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Climate Safe House: A Community Housing Project Tackling Catastrophic Sea Level Rise in Coastal Communities

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Abstract**—**New Zealand, an island nation, has an extensive coastline peppered with small communities of iconic buildings known as Bachs. Post WWII, these modest buildings were constructed by their owners as retreats and generally were small, low cost, often using recycled material and often they fell below current acceptable building standards. In the latter part of the 20th century, real estate prices in many of these communities remained low and these areas became permanent residences for people attracted to this affordable lifestyle choice. The Blueskin Resilient Communities Trust (BRCT) is an organisation that recognises the vulnerability of communities in low lying settlements as now being prone to increased flood threat brought about by climate change and sea level rise. Some of the inhabitants of Blueskin Bay, Otago, NZ have already found their properties to be un-insurable because of increased frequency of flood events and property values have slumped accordingly. Territorial authorities also acknowledge this increased risk and have created additional compliance measures for new buildings that are less than 2 m above tidal peaks. Community resilience becomes an additional concern where inhabitants are attracted to a lifestyle associated with a specific location and its people when this lifestyle is unable to be met in a suburban or city context. Traditional models of social housing fail to provide the sense of community connectedness and identity enjoyed by the current residents of Blueskin Bay. BRCT have partnered with the Otago Polytechnic Design School to design a new form of community housing that can react to this environmental change. It is a longitudinal project incorporating participatory approaches as a means of getting people 'on board', to understand complex systems and co-develop solutions. In the first period, they are seeking industry support and funding to develop a transportable and fully self-contained housing model that exploits current technologies. BRCT also hope that the building will become an educational tool to highlight climate change issues facing us today. This paper uses the Climate Safe House (CSH) as a case study for education in architectural sustainability through experiential learning offered as part of the Otago Polytechnics Bachelor of Design. Students engage with the project with research methodologies, including site surveys, resident interviews, data sourced from government agencies and physical modelling. The process involves collaboration across design disciplines including product and interior design but also includes connections with industry, both within the education institution and stakeholder industries introduced through BRCT. This project offers a rich learning environment where students become engaged through project based learning within a community of practice, including architecture, construction, energy and other related fields. The design outcomes are expressed in a series of public exhibitions and forums where community input is sought in a truly participatory process.

Keywords**—**Community resilience, problem based learning, project based learning, case study.

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I. Introduction

CONSIDERING the challenges society and environments are facing today, it is of utmost importance to consider how design education facilitates learning to a new generation of sustainable design practitioners. This paper investigates the benefits and complexities of problem-based learning as explored in a project within an architecture and design educational context. Using a case study approach, the authors demonstrate how design demands, multi-layered contexts, competing systems and different stakeholders add to the level of complexity that need to be considered in various design iterations. The research finds that project based learning showcases similarities to action based research, both in processes and design outcomes. The paper provides evidence for the value of involving stakeholder feedback in a longitudinal project and suggests how learners can shift from outcome oriented researchers to process oriented practitioners. The case study is based in a coastal community in New Zealand that is affected by climate change and resulting socio-economic pressures.

II. Pedagogy

Problem based learning (PBL) in design education has been well exploited as a proven tool for developing design concepts and where there are real world applications, learning opportunities can be strengthened.

Graaff and Kolmos [1], in discussing the characteristics of PBL, list a *participant directed learning process* as a significant feature of PBL with *experience learning* as implicit in allowing students to build from their own experiences and interests to create connections with the formulation of the problem. *Activity based learning* is considered central to the PBL process and they acknowledge that project work is problem-based by definition. Other key attributes of PBL include; *interdisciplinary learning* allowing for exploration to extend beyond subject boundaries and considering problems within real situations, *Exemplary practice* where students gain a deeper understanding of complex issues through the transfer of previously acquired knowledge, theory and methods to new areas of learning, and, *Group-based learning* where personal competencies are developed within an environment of group collaboration.

Savery [2] discusses the characteristics of project based

learning as being "an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem". Savery considers the value of this type of learning to be in the facilitation of a reflective process where critical analysis and application is fundamental to the success of the project and learning outcome.

III. Context

Coastal communities' vulnerability in response to global conditions of climate change has major repercussions for countries like New Zealand, [3], [4].

Historically settlements formed around the extensive coast line developed from the need for shelter, food and accessibly to trade. The typology of such settlements follows principles of modest dwellings built with limited resources and expertise.

The changing environmental, social, economic and political parameters around coastal regions and the genuine modesty of these buildings have put considerable pressure on the viability of such settlements. Over recent years values placed on land, and in particular coastal locations in New Zealand, have come to be indicative of the social and economic growth and investment opportunities with demand from both local and offshore investors. Where land commodity values are less pressured, i.e., less desirable, communities have become somewhat marginalised due to the lack of economic attention placed within the development of them. New dwellings in these areas, in accordance with flood risk parameters and rising sea level predictions, are required to be made safe, i.e. 2 m above sea level and transportable. They adhere to current local building regulations and thereby expose the shortfalls of the building practises of a bygone era.

Organisations like The Blueskin Resilience Communities Trust (BRCT) recognise the vulnerability that these types of communities face through rising sea levels and increased flooding by proposing a solution that addresses social housing targeting community resilience. As an organisation their dedication to developing community led solutions to climate change issues have led to proposals for New Zealand's first community-led wind energy development (2008) and latterly the initiation of The CSH project. Their website outlines a timeline from 2016 – 2020 for the research of existing stock in flood hazard zones, the perceptions of residents and resident led plans for possible responses followed by development and construction of the first CSH. This longitudinal project is intended to develop a knowledge base with clearly defined responses to housing and vulnerable populations as coast lines change as a result of climate change. BRCT intend for this to be a pilot scheme and as such see this as an opportunity to provide valuable resource information and enable similar affected communities to reach a possible solution. Blueskin Bay, as a community, celebrate their diversity and unique geographical position and have come together in support of such proposals in order to address the ever increasing threats upon their existence.

Understanding the direct and indirect parameters, outlined in Fig. 1 that influence communities affected by climate change goes some way to understanding the complex matrix that will be negotiated throughout the proposed project. By providing a facilitated learning environment where students are given an opportunity to establish meaningful design contributions through the establishment of place-making, it is anticipated that a deeper level of understanding around the effectiveness of design responsive solutions to global issues will be formed.

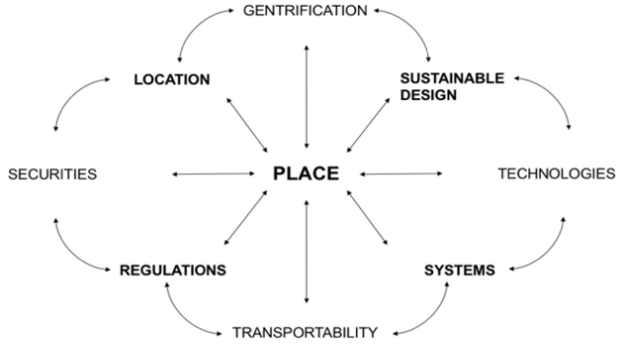

Fig. 1 Factors that inform the contextual relationships for CSH Project

IV. Process and Intention

The aim of this project was to create a dialogue that engages practitioners, researchers, and learners that respond to community and user needs and provide an educational framework where all participants have value in participation. In terms of maintaining and engaging in the participatory process, encouragement of BRCTs involvement as client/stakeholder was welcomed in developing a true critical, reflective process within the learning environment and invitations to participate in key crit sessions supported.

Forming relationships early within the design process was critical in order to give students a strong sense of the context for this project. Initial investigations were made into the notion of place, in terms of understanding why places are important for people, in particular how architecture and environmental design can be a vehicle for place making. Relph [5] formalises this inherent relationship between space and place as the agent in which people ascribe meaning between the physical aspects of space and the values that people give to that place. Further, in terms of understanding the impact of displacement and resettlement on communities like that of Blueskin Bay, Million's [6] investigation, as cited by Seamon and Sower [7], highlights that psychologically we form long term connections to our environment and that when contested a process of loss is experienced, a factor that needs to be carefully negotiated. Therefore, it was important in this project that students had an understanding of place attachment in order to maintain the sense of physical, cultural and perceptive connections that the community have established.

Ascertaining parameters were considered to be the next phase for the students in order to create a response that was based on facts rather than assumptions. This area of the design

phase is habitually problematic for students as conceptual projects often have a degree of subjectivity attached to them however in this particular situation there were clear obstacles to navigate; in particular the framework set by local planning authorities being 2 m above sea level and re-locatable (transportable) and BRCT's own values that included the identification of sustainable systems that adhere to not only a re-locatable scenario, but also the apparent socio-economic variables of the community.

V. CSH Project: Case Study

The CSH is an architectural design project that provides a vehicle for the facilitation of user-centred design education in sustainable practise creating a design response that stems from community and user needs rather than applying principles to design problems.

CSH offers the promise of deep learning within a real world project; it offers the added advantages of clearer, more embedded stakeholder roles with project delivery being the decisive goal of the BRCT. Unlike other projects taken up by Otago Polytechnic design students, the CSH project was recognised early on as a project that would require a long lead time and it would be unlikely to be completed by a single year cohort of design students, rather it was seen as an opportunity to evolve a real world project/problem across several semesters and different final year student groups.

The first students (Group A) introduced to the project, did so as part of their final semester of study and the project became their final exhibition project. The students developed the initial project as outlined by BRCT and in response to their interpretation of community needs. Deliverables were multiple developed design outcomes.

BRCT representatives met with students on site and discussed historic issues of flooding in the area. They introduced students to a potential recipient of the CSH pilot project whose home had become seriously compromised by previous flood events. The students then embarked on research relating to the construction and environmental issues that were seen as important to inform the resolved project and responded to the BRCT brief. A key element of the student design brief was to produce a modelled solution that would act as a catalyst for discussion with the community and a foundation for further design exploration with students in the following year. The students concepts were first exhibited as part of the 2016 graduate exhibition and again, later, alongside climate change information and research provided by BRCT, at the community gallery in Waitati, Blueskin Bay February 2017. The value of both venues meant that the various stakeholders could engage in an active dialogue that addressed negotiated relationships between designer and recipients. The exhibitions of the student work provided feedback from stakeholders that then could be used to inform a more considered response to the project issues.

Group A responded to BRCT as client/stakeholder also to a representative of the community as a potential user. Their responses were based around BRCT's presupposed conditions of what they believed design outcomes should achieve in terms of sustainable solutions, what a potential user would like to experience and context analysis. For group A, the design driver became a response to establishing a relationship to place both physically, through vernacular design responses, and geographically, through site, situation and environmental analysis. Context, site, situation and connectivity to place became the main drivers in the development of individual responses.

The second cohort of students (Group B) were in the first semester of their final year and their course outline expected a more research focused exploration of the issues. The Group B objective was to respond to the feedback from the community taking multiple aspects into consideration and reach a single solution.

An integrated and group design developed as the complexity of the topic became apparent. At completion of the course, Group B produced a construction specification that used 'the living building challenge' as a tool for selecting materials and processes that responded to environmental and healthy living standards. The Living Building Challenge (LBC) is a certification program that provides a framework for design and sustainability,

Group B responded to the design challenge differently, partly because their course project brief had a different set of deliverables than those of the previous group, but also because the developed brief generated from community feedback after the Waitati exhibition and alongside the concurrent research project exploring 'the living building challenge' had helped to highlight other complex issues impacting on the project. It was seen that the project design itself was deceptively complex as it was inappropriate to provide a solution that did not consider wider issues, including; construction practices and materials that contribute to global warming and a model of social housing that recognised multiple facets of community and community resilience.

VI. Discussion

The approach to the BRCT project brief differed for the two student groups and this led to significantly different outcomes. However, although distinctively different, both groups provided valuable design input into the resolution of the climate safe project and demonstrated the value of a staged or staircased project brief to uncover multiple facets of the complex problem.

The Group A response to the brief was influenced by the fact that the individual design outcomes of students were to form the basis of their final graduate exhibition and their aspirations to create a personal statement would be represented in this outcome. The desire to give form or architectural expression to the project became a significant driver. The graduate exhibition provided an opportunity to celebrate their individual achievements, whereas, the community exhibition provided a forum for focused critique of the situation informing the design brief.

The initial CSH design brief included a number of design assumptions which included preconceived design features. In addition to this, the BRCT introduced a potential recipient for

the pilot CSH and students struggled with identifying BRCT as the client rather than developing solutions to fit the needs of one resident who may benefit from the project. The positive outcomes of this was that the students' models and associated presentation material generated opportunities for discussion as this provided a platform for critique.

Investigations into systems and technologies was theoretically approached as economic and environmental design drivers and collated into a shared information resource where students could draw upon during the design phase. However, during the actual designing phase these aspects appeared to become of less importance as Group A became more involved in responding to the site and situation. This therefore offered a clear starting point for Group B to approach the next phase with a particular understanding of their contribution in developing sustainable system solutions that meet the socio-economic diversity of the community.

Group B responded to a brief that had refined project parameters that were informed by community and client feedback and quickly recognised the value of a collaborative approach to obtain knowledge relative to new and complex issues. As a result, through research, students were able to speak with authority on the systems and materials they had explored, they developed expertise in specific fields that enhanced their value and relevance as individuals within the group situation.

The resolution from Group B has as yet to be presented to the community and therefore their validation, thus far has been isolated to the members of BRCT/client. The strength of Group B's collaborative approach meant the resolution was succinct and provided BRCT with a set of system specifications that will enable further facilitation of partnerships to evolve. In essence, the Group 'B' solution was a blueprint for design application rather than the design itself.

Group B also investigated the project in regard to compliance with the Living Building Challenge. Particular focus was on attributes, systems and materials that comply with the U.S. based certification system. Naturally, the New Zealand based learners found, when contacting suppliers, that products would not address the narrowly defined parameters. It provided the group with increased awareness about core aspects of sustainable design potentials and readiness of the market to address global concerns.

VII. Conclusions

This project has highlighted some key aspects of problem-based design research within architecture education environments. At first, both learner cohorts struggled to understand the complexity of the project and to negotiate design outcomes. Clear focus has previously been on concrete project outcomes and deliverables. It was found that internal discourse and external input enabled learners, after a few weeks, to comfortably discuss goals and objectives with clients and stakeholders alike. Group B in particular started to educate suppliers and manufacturers about desired product and material attributes. It became apparent that focus for the students shifted from an outcome oriented design approach to a process focused design education. Thus, the project helped learners to shift thinking and to develop a clear rationale for design solutions that introduce aspects of sustainability in a meaningful way.

Learners: Learning > Teaching > Learning
Faculty: Teaching > Learning > Teaching

Fig. 2 Learning – Teaching Cycles

Fig. 2 illustrates the process of engaging in a reflective methodology allowing for a repositioning of viewpoints to naturally occur and responding to fluid concepts rather prescribed ideologies. A shift and repositioning in the approach of the facilitator in relation to traditional architecture and design pedagogy took place, as learners redefined the project brief in line with their own findings on sustainable practice and feedback provided by various stakeholders. Learners were required to use their self-directed research to clarify their ideology and make sense of, what were at times, competing values.

The nature of the project and evolving parameters required instructors to respond to influences offered by learners and external stakeholders. Resulting discussions enriched the learning environment and highlighted the relevance of the design inquiry for learners and external stakeholders alike. The value of working with and for communities becomes apparent for both learners and instructors.

It was important that learners developed skills to successfully navigate a problem based project where through their own inquiry into issues of sustainability they were able to provide a meaningful response to the initial brief. Learners of Group A and B turned into curious and responsible practitioners.

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