubble and steel.

New North Road Shell Station – 2.1Km from site

The New North Road Shell Station was upgraded late 2009 and consequently the canopy was upgraded. The canopy’s structure could have been salvaged to use in the design.

Independent Prestige Car Yard – 0.9Km from site

Long span steel structure and five roller doors.

Generic waste materials were found at a range of sources within the semi-industrial areas Eden Terrace and Morningside. These materials include varying transport pallets, industrial liquid containers and scrap timber.

Kingsland Harvest Map



Figure 25 – Harvest Map of Kingsland mapping potential construction materials

4.3 Ecosystems are diverse in components, relationships and information

4.3.1 Programme

The site is split to accommodate a dominant programme with smaller sub programmes in close proximity, in order for relationships to develop. To further integrate the idea of a building in a state of flux, it seemed appropriate that the building's occupation might also be in flux, constantly changing. This is achieved by choosing a dominant function which encourages a high turnover in occupants, providing both daytime and evening functions and inclusion of public amenities to ensure public interaction.

Dominant Programme – Wasted Opportunities

As a result of the Urban Scan, the following conclusions were drawn:

- Kingsland has a number of designers and artists living and working in the local area.
- There is a strong industrial presence.
- There is an existing material reuse culture
- There is locally available waste, surplus and second-hand goods.

Based on these factors, it was identified that the site would suit a mixed-use space that promotes product and material reuse through creative activities. The site would become a 'Creative Quarter' named Wasted Opportunities that incubates New Zealand artists and designers, while encouraging them to reuse materials in their work to reduce local waste. 'Wasted Opportunities' would consist of the following features:

- Subsidised studio and workshop space for artists and designers who use discarded, second-hand and waste products in their work.

- Provision for two designer/artist-in-residence positions to encourage the passing down of knowledge from those more experienced to the facility's users.
- A separate studio space to host evening classes for the public to help spread knowledge and skills within the community.
- Retail gallery and exhibition space for users to promote and sell their work to the public.
- A café opening onto the laneway to draw the public to the facility and aid the activation of the space.

The facility would be council subsidized with additional funding provided by the Zero Waste New Zealand Trust¹⁰⁰. It would be modelled similarly to Toi Poneke, a facility in Wellington that offers low rent studios to developing young artists. Toi Poneke gives each user three years access before they are expected to move on, making way for new applicants.

Wasted Opportunities' users would explore the integration of waste in art and design in a variety of fields and scales, including

¹⁰⁰ The Zero Waste New Zealand Trust is a funding, advocacy, support and information group fostering community development projects for minimising waste.

architecture, product and object design, furniture design, fashion design and jewellery design. The low or free rent space that it offers would become an attractive incentive for people to work with waste materials. With both young artists and designers changing triennially a flux of occupants is ensured, keeping the facility fresh, and work in the retail gallery changing.

The 'Creative Quarters' and adaptive re-use ideology work hand in hand, as many artists colonies and designers studios are started in industrial buildings due to the low cost, the spaces that these buildings provide and the freedom to alter them to suit their needs. The building reuse would help lower the start up costs of the facility and provide a unique and inspirational environment for its users.

Sub-Programme

The substation remains active on the site but has been relocated to the south-eastern side of the site and lifted off ground level to free up the more prominent street facing buildings for retail and public activities.

4.3.2 Relationships Established

The chosen programmes form mutually beneficial relationships with one another and the wider community.

During site visits it was noted that the transformers give off large amounts of waste heat during use. This waste heat could be captured using a heat exchanger, transferred to water, and pumped to the studio, workshop, café and gallery. Return pipes would see cool water return to cool the transformers, where it is reheated again in a cyclic process. The existing decommissioned sprinkler system that spreads across the site could be used to transfer this hot water, with additional pipes added to service each heating zone.

Non-hazardous surplus, broken and waste goods or materials are supplied by industry and the community which are then used by the studio and workshop occupants to create, or recreate new products for display and sale in the retail gallery. These, in turn, are bought by residents and others shopping in the Kingsland area.

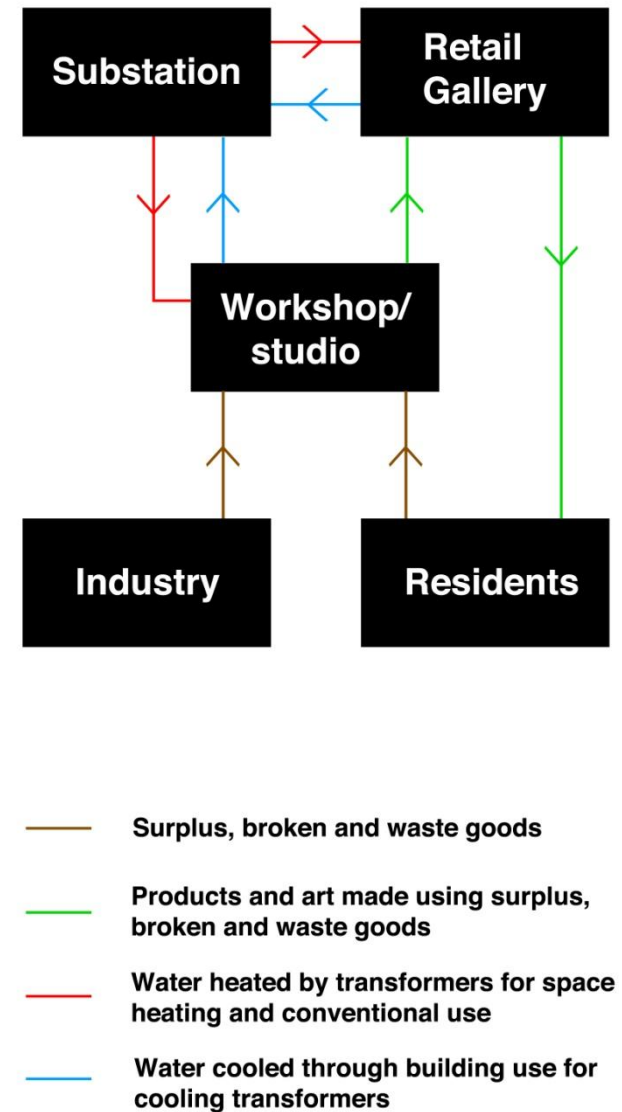


Figure 26 – Relationship diagram of functions on site

4.4 Key Design Issues Addressed

4.4.1 Site Permeability

The substation's site and buildings are of historical importance as well as of functional value, but the site is occupied inefficiently and arguably requires redevelopment. Such a site deserves to be more publicly accessible, which in turn would make it better integrated with the rest of Kingsland and encourage further development off the shopping precinct on New North Road.

By opening the gates off Central Road, removing parts of the fence on Kingsland Terrace and making use of an existing service lane from New North Road the site becomes considerably more permeable, allowing access to the pedestrianised laneway running through the site. The three points of entry make their intersection a destination rather than just a linear journey with beginning and end, encouraging one to stop. The proposed café is conveniently placed at this intersection to receive patrons.

In order to 'activate' this laneway the most 'public friendly' programmes line one side of the laneway while the studio on the opposite side will have a combination of display windows for its users to display work and for pedestrians to observe people at work. As a general rule access to all buildings on the site is encouraged off this laneway.

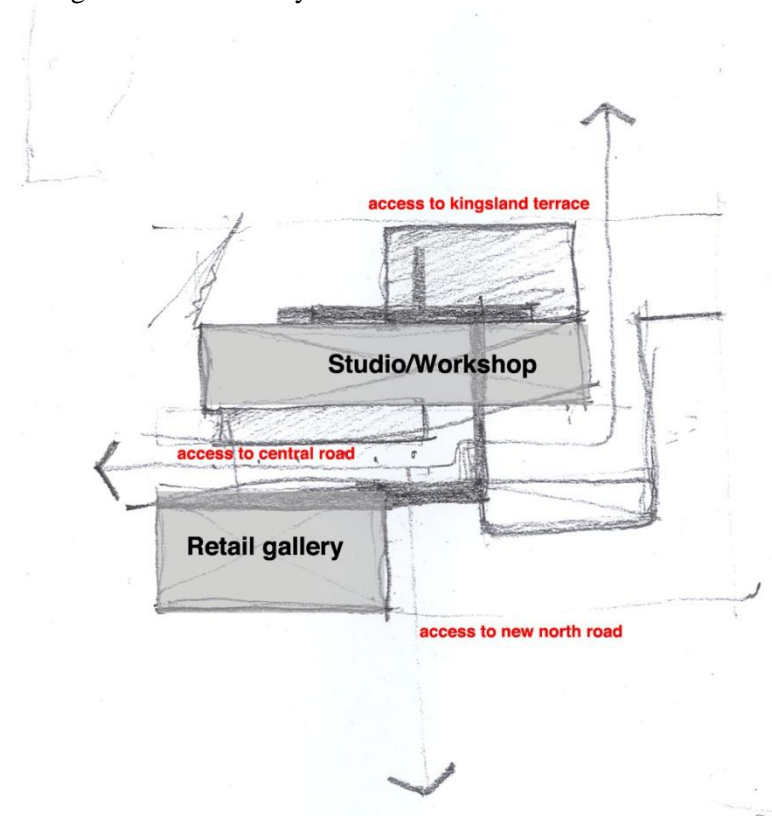


Figure 27 – Drawing showing three points of access to internal laneway

4.4.1 Massing

The massing of the proposed site additions is determined by three factors: the free space on the site, the structures that are being reused and light. Parts of the site were identified where development could occur. These included in, and above, the transformer bays, on top of the 1930's buildings and part of the 1960's building, and in an empty section on the north eastern side of the site. Additions their massing was explored through sketch and modeling.

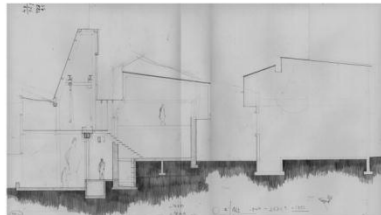


Figure 27 – Explorations of massing in section

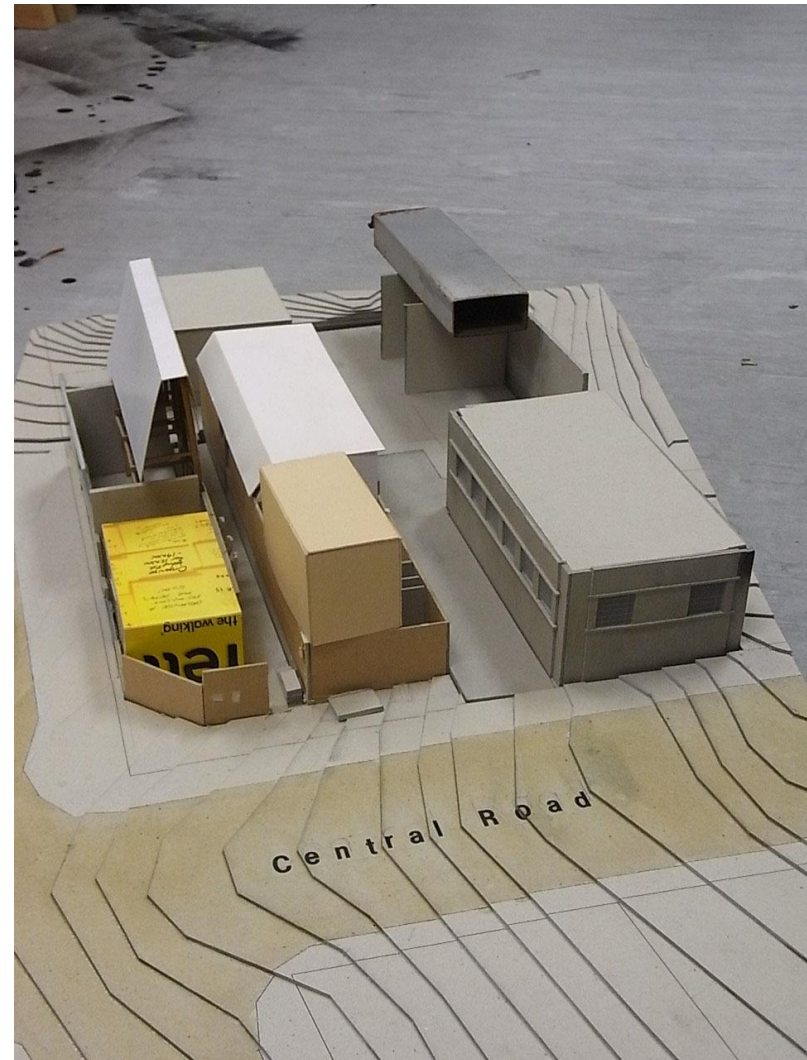


Figure 28 – Exploration of massing using working model

4.4.2 Planning

The layout of spaces is largely determined by the placement of the loading zone, where materials will arrive at the site. This is placed on Kingsland Terrace due to its reduced traffic, and includes off-street parking for delivery trucks. Workshops and material storage are all clustered around this area, including inside the 1960's building, and ex-transformer bays, to minimise manual transport distances of materials to workshops.

Studio space is provided on the ground and proposed first floor of the 1960's building at the front of the site to separate it from the workshops.

The retail gallery is positioned inside the 1930's Art Deco building. This is positioned strategically as a 'lure' to provide interest and draw people off Central Road and onto the site. Placing the gallery's entry on the lane, rather than on central road further encourages this. The space is also ideal as a gallery due to its high ceilings and quality of light. Parts of the substation's switchgear housing from within this building is kept and modified to become display cabinets.

Lifting the transformers onto platforms above ground would permit parts of the site to be used publicly and would allow the workings of the substation to be displayed safely.



Figure 29 – Proposed Ground Floor Planning (Not to scale)

4.5 Ecosystems optimise the system rather than its components

The materials found and documented in the Harvest Map become ‘food’ for the growth and development of Wasted Opportunities, informing its design. Detailed descriptions of the properties and integration of some of these materials are addressed in this section. Their applications were informed not only by their material qualities as described below, but also through the recognition of particular needs as the planning and massing evolved.

4.5.1 Street signs

Road signs are commonly made from 3mm sheet aluminium with two layers of PVC vinyl coating, one the reflective background and the other the graphic of the sign. According to RTL, a road sign supplier in New Zealand, the average road sign has a typical lifespan of between ten to fifteen years. This is determined purely by the reflectivity of the vinyl, which diminishes with age. The reflectivity is often reduced through the surface being scratched due to removal of tagging with abrasive cleaners and rough handling. Road safety signs are legally required to reflect a certain

amount of light, and are tested and replaced by sign maintenance crews.

Although the aluminium body is a highly recyclable material, road sign recycling is complicated due to the vinyl layers, which are difficult to remove. A definitive answer from Directionz regarding their method of disposal could not be attained, but it was made clear they are available for purchase through donation.

Old road signs make an interesting building material, as the aluminium sheet is an extremely durable material, yet is easily cut and bent. Despite having diminished reflective qualities, most signs are still very reflective in the presence of direct light. To take advantage of these characteristics the signs are cut into quarters, bent on the diagonal and pop riveted back to a galvanised steel frame to create an inventive screen that filters sunlight into the room behind. Positioned above the 1960’s building on Central Road façade; the screen doubles as a ‘beacon’, drawing people from the main shopping precinct down Central Road.

Road signs are usually placed perpendicular to the street in order to receive light emitted from passing car's headlights. Used as sunscreen on the building they sit roughly parallel to the street, but by bending them they are brought back to an angle where they will receive varying grades of car headlights and be lit up. The back faces of each piece of sign are painted out white to allow light to be reflected back into the building. In cut and bent sections, the signs and their graphic become abstracted.



Figure 30 – Photograph of road working sign (left)



Figure 31 – Three explorations using road signs as a screening material (right)

4.5.2 Rackable Plastic Shipping Pallets

Rackable plastic pallets are used for transporting goods nationally and internationally and can be slotted directly into a rack with no need for shelving. They come in varying shapes and sizes but generally have at least two common dimensions, the depth 145mm and the width 1,200mm. Plastic pallets are made of a range of plastics, but most commonly polypropylene. The lifespan of each pallet varies depending on pallet type and use, but averages at around seven years.¹⁰¹ The plastics pallets are susceptible to UV degradation, over time becoming brittle and breaking under the load applied to them for shipping purposes. Once damaged, they are left unused in stockpiles. Although they are considered recyclable, the Plastic Pallet Company would not give a definitive answer regarding whether the pallets actually are recycled or not, but confirmed that they are not recycled in New Zealand at all.

Rackable pallets are strong and lightweight due to their intricate structural patterns that reduce the amount of material needed to manufacture them. The pattern is repeated, slightly offset, on parts of the lower half of the pallet to reduce buckling when racked.

101 The Plastic Pallet Company, *Home: The Plastic Pallet Company*, <http://www.plasticpallet.co.nz/> (accessed 07 11, 2009).

This offset pattern makes these pallets ideal for screens, as it permits pockets of direct light as well as reflected light. The pallets in the screen have been arranged in a ‘saw-tooth’ pattern in plan and have been detailed in such a way that the pallets slot vertically in between a ‘c’ section channel at their top and bottom. This allows the easy removal and replacement of the pallets as need be, as well as relieving the pallets of any load that might cause further damage.



Figure 32 – Pallet used as a screen in flat bedroom (left)

Figure 33 – Perspective of proposed ‘saw tooth’ pallet screen (right)

Figure 34 – Photo of rackable plastic pallet (bottom right)

4.5.3 Toughened glass panes

Stacks of dead stock toughened glass had been stored at Sauvarins Glass in Kingsland for five years due to an over order of product. As the glass is toughened it cannot be recut otherwise it will shatter, and so had been kept as replacement panes. The glass is of varying size and tint. There were also a number of reject glass shower doors that have been stored behind other stock. The use of this glass in the design requires designing around its dimensions.

4.5.4 Eden Park South Stand Structure.

Large raking steel If the South stand of Eden Park was dismantled rather than demolished, the raking steel sections that supported the terraced seating would have been recoverable and capable of being used in a new construction.

Five of the eight steel sections are used in the proposed design. They are used in their existing form flipped on end, creating a tall, tapering portal frame. The steel sections are kept in their existing shape to reduce the cutting and required to reuse them, and to better conserve their form and associated history. Flanges that held the concrete terraces in place would need to be removed. The structure

houses a studio/workshop with two levels. A section cut from the first floor creates an unobstructed nine metre void allowing tall sculptures to be made in an enclosed environment. A gantry crane services the space, bringing heavy materials in and allowing the removal of a finished sculpture. It also helps justify the use of the 290mm deep steel sections from the south stand, that otherwise would not have been required for a structure of that size.

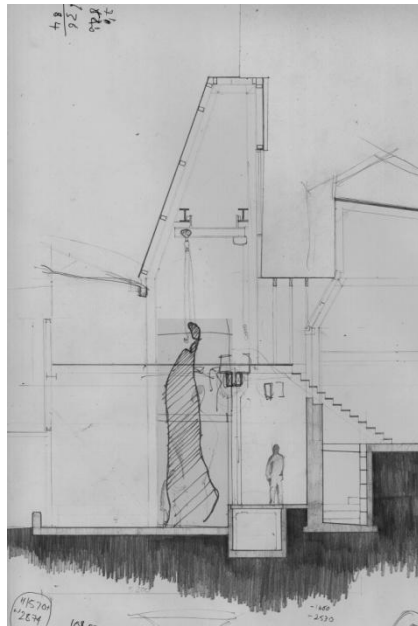


Figure 35 – Section showing the South Stand structure reuse (left)



Figure 36– Photo showing the south stand structure (right)

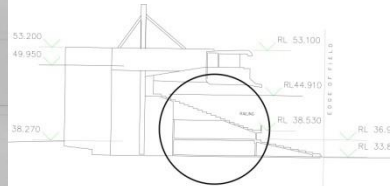


Figure 37 – Drawing showing previous location of south stand structure. (bottom right)

4.5.5 Shell Petrol Station Canopy

The old canopy was originally bolted to the ground making it easy to recover and reuse in a new construction. Service station canopies are an interesting structure, as they usually cantilever a great distance with minimal structure to free the ground plane and allow easy car access. This canopy will be reused as the primary structure for a workshop on the north-eastern corner of the site

4.5.1 Concrete rubble

Concrete rubble, if reused, is typically down-cycled as hard fill. Overseas, in places where aggregates are scarce, it is crushed and the aggregates are extracted and reused in new concrete. This practice is gaining popularity in Auckland as virgin aggregates are sourced further afield and their cost increases,¹⁰² but their use is currently limited to use in footpaths and driveways due to their quality. To extract the aggregates concrete typically requires processing off-site.

102 John B. Storey, Morten Gjerde, Andrew Charleson and Maibritt Pedersen Zari, *The state of deconstruction in New Zealand*, Centre of Building Performance Research, Victoria University Wellington (Wellington). 32

Concrete rubble is possibly more useful crushed on site with a mobile crusher and used as fill in gabions, rather than using quarried stone. This would reduce transport and processing, and their associated energy and monetary costs.

4.6 Ecosystems adapt and evolve at different levels and at different rates

The site has undergone considerable evolution during its time as a substation. This evolution continues with the integration of Wasted Opportunities ‘Creative Quarter,’ in two stages.

The structure in the 1930’s Art Deco building was identified as possible of carrying another level provided it was of light construction. This additional level added to the existing art deco building would allow the gallery to cater for larger exhibitions and small lectures.

It also sees an additional level added on top of the proposed classroom space to provide additional studio space. For this reason the classroom space proposed in the first stage will be over-structured to allow for the future load of the floor above.

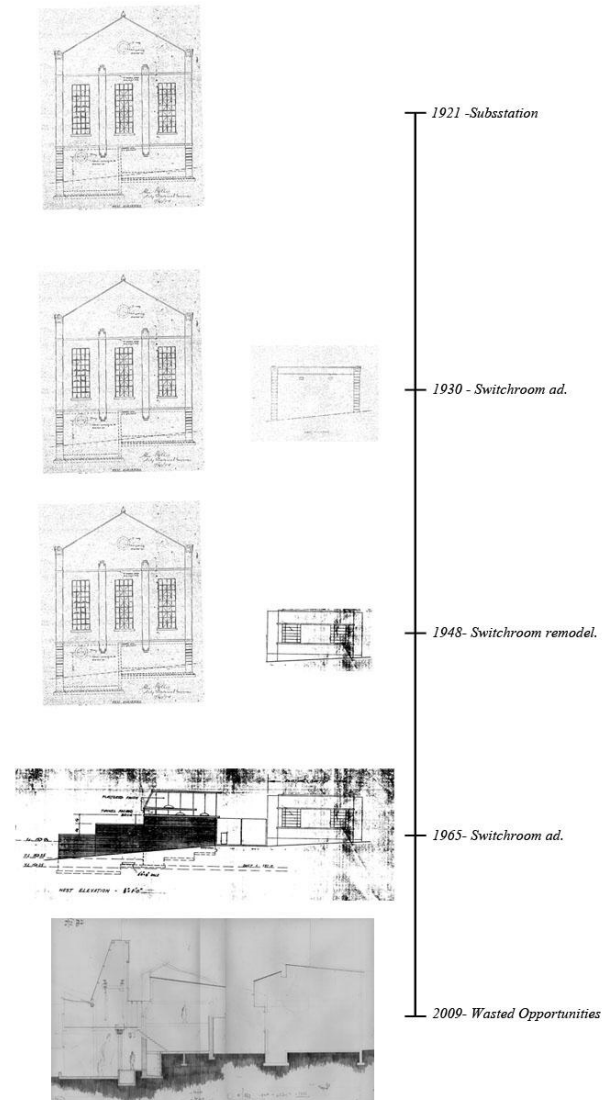


Figure 38 – Diagram showing site evolution

5 Conclusion

As stated in the Introduction, the area of studies significantly shifted over the duration of the project from what was originally defined and, as a result, the scope of research broadened considerably. The shift from the topic of adaptive reuse to the wider topic of Ecosystem Biomimicry expanded my research to encompass pattern-finding and establishing connections between the natural and the built environments. This positioned adaptive reuse as just one of many collated strategies that encourages the prolonging of buildings and their components.

Together, the strategies consider the building's whole life cycle: from what they are made out of, how they are made, how they are maintained, and what happens to them when they cease to work. They not only encourage buildings to be resilient, but also their materials and components through reuse rather than recycling.

They are by no means a perfect translation of a biological ecosystem's workings, but can be used as a starting point for architects to apply similar principles in their designs using existing

building practices. Applying the fundamentals of an ecosystem to architecture to develop more resilient constructions may only mean the resulting building is *capable* of being more resilient, as ultimately support for this will need to come from society as the users of buildings. We need to change our concern for the short term and start looking at the long term.

The application of these strategies to the existing electricity substation in Kingsland required working with 'the existing' and, hence, posed constraints on the design. These constraints, including the site's existing buildings and the locally sourced demolition and waste materials, have largely directed the design. The relationships that exist on site between the studios and workshops, the substation and the art gallery reinforce and mutually benefit each other, and have the potential to make further connections within the neighbourhood. This is especially the case regarding heated water produced by the substation, as during summer periods when space heating is not required there would be surplus that could be used by local businesses or residents.

The 'Wasted Opportunities' programme responds to the growing number of designers and artists who utilise waste or surplus materials in their work. They epitomise the term 'Waste is food', reinstating value in products through craft and clever thinking.

They see potential in what others would not think twice about discarding. The programme and aesthetic developed are particularly fitting in Kingsland as a result of the extensive research and time spent in the area. Together they display a clear understanding of Kingsland and its community, and provide future direction for the suburb to develop its identity of a creative and diverse community further.

There are many limitations involved in the application of the strategies outlined in the research. These include conflicts existing between strategies, the sourcing of second-hand and waste materials and their performance in a building.

Conflicts can occur when applying two or more of the outlined strategies to a design, as found in my own application of the theory. Design-for-disassembly, for example, encourages a building's parts to be reused or recycled at the end of its useful life, but this could be considered as advocating the unnecessary removal and replacement of a building, as opposed to its conservation. As a consequence, all of the strategies may not necessarily be employed in a single building, rather a selection of them. It is for this reason the outlined strategies can be seen as 'guides,' rather than 'rules.'

The sourcing of second-hand and waste materials through harvest mapping is a difficult and time-consuming process. The Underground Food Economy¹⁰³ is a local online resource where users locate fruit and nut trees on a Google Map that have unused produce going to waste. This allows locals to find free produce in their neighbourhoods and make use of it. Perhaps this idea could be developed to include a product and materials sector, which would make the sourcing of materials significantly faster. It would require local businesses to be transparent about what wastes they are producing, and would allow others to utilise these wastes as a resource.

The reuse of second-hand and alternative building materials will never completely replace the use of 'new' or 'virgin' materials, but still should pervade our building designs. Their use should be encouraged and supported in conjunction with new materials, as an approach to sustainable design. Government subsidies offered to those designing with such materials would help lower costs associated in testing and proving the material's performance in construction, as required by our performance based building regulatory system.

¹⁰³ <http://maps.google.co.nz/maps/ms?hl=en&ie=UTF8&oe=UTF8&msa=0&msid=105452119347441306027.00046e04e65dedbbc7079>

Future possible areas of research could include further investigation into the reuse of waste materials and their possible applications in a building. Their performance could be tested in a prototype building in order to ascertain whether the specific selection of materials indeed make useful building materials.

The concept of the 'Industrial Ecosystem,' as mentioned in the Current Review of Knowledge, has much potential to be developed through the research of different industrial processes, their resulting wastes, and their useful application as raw material or energy for another production process. This would require cooperation with industry to gain an in-depth understanding of their processes and resulting wastes, and matching this waste to another process in order to establish a food web similar to in ecology.

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7 Appendix



7.1 Appendix A : Declaration

Name of candidate: BRAD BALLE

This Research Project (Design and Explanatory Document)
entitled:

**Wasted Opportunities - *Developing resiliency in
architecture through ecosystem Biomimicry***

is submitted in partial fulfilment for the requirements for the Unitec
degree of

Master of Architecture (Professional)

CANDIDATE'S DECLARATION

I confirm that:

- This Research Project represents my own work;
- The contribution of supervisors and others to this work was consistent with the Unitec Regulations and Policies.
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

Research Ethics Committee Approval Number:

Candidate Signature:

.....Date: 21/05/10

Student number: 1220111

7.2 Appendix B - Precedents

As a part of initial research, a number of precedents were chosen that displayed varying qualities similar to those found in ecosystems. These include the reuse of materials to create new construction, local sourcing of these materials, incremental development and designing for demolition.

1. Informal Settlements (Squatter housing)

Various Locations

Informal settlements are of great interest to me. Despite the generally crude nature of their construction and lack of services, I believe they readily display ingenuity, creativity and sustainable methods of construction.

These minimum cost shelters are commonly designed and built by their owners, which is important as it means they are suited to each family's needs, as opposed to the generic housing that informal settlements are often replaced with. They are typically constructed with whatever is at hand including second-hand construction

materials and waste materials including flattened oil drums, kerosene cans, vehicle tyres, sacking and plastic sheeting.¹⁰⁴

Their makers can be seen as the saprophytes of our society, building with the discarded purely because that is what is locally available to them.¹⁰⁵ It also means that these products end up used in a situation where their lifespan is greatly extended.

Due to the relative value of some of the materials, and the construction methods used, the shelters are often disassembled when no longer required. Materials are then reclaimed, sold and reused in a new construction. They are also commonly built in increments; added to when extra space is required for growing families.¹⁰⁶

I believe the inconsistent standard of the craftsmanship of informal settlements, their ad hoc aesthetic and what they stand for is

104 Paul Oliver, *Built to Meet Needs - Cultural Issues in Vernacular Architecture* (Jordan Hill, Oxford: Elsevier, 2006). 365

105 Gerald Gordon, *The Transformation of Informal Housing into Permanent Sustainable Settlement*, Breaking New Ground In Housing Delivery, Human Settlements, Republic of South Africa,

<http://www.housing.gov.za/content/Research/2004%20Seminar/Seminar%20Presentations/43%20Gordon.pdf> (accessed 04 27, 2010). 3

106 Ibid. 1

commonly what makes them disliked among cities. However, by applying similar techniques of material sourcing and construction as outlined above to contemporary architecture, perhaps a balance can be found, where both the process and product are seen to be positive.



Figure 39 – Rio de Janeiro Favela, an example of informal settlements

2. Tate Modern

London, England

Herzog & de Meuron, 2000-2012

Tate Modern is Britain's national museum of modern and contemporary art. The museum itself was a redundant power station building in Bankside before its adaptive reuse in 2000. Herzog and de Meuron's strategy for the reuse of the power station included leaving much of it intact to retain the character of the original building. The major additions to the building are in the form of glazed boxes acting sources of natural light into exhibit space.¹⁰⁷ A second stage due to be completed in 2012 will see a contemporary truncated building added, providing a greater variety of exhibition of spaces for a range of scales and media.

In both stages spaces characterised by the building's previous use become features of its redesign. The two prime examples are the Turbine Hall, which has become the gallery's entrance and an exhibition space for larger works, and the proposed adaptation of large underground oil tanks as exhibition space. The architects obviously acknowledged that little needed to be done to turn parts

107 John Perrin, *Tate Modern*, 2002,

<http://www.galinsky.com/buildings/tatmodern/index.htm> (accessed 05 05, 2010).

of the building into unconventional, yet unique, exhibition spaces that do not seem to detract from the artwork.

Interestingly, a part of the power station is still operational on site and will be further reduced in size by modernising equipment, freeing up space for Tate Modern's second stage of development. As part of this second stage waste heat will be harvested from the power station transformers for use in the museum.¹⁰⁸ This coexistence and interrelation of two very different functions within the same site is a successful precedent for my proposed substation redevelopment.



Figure 40 – Tate Modern exterior

Figure 41 – Tate Modern's turbine hall exhibition space

108 Tate, Transforming Tate Modern,
<http://www.tate.org.uk/modern/transformingtm/vision.htm> (accessed 11 13, 2009).

3. Villa Welpeloo

Enschede, The Netherlands

2012 Architecten, 2010

Villa Welpeloo is a house that has been designed and constructed with over seventy percent reused waste and demolition materials¹⁰⁹, on a site previously devastated by a fireworks explosion in 2000. The materials were sourced locally and include steel sections of a dismantled textile machine used as the structure of the house, the inner boards of timber cable reels as cladding and glass off-cuts as glazing.

The house serves as evidence that it is possible to build a functioning contemporary building with reused materials and components as fundamental parts of design, rather than just tacked on surfaces.

109 Cesare Peeren, *First 70 % reused villa*, 2007,
<http://www.superuse.org/story.php?title=first-70-reused-villa> (accessed 06 03, 2009).

4. RDF181 Headquarters

Brussels, Belgium

Rotor, 2007

RDF 181 was a temporary headquarters of the design group ROTOR, constructed on an empty site in Brussels. The headquarters was constructed in and around the concrete buttressing of a neighbouring set of apartments, using a temporary, reusable structure and industrial waste products. These products include adhesive tape deemed unfit for sale as a transparent cladding, off-cuts of EVA-foam as insulation and scrap timber as a flooring material.¹¹⁰ It was also designed with disassembly in mind, which affected the choice of construction and material choices including the use of scaffold as a primary structure.

The RDF181 headquarters is not only a great example of waste material reuse, but also an interesting example of an attached construction integrated well with an existing building. Instead of the buttressing being hidden between walls, it is exposed and become an expressive feature of the space.



Figure 42 – Exterior view of RDF181 Headquarters

Figure 43 – Interior view of RDF181 Headquarters showing concrete buttressing penetrating space

110 Maarte Gielen, *RDF1 Press Release*, RDF181, 2008, <http://www.rdf181.be/rdf181-press.pdf> (accessed 04 25, 2010).

5. Mason's Bend Community Centre

Hale County, Alabama, USA

Rural Studio, 2000

Mason's Bend Community Centre is an open-air pavilion located in Alabama's second poorest county. It was designed and constructed by students of Auburn University to serve a number of purposes, including holding church services and hosting book and health mobiles.

The pavilion is constructed using materials sourced within the community, including rammed earth for walls, laminated timber trusses made from locally grown timber and eighty scrapped Chevy Caprice car windshields.¹¹¹

The chapel is a considered and well-crafted contemporary building. The unusual materials such as the windscreens have been cleverly integrated into the building and become its most defining feature.

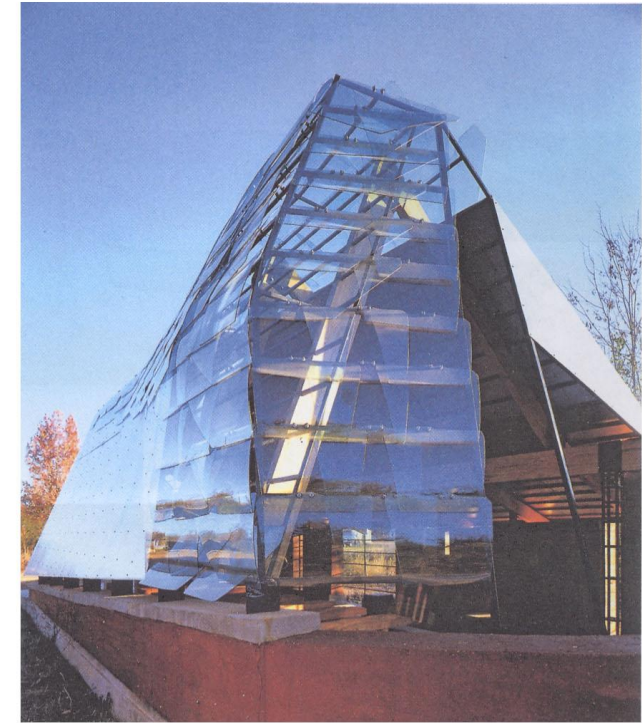


Figure 44 – Multiple views of Mason's Bend Community Centre

111 Andrea Oppenheimer, *Rural Studio - Samuel Mockbee and an Architecture of Decency* (New York: Princeton Architectural Press, 2002). 49-50

6. Athfield House

Wellington, New Zealand

Ian Athfield, 1965 - ?

Ian Athfield's own house in Wellington, Khandallah is of interest due to the nature of its construction and use. It is a building that is added to and adapted iteratively to host a diverse range of functions. The construction of Athfield's house began in 1965 and construction continues to date, with 'Ath' claiming "it will never be finished".¹¹²

This continuing 'work in progress' is essentially a collation of multi-levelled concrete block forms, varying in shape and size, all linked together and finished in uniform white plaster. It is more than just a house; it is a collective of a number of interconnecting flats, office spaces, an observation tower, and at one point in time, a café. Athfield believes, "it's an appropriate response to how suburbia has to change. You actually have to build on the accidents

of the past, on the physical environments which got created because something happened".¹¹³

112 Tony Van Raat, *Gold Medallist: Ian Athfield, Architecture New Zealand*, May/June 2004, 81-90.

113 Ibid.

7. Skybox

Wellington, New Zealand

Melling:Morse Architects, 2000

The Skybox is a four-storied single apartment in Wellington that straddles a commercial building below, with its steel legs transferring its load over the building beneath it to the ground. The Skybox is the consequence of a number of changes to Wellington's City Plan in the early 1990's, including a new district plan permitting development in the air space above most buildings to a datum height, as well as encouraging multiple uses of buildings and site.¹¹⁴ Other examples of 'Rooftop Constructions' in New Zealand include Architecture Workshop's *Wakefield Street Apartments, Te Aro* (2001) and Archaus' *Galleria* (2001) to name a few.

Skybox forms part of an honest building typology that allows for successive development to occur on a site with minimal interference to the building below. As a consequence an intriguing strata of building layers develops on the site, similar to recorded stratum of rock and soil deposits found in nature. Rooftop constructions not only conserve, but aid development of diversity

within the streetscape, an attribute that gives monotonous streets character.



Figure 45 – Exterior view of Skybox straddling the building below

¹¹⁴ Gordon Holden and Morten Gjerde, *Urban Sustainability: Comparative Value of Building-Top Apartments*, 2007, <http://download.sue-mot.org/Conference-2007/Papers/Holden> (accessed 02 29, 2009).

7.1 Appendix C - Furniture Rehabilitation

7.1.1 Rehabilitation – Patched Drawers

A set of drawers was found on the roadside in a local inorganic collection. The drawers were badly damaged, missing their top, back and part of their front face. I felt by simply restoring the drawers to their original state, I would be diminishing their integrity and denying a critical moment in their life by concealing evidence of what made them redundant in the first place. Instead, the drawers were repaired using contemporary materials and methods. Leon Krier’s views on building restoration reinforce this belief:

Replacement of missing parts must integrate harmoniously with the whole, but at the same time must be distinguishable from the original so that the restoration does not falsify the artistic or historic evidence.¹¹⁵

Missing parts of the drawers were replaced with found plywood off-cuts that juxtapose the existing timber. The contrasting interventions pay respect to the original by reading as added

elements, whilst taking on some of proportions of the original and adding a contemporary edge. The additions wrap over the back, top and front faces flush with the sides of the existing drawers, but protrude over the top and left side of the drawer due to the thickness of the material. This detail helps ground the additions to their host with plywood patching previously damaged areas.



Figure 46 – Drawers before rehabilitation (left)

Figure 47 – Drawers after rehabilitation (right)

¹¹⁵ Leon Krier, *Architecture - Choice or Fate* (Berkshire: Andreas Papadakis, 1998). 75

Alterations to the existing top drawer were made to further help ground the addition and to alter its function somewhat. The drawer was cut in two, resulting in one large and one small drawer. The smaller of the two was painted black, and then both drawers were etched with a laser to remove paint, varnish and wood, revealing a scorched surface and a graphic on the smaller, painted drawer. A new finger hole was drilled into the smaller drawer and a piece of dowel was added to the interior acting as a rail to hold its contents. The placement of the dowel rail coincides with the placement of the graphic, protruding through the drawer's front face and becoming the eye of the etched character. The larger drawer was relined with plywood to alter use of the drawer and to continue the wrapped, contemporary surface back inside the drawer. It was lined in such a way that when pens are placed in it, they always roll to the front, allowing easy access. Clear acrylic was attached to cut face to stop the pens rolling out the side and to act as a window, revealing the junctions of the old drawers and the new plywood lining.



Figure 48 – Etched draw (left)



Figure 49 – Notched draw detail (right)

Figure 50 – Relined draw with Clear acrylic window



7.1.2 Rehabilitation – Naked Chair

A discarded Unitec computer chair was found next to a rubbish skip on campus with badly worn seat material, a loose backrest and missing a wheel. It interested me that these minor faults were inhibiting the chair's continued use and could have been easily fixed. Rather than just repair the chair, I decided to also simplify it. By removing parts of the chair that were likely to contribute to its future failure I was able to reduce it to its bare essentials, revealing its inner workings previously concealed by superficial layers of plastic, foam and fabric.

Once the torn fabric and foam were completely removed from the chair, the moulded plywood backrest and seat was revealed. Both were sanded clean using an angle grinder and the seat was further shaped to reflect the original moulded foam, increasing the chair's comfort and revealing the veneer layers in the plywood. This idea was carried through into the five-spoke base with a crafted, plywood replacement mimicking the profile of its plastic predecessor, with sanded curves that expose the veneer in a psychedelic pattern to match the seat and backrest.

Over 80 percent of the plastic on the chair was removed, including around the pneumatic shaft and the plastic shells that conceal all

fixings. In doing so I have liberated the chair of its superficial elements whilst exposing all fixings and working parts, giving the user an understanding of the chair's construction and an insight into how to fix it.



Figure 51 – Desk chair before rehabilitation



Figure 52 – Desk chair after rehabilitation

7.1.3 Architectural Application

The act of rehabilitation of something defunct using surplus contemporary materials in a respectful, crafted manner. This idea directly relates to the additions of buildings and exemplifies the manner in which they should be treated, respectful of the original without pretending to be original.

7.2 Appendix D

In order to establish whether Kingsland was the creative community it has been dubbed, I decided to collate and document all of the art, design and educational related businesses pre-existing in Kingsland. This evidence of an established creative presence in Kingsland is the foundation of my argument for the ‘*Wasted Opportunities*’ development.

Architecture Smith & Scully Ltd

61/6 Kingsland Terrace, Kingsland, Auckland,
PO Box 52204, Kingsland, Auckland,
Art and Design, Home and Garden

Bamboo8

www.bamboo8.com, Auckland
Art and Design, Clothing, Girls, Guys

About Frames

517 New North Road, Kingsland, Auckland
Art and Design

Adrian Nancekivell Design Ltd

6 Kingsland Terrace, Kingsland, Auckland
PO Box 52243, Kingsland, Auckland
Art and Design

BUGGYROBOT

54 King Street, Kingsland, Auckland
Art and Design

Connect the Dots

1/399 New North Road, Kingsland, Auckland
PO Box 8053, Symonds Street, Auckland
Art and Design, Community, Events, Media, Music, Office and
Business, Photography, Print and Publishing, Video/DVD

ConstableHurst Architects Ltd

6 Kingsland Terrace, Kingsland, Auckland
PO Box 52058, Kingsland, Auckland
Art and Design, Home and Garden, Real Estate

Creation House

10 Newton Road, Newton, Auckland
Art and Design, Office and Business, Print and Publishing

Creative Circle

361 New North Road, Kingsland, Auckland
Art and Design

Croydon Studios

326/h New North Road, Eden Terrace, Auckland
Art and Design, Jewellery, Media

Gaffer Glass

2 Collins Street, Morningside, Auckland
Art and Design, Real Estate, Technology, Trade

Glassarts

474 New North Road, Kingsland, Auckland
Po Box 52233, Kingsland, Auckland
Art and Design, Gifts, Home and Garden

MIXT Art and Design

502 New North Road, Kingsland
P.O.Box 56 276, Dominion Road, Mt Eden
Art and Design, Furniture, Gifts, Housewares, Jewellery

Atlantic Design

420 New North Road, Kingsland, Auckland
PO Box 101 365, North Shore Mail Centre, Auckland
Furniture, Home and Garden, Housewares

Sideroom.com

1/399 New North Rd, Kingsland, Auckland
Art and Design, Music, Photography, Print and Publishing

Spawn

361 New North Road, Kingsland, Auckland
PO Box 52 206, Kingsland, Auckland 1021
Art and Design, Media, Print and Publishing

Soar Printing

100 New North Road, Eden Terrace, Auckland
P O Box 8147, Symonds Street, Auckland 1150
Art and Design, Print and Publishing

Native Agent

507b New North Road, Kingsland, Auckland
PO Box 8302, Symonds Street, Auckland 1150
Art and Design, Clothing, Gifts, Jewellery

Peter Minturn Goldsmith School

353 New North Road, Eden Terrace, Auckland
PO Box 44014, Pt Chevalier, Auckland
Education, Jewellery

Raffles Design Institute

317 - 319 New North Road, Eden Terrace, Auckland
Art and Design, Education, Technology

7.3 Appendix E - Site Analysis

7.3.1 Heritage Analysis



Pre 1900	1940 -1950
1900 -1910	1950 -1960
1910 -1920	1960 -1970
1920 -1930	1970 -1980
1930 -1940	1980 -present

Kingsland Heritage Analysis

itage Analysis

7.3.2 Mapping of creative businesses, manufacturers and public spaces

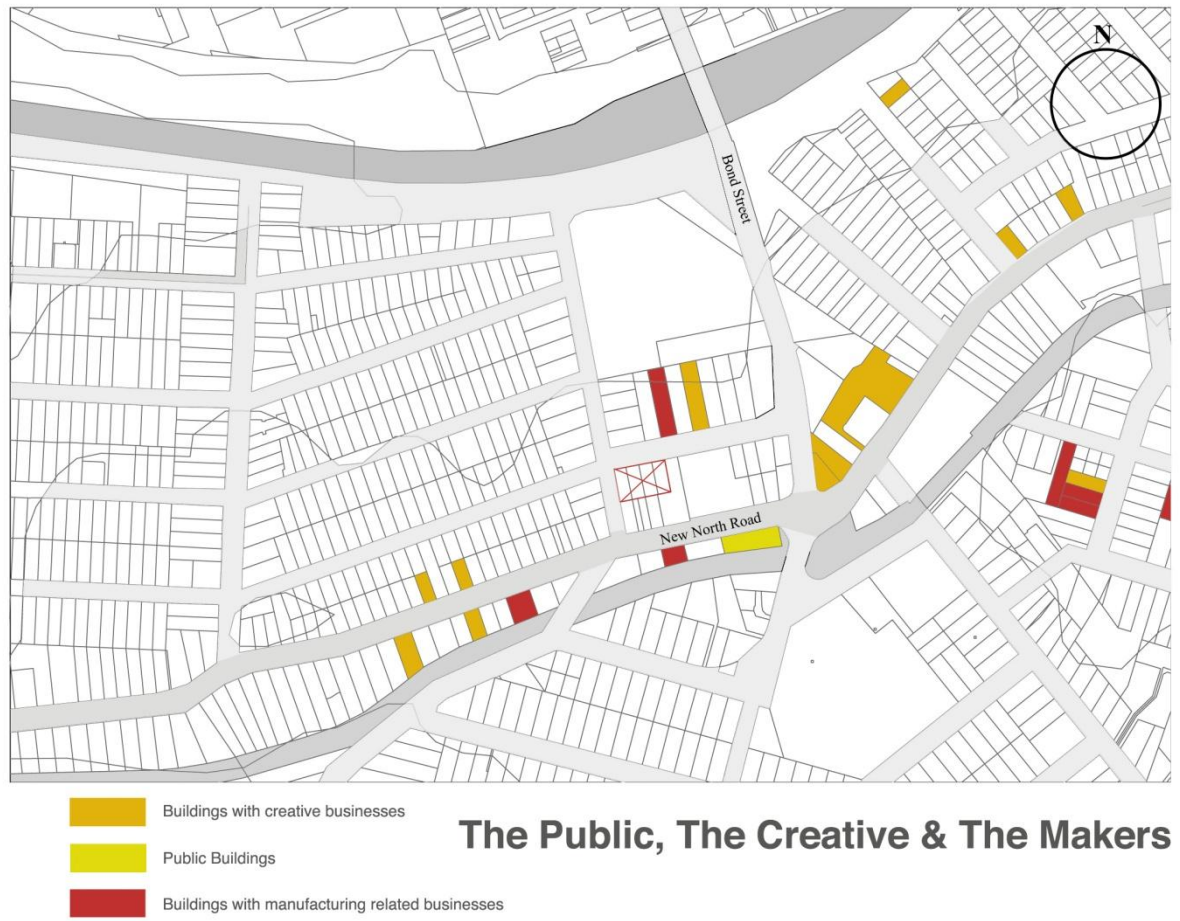


Figure 54 – Mapping of creative, businesses, manufacturers and public spaces in Kingsland

7.4 Appendix F – Finishes, Patinas and Weathering

Through analysing the Kingsland area it was acknowledged that age, and its resulting patinas and weathered surfaces, are a vital part of the identity of Kingsland. A series of experiments were conducted to develop methods of integrating these finishes into the proposed design.

7.4.1 Naked Chair 2.0

A similar exercise was conducted to the one in involving the reuse of a second-hand desk chair, but this time finishes and patinas were experimented with. The plywood surfaces were sealed with different products based on their contact with the user. The topside of the seat and backrest of the chair receive the most wear while in use, while their reverse sides receive less wear, typically only when the user is sitting down or the chair is being moved. I, therefore, decided to seal each face differently.

The harder wearing front face was sanded smooth and finished with three coats of water-based polyurethane, creating a durable protective coating. The reverse however was left lightly sanded

with glue and foam marks intact from its previous finish, then sealed with a homemade beeswax polish, which picks up grit and dirt off the users hand, and readily develops a patina. A small section of the front face of the backrest was treated differently again, left completely un-sanded, then painted multiple times before being buffed to expose the different coloured layers of paint and the texture of the plywood. This was a test of falsified patina, and the result, although visually appealing, feels unnatural and somewhat fake.

I believe the interventions will allow the chair to evolve more gracefully over time than in its original state while remaining durable and usable.



Figure 55 – Naked chair 2.0

7.4.2 Reverse Graffiti - Addition through Removal

Reverse graffiti is a method of creating art and graphic on walls or other surfaces by selectively cleaning them.¹¹⁶ The removal of the aged surface layer of a material to reveal the clean original material beneath creates a strong contrast between what is removed and what is kept. This sharpens our awareness of weathering and the build up of dirt on materials, but does so without completely removing it all and sterilising the material completely.

To test this reverse graffiti for myself a stencil was drawn in Autocad, laser-cut out of acrylic and clamped onto a series of different materials and water blasted to leave the graphic behind. The stencil was tested on concrete that had blackened with age, and a timber fence covered in a thick layer of mould.

My interests in reverse graffiti lie in the ability to create a graphic through removal rather than addition. Also, the cleaning can be done with a water blaster, which involves no harsh chemicals. It is beginning to be used for advertising purposes and has been

employed by companies including Puma, ING Bank and Sony.¹¹⁷ I felt this would be an interesting manner of sign writing the facility in a way that is sympathetic to the existing site and Kingsland's identity.



Figure 56 – Reverse graffiti on concrete



Figure 57 – Reverse graffiti on timber fence

116 Reverse Graffiti, 11 12, 2008, <http://www.supereco.com/glossary/reverse-graffiti/> (accessed 10 10, 2009).

117 Ibid.