Constructing Resilience: The Wellington Studio

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Design Studio

RESEARCH

This paper describes the results of a design studio on climate change at Victoria University of Wellington (VUW), New Zealand, in 2007. It discusses the processes and outcomes of the studio and the subsequent testing of student work against a resilience model developed by Canadian ecologist CS Holling (1973, 1998; Walker et al, 2004) to create a framework for the design of resilient cities.

The fourth-year undergraduate studio Designing for Change was undertaken in collaboration with Cath Stutterheim of RMIT University and was based on similar work developed by Stutterheim for RMIT in 2006. The studio brief asked students to quickly evaluate a range of scenarios. It recognised the threat of inundation as an opportunity to address intractable urban, social and environmental problems. The brief posed threats in order to reveal the weaknesses in a city's formal and social structures and create an opportunity to reframe or rethink them.

THE BRIEF

The hypothetical for Designing for Change posed the following scenario: 'Imagine a sea level rise in Wellington over 50 to 100 years, of between one and three metres (including tides and storm surge). How would it affect low lying sites in the city? How could we help the city to adapt?' The hypothetical acted as a diagnostic tool, identifying vulnerabilities and possible areas for intervention. Instead of focusing on immediate solutions, it encouraged students to assess a city's capacity to respond to change.

There is very little flat land in Wellington; a large proportion of the harbour's edge was either lifted out of the sea during recent earthquake events or is the result of reclamation for industry. However, four sites had obvious potential for investigation: three on Wellington harbour and a fourth close to the city on Wellington's south coast. The four sites can be described as follows:

> *Petone/Lower Hutt*: A very low-lying area at the mouth of the Hutt River, adjacent to contaminated industrial land and the Waiwhetu Stream. It is notorious for being the most polluted waterway in Wellington.
>
> *Waitangi Stream*: The central business district's primary catchment. The stream was piped underground early in the city's development, its infrastructure is old, the pipes are low-lying and the system is often contaminated by the adjacent sewer line.

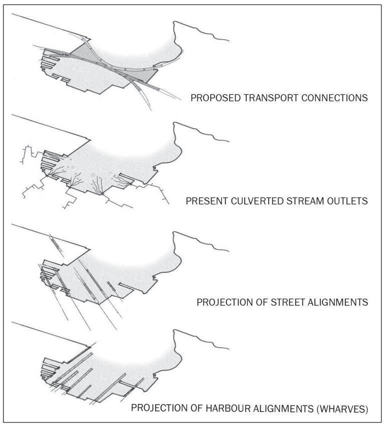
Project sites: (1) Petone/Lower Hutt; (2) Waitangi Stream/Wellington CBD; (3) Seatoun; (4) Lyall Bay/Rongotai.

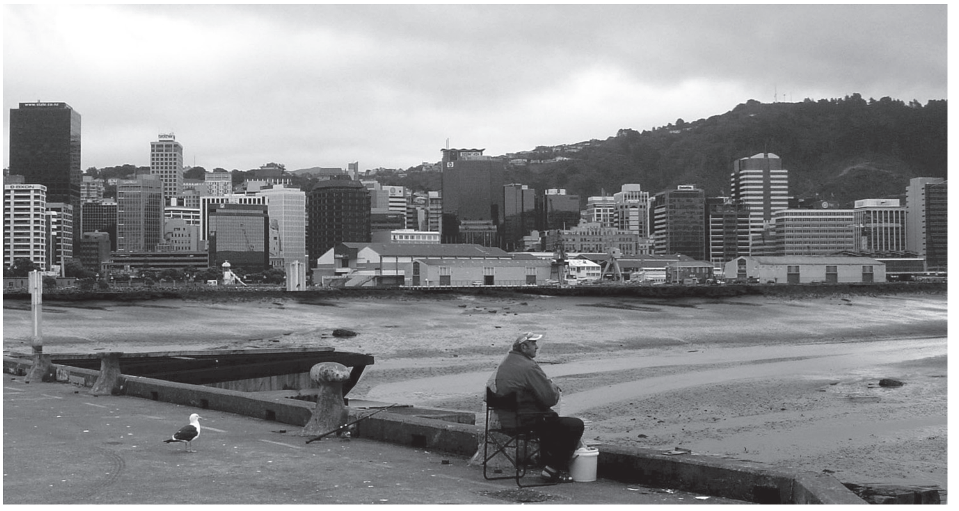
Seatoun: Near the entrance to Wellington Harbour, with an unusually high proportion of sunny flat land and beautiful views, making it one of the most expensive residential enclaves in the city. It is also the site of an old army barracks and landfill, which have left very high levels of contamination in the soil.

Lyall Bay/Rongotai: On the south coast, this area was under the sea before the 1855 earthquake. It is now the site of Wellington International Airport, a 'big box' retail development and a low-density suburb of single-storey residential dwellings.

THE PROCESS

The studio was preceded by a two-day seminar at the City Gallery, Wellington. Government representatives, representatives of cultural groups and experts from a wide range of relevant disciplines discussed the implications of climate change for New Zealand. Recently published Intergovernmental Panel on Climate Change





Proposed transport connections across harbour (above) (Simon Stantiall).

Construction of a defensive sea wall (right), drains the basin and protects against inundation from the sea (Simon Stantiall).

(IPCC) figures on the global effects of climate change broadly contextualised the issues before the proceedings quickly moved to envisaging regional and local implications for the global scenario. Through the ensuing discussions, it became apparent that neither contesting Wellington's coastal areas, nor a willingness to radically reframe or restructure them, was anything new for Wellington. The chosen sites were already rich with a history of multiple delineations. Most of the Māori pā,[1] sited for their proximity to fresh water, good soil, amicable weather conditions and defence capabilities, were lost or buried through successive and hasty reclamations around the harbour's edge. A degree of haste, which ecologist and historian Geoff Park (2007) stressed, presented Wellington as 'a *sudden* second start place for the colonials' following the establishment of colonies in Australia. According to biological scientist Matt McGlone (2007), this mentality of rapid restructuring and proud destruction of the indigenous landscape continued right through to the 1960s, an era of which most of Wellington's major infrastructure is a relic. The encroaching shoreline was also revealed to have legislative implications, with the movement of the mean high water effectively shifting the boundary between areas of district council and local council jurisdiction.

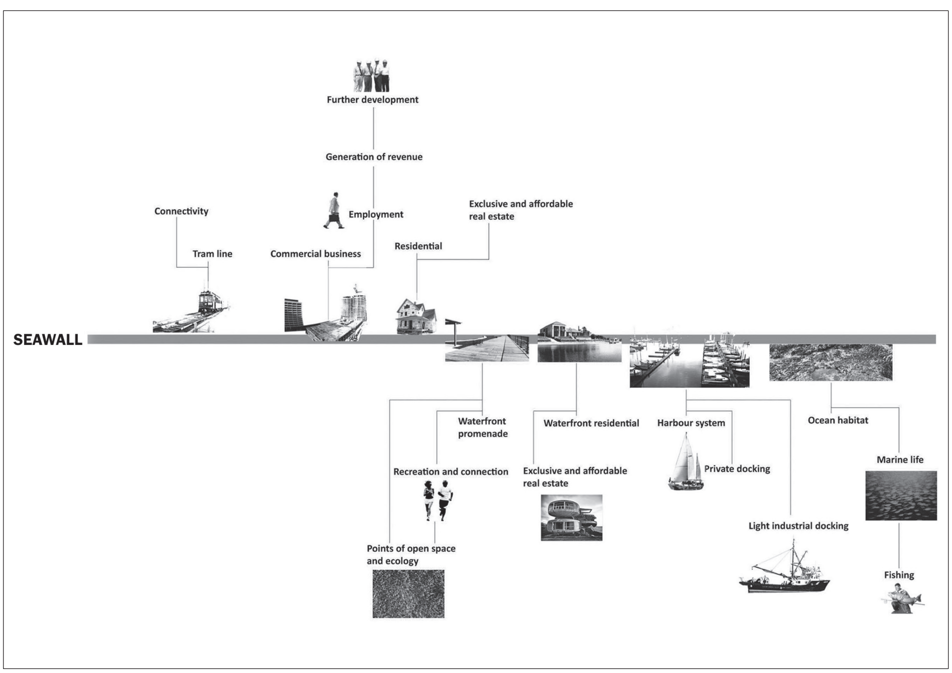
Following the seminar and a two-week period of intensive mapping and synthesis, students were asked to develop a 'hunch' or quick conceptual response to their site's issues. This encouraged an early, physical connection to the site and helped to continually draw the students from the abstract (the strategy) to the particular (the site) throughout the course of the studio. Two successive briefs were then issued. The first was to design a protective structure, the second, to stage a managed retreat. The first brief encouraged students to identify what, in fact, they were protecting and how they were protecting it, and to test the implications of their structure on the rest of the city. The second was as much about managing change over time as about physically shifting inappropriate development away from the water's edge. Each response required that the students critically assess the existing form and systems of the city, investigating them at every scale, to determine their capacity to adapt and their responsiveness to change.

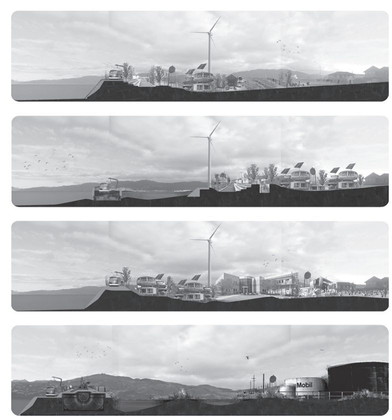
STUDENT OUTPUTS

A number of studio projects proposed sea walls as catalysts for change – the walls becoming generators of new urban agglomerations.

Simon Stantiall (Allan, 2007), in his project for the central business district, sought to continue Wellington's agenda for reclamation to create more flat land for the city. His *caisson*-like structure protected the city's core from sea-level rise, while facilitating a faster, more efficient and sustainable transportation link between Wellington's northern and southern suburbs, acting as a symbol of the city's renewed commitment to change. The provision of transport, environmental and recreational strategies was intended to mitigate the effects of climate change, while a new development of integrated urban and ecological systems would act as a model for a new type of city.

Similarly, at the opposite end of the harbour in Petone, Felix Smith (Allan, 2007) proposed to reconfigure the city centre along a newly constructed waterfront edge. Smith, like Stantiall, proposed that the wall not only support a variety of recreational programmes, but also act as a key link in new transport routes, creating valuable space for larger scale, more energy-efficient transport networks. However, there was an extra layer of complexity here. Many cities have to deal with the consequence of the physical relationship between contaminating industry and water. This is particularly difficult when the land is low-lying, with a high water table. It can be a challenge to isolate contamination and prevent it from seeping into adjacent waterways. To address the highly contaminated Waiwhetu Stream, Smith's sea wall also deflected the course of the Hutt River towards and through an area of industrial reclamation planted with remediative strips of vegetation.





Sections through Petone foreshore (above).

A sea wall is proposed to protect the Hutt Valley and Petone foreshore from inundation (left). This infrastructure re-invigorates the area's economic, ecological, recreational and social function (Felix Smith).

Framing harbour views (above left) (Matt Pepper).

Pedestrian interaction with salt industry (Matt Pepper).

The reclamation fill was to be progressively cleaned and deconstructed as seawater inundation occurred. The new estuarine wetland environment would filter and remediate the contaminated soil, creating an environmental park and an important educational experience for the regional community.

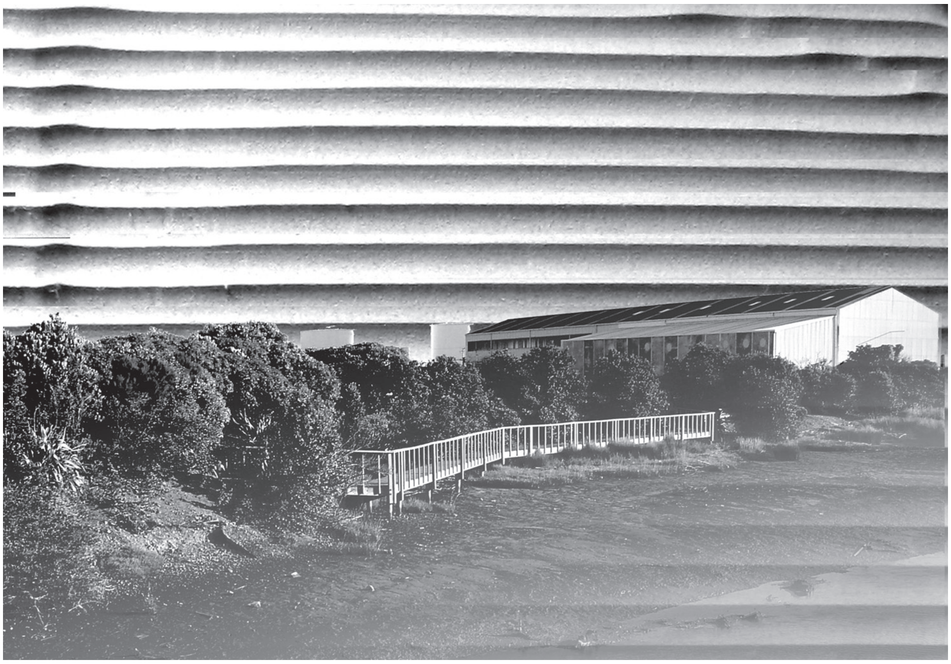
Most students dealing with Petone's industrial zone identified those industries that were likely to close down over the next 20 years, consolidated them and relocated the remaining industry to higher ground. In contrast, a project by Matt Pepper (Allan, 2007) was mindful of the cultural and economic significance of industry in the Lower Hutt area and its potential to directly enhance or detract from the livelihood of its residents. Pepper proposed a new direction for primary industry in the area, which made use of the landform (the Hutt River plain) and a new resource in high abundance – salt. The community would deconstruct Petone as it was inundated by the sea; the salvaged materials used to form retaining structures would act as evaporation ponds. A 21-kilometre walkway circumnavigating the salt ponds supported a mix of retail and recreational programmes.

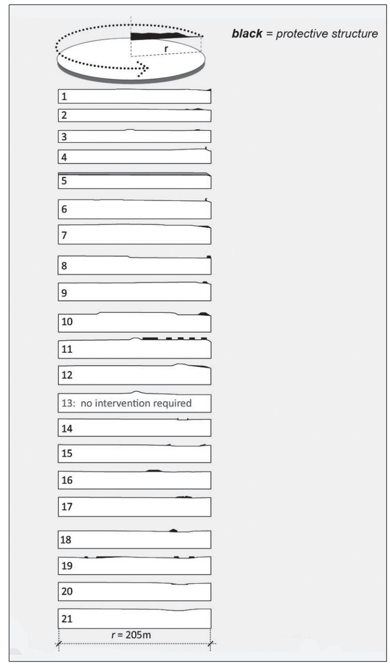
Finally, coastal engineering is often visualised in terms of superstructures, long causeways, giant sea walls, bulky groins and breakwaters. However, these superstructures are often associated with other secondary structures such as fences, drainage and signs. Jamie Roberts (Allan, 2007) proposed that a further broadening of this visualisation could also include 'soft' forms of infrastructure, such as social groups, cultural conventions and site programmes. Based on this, Roberts proposed multiple protective structures for 21 sites in Petone, the locations of which were determined through a matrix of variables. The 21 sectional interventions were placed according to combinations of geological composition, existing land use and hydrological adjacency. Then, by revolving the sectional profile with the protective structure in place, ideas of absolute containment proposed by the protective structures were modelled, tested and compared. These revolved models were further developed through lateral milling in the managed retreat stage in order to understand the decomposition of their initial profile over time. The models were then used to simulate inundation scenarios for the Petone/Waiwhetu area, through which the sites on which to focus urban design activity were selected.

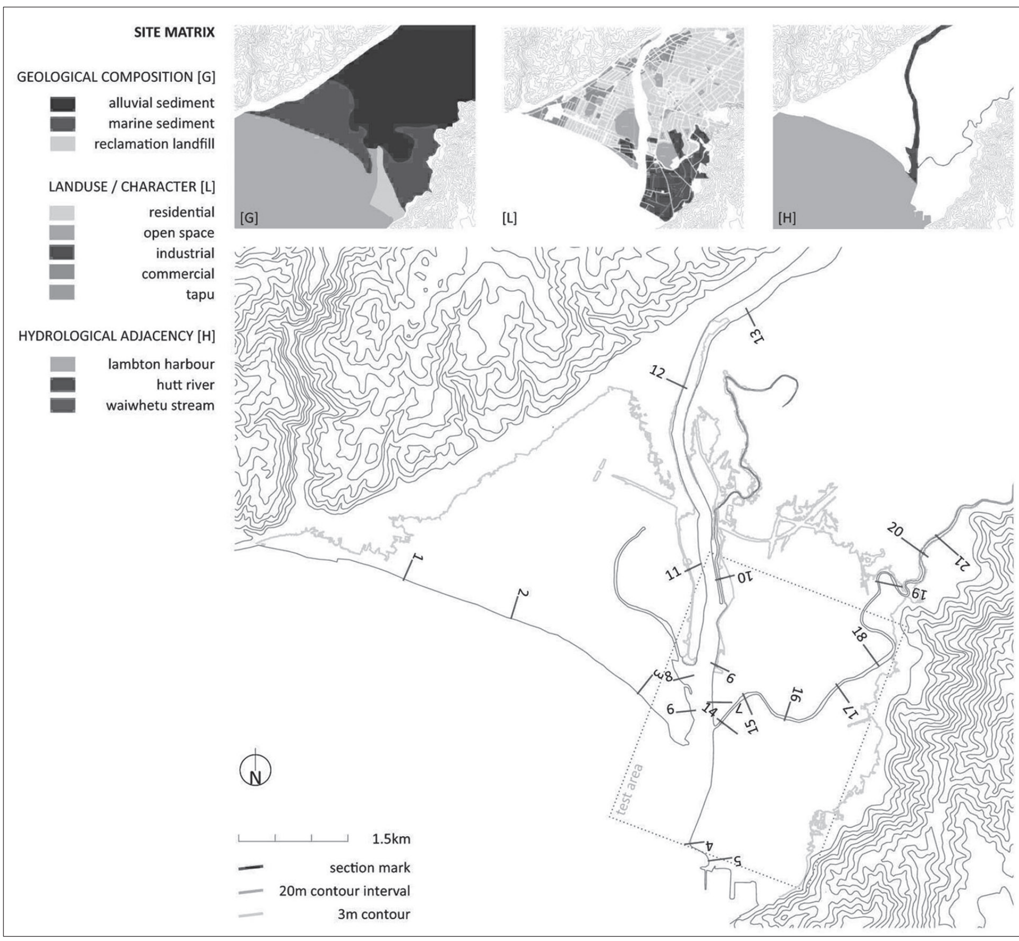
Opposite page: Lateral milling (top left) examines the decomposition of edges over time (Jamie Roberts).

Twenty-one revolved sections through Petone examining containment (Jamie Roberts).

Matrix of variables (bottom): geological composition, and use/character, hydrological adjacency (Jamie Roberts).







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Fa	Ind	Str	19
Fa	Res	Str	20
Fa	OS	Str	21
Fa	Res	Har	/
Fa	Ind	Har	/
Fa	Com	Har	/
Fa	OS	Har	/
Fa	Com	Str	/
Fm	Ind	Har	1
Fm	Res	Har	2
Fm	OS	Har	3
Fm	OS	Riv	7
Fm	Ind	Riv	8
Fm	OS	Str	16
Fm	Ind	Str	17
Fm	Res	Str	18
Fm	Res	Riv	/
Fm	Com	Riv	/
Fm	Com	Str	/
Fm	Com	Har	1
Rl	Ind	Har	4
Rl	OS	Har	5
Rl	Ind	Riv	6
Rl	Res	Riv	9
Rl	Ind	Str	14
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PRELIMINARY ANALYSIS

The scenarios posed during the studio prompted many students to assess the risks associated with inundation at multiple scales. The threat of inundation required an assessment of physical risk in the immediate vicinity, whilst affected systems (physical, economic, social and political) could be traced to determine the relational vulnerabilities of the city in its ever-widening context. As the studio progressed, students began to explore the nature of those systems, their interdependencies and the relationship between the concepts of vulnerability and resilience, particularly in regard to the form and structure of the city. Following the studio, as part of the evaluation process, students explored the nature of resilience in more detail. Our aim was to define the characteristics of a resilient response and the qualities of a resilient city, testing the studio outcomes (the student work) against these findings to develop the beginnings of a framework for designing for, and with, change.

RESILIENCE

We chose to investigate resilience because it focuses on strengthening systems rather than managing threats. Although there is a growing discourse associated with the resilience of cities, much of it relates to the recovery and reconstruction process following a catastrophic event (Vale and Campanella, 2005). Much less attention has been paid to the formal characteristics of resilient cities or the role that design professionals might play in retrofitting to build a city's capacity to adapt to the cumulative impacts of change.

'Resilience' is a term that is widely used to describe response to change. Different disciplines use different definitions to suit their own purpose. A derivative of the Latin *resilire* (to 'leap back'), the word is defined by the *Oxford English Dictionary* as 'the capacity of an object to recoil after stretching or compression or of a person to withstand or recover quickly from difficult conditions'. While there is a great deal of consistency in meaning between disciplines, the key differences appear to arise from different understandings of the nature of change.

This understanding has been influenced by the relatively recent shift from a linear, binary, reductive and mechanical paradigm, which reached its climax during the nineteenth and early twentieth centuries, to 'a more nuanced understanding of sociotechnical ecology, informed by recent advances in chaos, complexity, and information theories' (Perelman, 2007, p 26). The shift has precipitated responses in disciplines as wide-ranging as psychology (Deveson, 2003), world systems analysis (Chase-Dunn and Hall in Gotts, 2007), economics, medicine and national security (Perelman, 2007), all based on 'integrative modes of inquiry and multiple sources of evidence' (Holling, 1998).

The resilience model

Two key definitions of ecological resilience reflect this shift. The first considers resilience to be a measure of the speed with which a system returns to an equilibrium state after a disturbance (Pickett, et al, 2003). Holling (1996) refers to this definition as 'engineering resilience'. Emerging ecosystem theory began to dispute the existence of equilibrium states, so the definition was refined by Holling in the 1970s, and further clarified through collaboration[2] in the 1990s, to reflect the discipline's change in focus. The revised definition, which we chose to investigate further for the purposes of the studio evaluation, refers to resilience as 'the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Walker, et al, 2004).

The model created to accompany this last definition is particularly useful for urban design and urban systems because it describes the behaviour of complex adaptive systems (called social-ecological systems or SESs) and assumes humans to be integral components of those systems. Cities, according to this definition, are SESs. The model describes the behaviour of a system when it is disturbed. It appears to have been influenced by the British geneticist Conrad Waddington's epigenetic landscape which he conceived between the 1930s and 1950s as a visual model to describe the path taken by a human embryo subjected to multiple influences (Slack, 2002). Both models use a ball or marble to represent the subject (in Waddington's case the embryo and in Holling's, the SES). The landscape or basin in which the subject sits (its topology) is the product of four variables that control either the topology of the basin or the movement of the subject within that basin. A change in type or magnitude of any of the variables will affect the path taken by the subject.

Holling develops this idea further by describing not only the parameters that control the movement of the subject, but also the activity of the subject as it responds to disturbance. The topological landscape in the resilience model consists of a series of attracting basins or system 'states'. They are defined by Walker, et al, (2004) as:

> *Latitude*: the maximum amount a system can be changed before losing its ability to recover.
>
> *Resistance*: the ease or difficulty of changing the system.
>
> *Precariousness*: how close the current state of the system is to a limit or 'threshold'.
>
> *Panarchy*: influences from states and dynamics at scales above and below. For example, external oppressive politics, invasions, market shifts or global climate change.

A resilient system is said to be one that has the capacity, in response to disturbance, to remain within the basin. The idea is not for the system to remain in an equilibrium state but for it to continually change in response to disturbance in order to 'stay in the game' (Pickett, et al, 2003). For example, where the system is a human body, the adjacent basins might represent the two states describing 'life' and 'death'.

This model is particularly useful to landscape architecture in that it provides a framework to discuss urban environments in ways that control either the topology of the basin (e.g. infrastructural links) or the movement of the subject between basins (e.g. the existence of a suburb). For the purposes of the studio evaluation, these variables were tested against the forms and processes of urban systems to determine the influence an urban designer might have on a city's adaptive capacity. Theoretically, modifying any one of the variables would have a positive effect on resilience. The scenarios developed by the students in response to the climate change hypothetical were examined to understand the type and magnitude of intervention required to achieve a particular response.

To better understand the qualities of each variable in relation to the urban environment, students also began a resilience glossary, drawn from a variety of disciplines. We searched for commonalities as well as disciplinary nuances that might give a depth to our understanding of the concept. The key definitions are described below.

The resilience vocabulary

Homeostasis

Homeostasis is an important concept because it sheds light on the resilience model, particularly as it describes the relationship between change and relative stability, a defining characteristic of open systems.[3] The human body is a good example. At one scale, it is relatively stable, but to achieve that stability in the face of a constantly changing external environment, it sustains millions of minute, internal changes at a cellular level (or 'scale').

Feedback mechanisms

The body uses a series of feedback mechanisms to achieve homeostasis. Its core temperature exists within very narrow parameters of between 36 and 37 degrees centigrade. This could be described as the *latitude* of the body's system. If it becomes colder or hotter than this, a feedback mechanism (shivering or sweating) returns the body to its optimum temperature. The feedback mechanism enhances the body's *resistance,* making it less vulnerable and keeping it away from the *threshold* of alternative systems: the difference between life and death. This mechanism is so powerful that it makes the body's position less *precarious*, helping it to achieve relative stability, or homeostasis.

A road network is another example of the way feedback mechanisms work. The size of a road determines the amount of traffic it will take. If there is too much traffic, people will stop using it, returning the road–user relationship to its optimum state.

People learn and innovate in response to change and can intervene in urban systems to become part of the feedback loop. The effectiveness of this adaptive response depends on the strength and effectiveness of both governments and communities (known respectively as the 'top down' and 'bottom up' approaches). Engagement raises awareness and therefore adaptive capacity. Education is an important part of this process, encouraging communities to adapt to change.

Latency

Stanford Anderson, Professor of Architecture at the Massachusetts Institute of Technology (MIT), defines latency as 'the unrealised potential environment', discussing the need to 'choose among alternative environments and to select ways in which [to] use and interpret extant physical environments with as yet untapped, latent potential' (1978, p vii). Latency in the urban environment is related to *latitude* in the resilience model. The existence of the former creates opportunities for the latter.

The latency of a physical environment has spatial, social and temporal dimensions and occurs when a space is designed to be loosely coupled with its intended function (described as a 'loose fit' or 'robustness') over time (often referred to as 'adaptive re-use') or through shifts in thinking related to different social values. Anderson (1978) describes environments as 'machines', where function and form are so tightly coupled that a change in function is almost impossible, citing coffins and freeways as representative examples. It is interesting, many years later, to note the robustness of his definitions. For example, shifts in thinking, precipitated by a need for public space in a highly urbanised environment, led Enric Batlle and Joan Roig, architects for Parc Trinitat in Barcelona, to graft a sports park onto a freeway intersection (one of Anderson's 'machines'). In fact, the urban environment appears to have a great deal of potential to accept unexpected functions, with designers in the last two decades in particular exploiting the latency of urban surfaces (roofs, walls, roads) as components in urban water-management systems.

STUDENT WORK THROUGH RESILIENCE

This vocabulary was used to extend our understanding of the concept of resilience. When tested against the student work, it began to frame a series of discrete actions that could be employed by designers to retrofit resilience in the urban environment. Following is an example of this process, using the work of student Nick Jones and his project 'XYT' in Rongotai (Allan, 2007).

The landscape of Rongotai has been subjected to a number of dramatic changes in its short history. Its rise out of the sea during the 1855 earthquake is probably the most dramatic. Then it settled into a relatively stable state of shifting dunes and wetlands. Settlement precipitated a new state, which included the environment and humans together in a combined system (an SES). The construction of infrastructure has created a tenuous stability; the infrastructure itself is neither particularly flexible nor resilient.

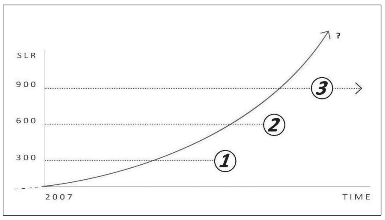
The sea wall, constructed to protect the suburb and the coast road, State Highway One, from storm surge, is a good example. It has replaced a dune system, and the scouring action of the waves against the wall causes erosion of the beach sand in storm periods. The likely response of the local council to sea-level rise in this area will be a gradual raising of the wall which will, in turn, exacerbate scouring and cut the town off from the beach. To maintain the beach in its existing condition, the council will need to continually replenish the sand. The *panarchic* influence of sea-level rise will potentially provoke the next system shift, precipitating failure of the storm water system, widespread flooding, loss of the beach and severing of the highway.

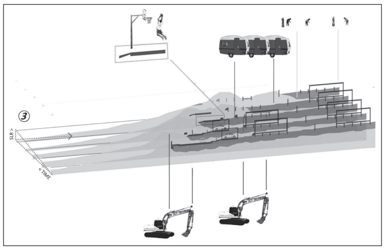
Project 'XYT' identifies ways to maintain the *relative stability* of Rongotai on one scale (the scale of the suburb) by identifying interventions that would allow vulnerable systems to respond to change on a micro scale (the vulnerable systems being in this case storm water, traffic, housing and the coastal edge). Referring again to the model, the project proposes to introduce *latitude* into each system by identifying back-ups: for the storm water by exploiting the latent storage potential in the open space network, for traffic and housing by re-routing State Highway One and decanting the residential strip to a new medium-density development on higher ground and for the coastal edge by removing the wall and allowing the dunes to re-establish.

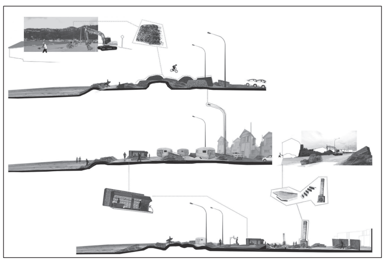
Jones proposed to do this in stages. He proposed a managed retreat, which was calibrated to the occurrence of impacts. The agent of this process (the local council) would act as the systems' feedback mechanism. This graph shows the relative vulnerability of these systems over time to sea-level rise, where the x-axis relates to relative sea-level rise and the y-axis to the proposed interventions. Change is initiated when, and only when, it is necessary.

Not only are all of the systems less vulnerable because they have latitude (or a back-up system), their resistance is strengthened by the presence of a feedback mechanism (the adaptive manager). In this way, the suburb is able to achieve a new, homeostatic state.

The final defence, the sea wall, is demolished once the other systems' capacity for response has been established. Its removal connects two distinct spaces, each with its own associated activity, for the first time (the suburb and the seaside). At first glance, activities in both spaces seem to be a reasonably 'tight fit'. Jones used a video overlay technique to identify the space's latency, loosening the connection between place and activity and helping him to imagine hybrid activities for the new coastal edge. The demolished wall and houses are buried as a way of trapping sand to stimulate dune regeneration. Remnant carports and chimneys become elements in a new type of recreational landscape and the remnant houses are gradually subsumed beneath the dunes.



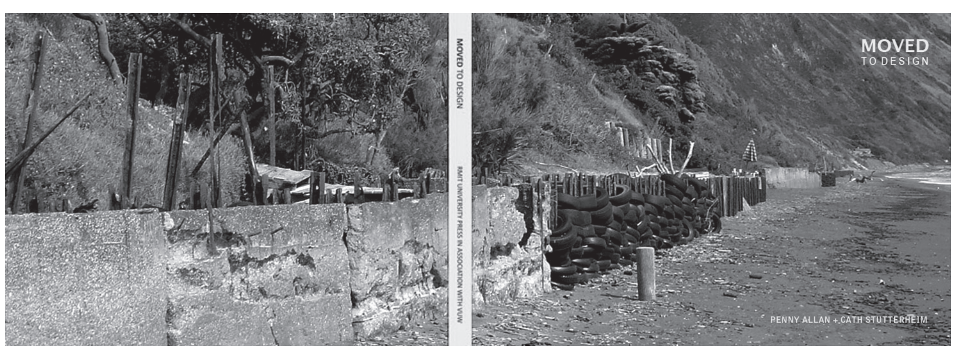




Graph showing implementation of strategies over time (top) (Nick Jones).

Sectional explorations of interventions over time (Nick Jones).

Sectional perspective of change over time (bottom) (Nick Jones).



Moved *book cover*
(Allan and Stutterheim, 2007).

CONCLUSION

This testing of studio work against Holling's resilience model has provided us with the beginnings of framework for action for both teaching and practice. Working within the framework has allowed us to investigate resilience at multiple scales, incorporating process and form, strategy and detailed design.

The concept of panarchy, relating to the multiple and multi-scale influences on a system, encourages us to see as widely as possible, and as designers to move purposefully between scales, from the regional to the microscopic, with opportunities for intervention at every scale. Latitude in a city can be discovered through shifts in scale, space and time and is particularly useful for designers in densely populated cities, in unexpected places. At the same time, open space networks are more important than ever, supporting multiple ecological and social functions, providing back-up networks for systems to shift in times of stress. The precariousness of a system, or set of interconnected systems, can be readily identified during the analysis stage of a project, but in order to maintain relative stability while still allowing for change, we need to be involved in a process of long-term adaptive management ('gardening' in the broadest sense of the word). This is often difficult when traditional procurement processes often work counter to engagement with a project beyond its date of delivery. Finally, resistance can be amplified when we recognise and exploit the role that people can play in cities. Human intervention is an important component of an urban system's feedback mechanism and should be encouraged through education and the active engagement of both communities and government.

The discourse associated with change is complex and can be confusing for designers who tend, as a default position, to abrogate responsibility for design in favour of an ecologically driven laissez-faire approach, which assumes that ecological processes are somehow more authentic than the hand of the designer (Waldheim, 2006). The work presented here challenges this approach. It investigates change through the concept of resilience to better understand the way urban systems respond to change, and exploits the design studio model to propose a more targeted and controlled approach to the design of cities – an approach that encourages designers to be proactive and involved in the design and retrofitting of resilient cities.

A video overlay technique identifies latency (Nick Jones).

NOTES

1 Māori settlement site.

2 In collaboration with Brian Walker, Stephen R Carpenter and Ann Kinzig (Walker, et al, 2004).

3 'Homeostasis' was coined by Walter Bradford Cannon to describe a concept developed by Claude Bernard in 1865 (Cross & Albury, 1987).

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