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Women in Fabrication: A platform for inclusive and diverse design

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Abstract: In New Zealand, over half of our architectural graduates are female but this number significantly drops within professional practice. The fact remains that industry is a male citadel whether in the realm of design or manufacture. This paper explores a new generation of women building their own coalitions and strategies that promise to bring about change within the architecture and the construction discipline with the formation of a collaborative group: Women in Fabrication. The purpose of forming a female fabrication group was to support learning through the process of making, creating a project-based platform that created leadership opportunities and better accessibility to fabrication and mentorship. Students were given the challenge of designing and building a pre-fabricated exhibit at a prominent Building Expo in New Zealand. With a timeline of six weeks, students had to learn CAD/CAM technology and apply what they learnt to a real-life design making situation- providing a platform for learning and sharing ideas. Digital design processes allowed for the project to be morphed, tweaked and customized with new interchangeable parts to suit the different prescribed audiences and function. This educational model aims to provide everything from leadership opportunities and understanding fabrication to networking with industry suppliers, whilst also providing senior female role models to young designers at architecture institutions.

Keywords: Fabrication; design-build; women; collaboration.

1. WHERE ARE ALL THE WOMEN ARCHITECTS?

There has recently been an increase of data surrounding the lack of visibility of women in the field of architecture and construction. The April 2016 issue of Architecture Now (Melbourne-Hayward, 2016) revealed that only 1% of women architects are in senior roles in New Zealand. Within the construction industry, the statistics revealed that only thirteen percent of industry employees are women and they can expect to be paid 12.7% less than their male counterparts (Hutching, 2017). Work created by women architects is largely unseen in journals and allied publications (Gatley and Lee, 2013). The contribution that women in architecture have made to the New Zealand context is under-researched or unknown.

When it comes to gender equity in architecture there is still a long way to go; there is still a need to develop the participation of women at the decision-making level in these industries.

Other professions, such as Law and medicine, two equally demanding and traditionally male professions, have been much more successful in retaining, mentoring and integrating women (Stratigakos, 2016). As New Zealand faces a skilled shortage within the industry as a whole (Wenman, 2018) why are there not more women signing up to take part to fill the vacancy?

1.1 What exists in the NZ context:

Understanding both past and present pathways and experiences of women who currently are practicing or studying architecture is very significant in terms of addressing the ongoing issues of equality. The current New Zealand context needs to look toward methods of working and promotion that challenge traditional hierarchies and foster inclusion within the social and environmental architectural condition.

Throughout our architectural education, a lack of female role models in industry and education is evident yet there are significant milestones and female figures that should be acknowledged in New Zealand. Lucy Greenish was elected an associate of NZIA in 1913. Alison Shepard, who was told she could not become an architect in New Zealand, travelled to London, graduated from the Architectural Association and became an associate of the RIBA in 1927. In 1933 Merle
Greenwood became the first woman to graduate with a degree in Architecture in New Zealand. Lillian Chrystall earned the NZIA bronze medal for her Yock House in 1964 (Gatley and Lee, 2013) – the first formal recognition that a woman architect was as good as her male counterparts.

There have been recent positive signs of change within the Architectural realm, with the key appointment of Christina van Bohemen as President of the NZIA, and with female enrolment into architectural institutions increasing up to 50%. Yet only 29% percent of registered architects are women - this is a significant drop in percentage (Strang, 2018).

Founder and CEO of non-for-profit PrefabNZ, Pamela Bell has been a prominent female figure within a male dominated construction industry. Bell stands as a role model for future generations of women in the construction industry. Her ‘Logs4Jobs’ initiative with Carter Holt Harvey Woodproducts, BCITO and CareersNZ aims to raise awareness of work opportunities for women and normalizing female participation within the field (Melbourne-Haywood, 2017).

Collaborative groups such as Women in Architecture NZ aim to create a network and work database of female architects. Their project Motu Kaikōura Lodge Building represents a generous investment in supporting community engagement and training women architects in construction processes; in partnership with NZIA Women + Architecture NZ and Strachan Group Architects (SGA). The building was developed as a prefabricated modular system and delivered – via helicopters and barges – to the remote island site (Hosking, 2017). The project was a 2018 Auckland Architecture Awards winner.

As one of the four founding directors at Makers of Architecture, Beth Cameron has played a fundamental part in pushing the boundaries of what’s possible as a female architectural graduate within the design and CNC fabrication realm. Makers of Architecture are reducing the gap between design and build, and they are continuing to experiment with experiential installations (Melbourne-Haywood, 2017).

At the University of Auckland’s School of Architecture and Planning (SoAP), student Melanie Pau with the help of Senior lecturer John Chapman re-invented the second semester Timber Technology Class in 2012 by drawing influences from Wikihouse construction systems. The first project entailed designing a plywood structure to improve safety and visibility at a primary school in a deprived area. The design received a number of international and national awards including Bentley Systems’ Scott Lofgren Student Design Award, New Zealand Wood Award and Design Institute of New Zealand’s Spatial Gold Pin (Patel, McMeel and Chapman, 2015). Pau’s success has led to an established course at SoAP and has subsequently led to the fabrication of nine other shelters utilizing similar design and build principles that were built over a five-year period. Three other female students have also taken to designing and fabricating their own structure at Henderson High School, developing on the previous year’s construction techniques.

In some respects, we have come a long way both in professional and academic spheres; but numbers show, especially in regard to leadership and promotion, that much more can still be done. The first step in attaining equality is to train architecture students to be proud and steadfast about the value of their labour and their ability to bring together a number of disciplines and fields of inquiry. The emphasis of ‘Women in Fabrication’ starts by creating a collaborative practice between the architecture and the construction discipline, university students and key industry suppliers; providing projects that create leadership opportunities and better accessibility to female mentorship. We need to open up to change by embracing and supporting the development of young women.

1.2 Technology

Many believe that by embracing new possibilities we abandon thousands of years of precedent (Celento, 2010, 78), however this concept is just a myth. It cannot be ignored that Pau and Cameron utilized technology to ease the acceptance of woman within the realms of digital fabrication. Production technology is undoubtedly challenging the way architecture is practiced and produced.

Simple automated file to factory process can allow architects and other designers to be more directly associated in the manufacture of building (Willis and Woodward, 2010, 208). Investment by young and entrepreneurial architects, engineers, digital hackers and academic researchers is allowing innovative ideas to be generated through the production of physical prototypes.

1.3 Problem

Current accessible and inclusive fabrication design processes embedded into education and practice are often experienced as dull, exclusive, and male-dominated, with many female students having limited access.
This paper recognizes the gap in education and promotion of young female architects entering the architectural industry and begins to shape the conversation in creating a more socially inclusive architectural environment. Women in Fabrication provides leadership, mentorship and real-life build experience opportunities by bringing currently separate and exclusive facets of the architectural industry together (Figure 1). Together these facets aim to facilitate collaboration, innovation and to develop knowledge, confidence and recognition for women in the architectural industry; increasing the awareness of the creativity and skills of women designers in the built environment and increase diversity and inclusion in the profession.

2. METHODOLOGY

This section discusses three core aims on how best to promote women in the fields of architecture and construction. The first issue to briefly discuss is the opportunities that are present in showcasing Women in Fabrication. The second is how communication becomes a key learning milestone. The third issue discusses the learnings that come from fabrication processes.

2.1 Opportunity: Showcasing Women in Fabrication at Unitec Institute of Technology:

To create opportunities to promote women in both fields requires collaboration between designers and builders, industry bodies and suppliers. The formation of ‘Women in Fabrication’ recognized the importance of supporting women, not only within architectural education, but also in the field of construction. Unitec Institute of Technology was in a prime and unique position to achieve this kind of participation as it is the only tertiary institution in NZ to offer both architectural and construction degrees.

Students were provided with best female role models during each phase of design - lecturers, technicians, product representatives and consultants all came on board to collaborate and help to strengthen leadership skills increasing awareness of diversity in the profession.

2.2 Communication: Management, Industry, Public realm:

Communication is an important backbone within the field of architecture (Stacey, 2012, p63). Architects, in general, do not make buildings; they design information to inform the construction of the building. The making of buildings in the traditional sense requires skill and expertise. However, software and technological advances are challenging this requirement. Automated tools provide the opportunity for architects to be neither designer nor maker, but both (Sheil, 2012, p9).
At the first point of contact with industry sponsors, suppliers and benefactors students were asked to present developed design schemes, processes and commentary on how the full range of issues were to be addressed. These issues ranged from budget constraints, prefabrication requirements, client needs and durability. Each project was to serve a dual agenda of providing social good as well as educational value.

2.3 Fabrication / Learning: Making, prototyping:

Digital forms can be easily produced in a digital environment, however to realize them in the physical world is another matter entirely. It can seem overwhelming when the incorrect approach informs production (Sass, 2007). The creation of the architectural prototypes needed to have a flexible, but rigorous approach to cope with the limited timeframe provided.

There is a need to break down design ideas into manageable portions to work with architects, engineers and other construction consultants, this produces numerous scenarios that can be tested, allowing for fewer uncertainties to arise (Anderson and Anderson, 2006). If you can test the design before committing it to the final product, you can afford to be more ambitious; although you must be confident since there is rarely enough time for major changes to be implemented into an idea (Thornton, 2005). By observing and researching how others have integrated different scales of prototyping into the production programme an iterative prototyping programme was selected to develop the design into a credible construction system (Stacey, 2008).

A workflow developed between creating digital virtual models and producing scaled mock up models which were essential for students to not only integrate their designs, but to converse with the industry partners. To put it simply, the act of prototyping was an essential stage of the project, ensuring construction stages went smoothly. The use of models produced at 1:20, 1:10, 1:5 and 1:1 were used to address several issues. They were used to assess the scale and size of the project, they also provided visual representation to all the shareholders in the project, and lastly they were used to refine elements of the sculptural form that looked out of place. The design team, which consisted of engineers, architects, students, industry professionals and academic staff, referenced the models throughout the design and fabrication stages (Janus, Contractor, Patel & McPherson 2017).

3. WOMEN IN FABRICATION AT BUILDNZ / DESIGNEX

An opportunity was offered by PrefabNZ – their XPO Exhibitions and Carter Holt Harvey Woodproducts - to promote young women at a predominately male centric event. This project was brought to the Unitec Institute of Technology ‘Women In fabrication’ team. It was the first ‘Prefab NZ Interactive Display, Brought to You by Unitec’ exhibit to be showcased at the Buildnz/Designex expo at Auckland’s ASB Showgrounds in June 2017. Conditions set by Carter Holt Harvey Woodproducts meant the final built project had to be feasible, while PrefabNZ required the students to use digital fabrication to showcase innovative construction technology. Labour, design process, organization, productivity and technology were just a few of the key components the female students were required to learn through the production of a series of experimental prototypes.

3.1 Timeline

Within six weeks, students were required to learn software then design, prototype and produce a well resolved outcome. Encouragement to investigate beyond the digital process meant students explored materials, errors, tolerance and the tight time frame led to a crash course in making.

The programme was split into three distinct segments within the six-week timeframe. The first four weeks were dedicated to design and documentation, where students were required to learn the software and produce scaled models to understand their design and how each component would be put together. The fifth and sixth weeks were scheduled for material procurement and workshop fabrication respectively. The last day of the programme was dedicated to transporting the prefabricated modules from the workshop to the expo for assembly.

The practice of prototyping allowed the students to formulate solutions to problems in efficient time. The students existing base skill set allowed for a workflow to be tailored and organized to maximize efficiency, and also ensured they built an increased understanding, experience and knowledge for future projects. In particular the students gained an understanding of how materials can contribute to design outputs and this in turn provided them with different perspectives on how to approach digitally designed outcomes. The combined input from different disciplines allowed for a fertile playing ground in which they could develop and test new successful strategies.
3.2 Design Concepts and Implementation

The industry brief was split into two. The first was to design a display that visitors could touch; creating a conversation around materials and construction. The second asked for a design exploration that predominately demonstrated how portal-frame structures and simple CNC-produced modular plywood boxes can cater for change and mass customization. The students, with the help of industry experts, came together to push the boundaries of what can be produced with Plywood given short timeframes and the construction systems pushed for greater inclusion of modular technologies and flexibility.

The “interactive display” comprised two pods: the “living pod” and the “interactive pod”. The “living pod” and “interactive pods” both showcased engineered timber technology Using CNC machinery a series of CNC plywood ‘kit of parts’ were created to demonstrate innovation and collaboration in offsite design and construction within New Zealand. The purpose of the ‘living pod’ was not to propose a specific solution; but rather to investigate what possible changes could be made to the building industry’s existing ways of working through automation. The final mock-up needed to be a habitable sleepout.

The design for the ‘Interactive pods’ was led by three key post-graduate female architecture students. These ‘Interactive Pods’ were imbedded with modular principles to ensure that future iterations of the design could be adapted and transformed into a product that could be customized to suit different functions and spaces; and that assembly and disassembly could be achieved in a short timeframe. Through the process of failure and redesign, students not only achieved incredibly original and thoughtful designs but also became more persistent, learning to work in heterogeneous teams. They became better at time management and self-development. The observations presented an encouraging finding that it is indeed possible for individuals ranging in experience and skill to easily learn, fabricate and assemble a functioning prototype within a short period of time.

After the exhibit was completed, the living prototype and interactive pods were repurposed for two different locations. The projects and collaborations had provided the students with critical design tools, knowledge and advice-leading to outcomes that efficiently answered the given briefs. The skills obtained could be applied across the board to different digital technologies and building practices, helping students develop the adaptive knowledge needed for the developing construction industry today.

4. FINDINGS

We observed that the establishment of this collaborative group allowed students to engage in intellectual activities and practices that would not be typical in mainstream architectural education, and experience new ways of working with novel levels of team collaboration. The industry network and the people working alongside these projects were the most important resources. These female representatives took time to give the female students advice and invaluable mentorship at different stages of the projects; creating a hierarchy of support and guidance for the next generation.

The efforts of Women in Fabrication and the support from industry are making architecture a better community for women, giving them confidence to pursue their design abilities further. An intergenerational mentoring programme has developed to help female graduates make the transition into practice.
4.1 Opportunity

All students were encouraged to look at a problem from different perspectives. Talking to industry and mentors about their work - learning about other people and different processes is a priceless learning outcome, one that cannot be matched. Everyone has something to teach, but it is important to emphasize that this is a reciprocal process – the younger students can also contribute and enrich the discussion.

Women in Fabrication adds to an existing framework, by helping to create significant pathways through practice and education, providing opportunities for mentorship and creating role models (both formally and informally). It is important that the contributions of women architects, students, graduates and young designers are visible, respected and rewarded.

4.2 Communication

In the initial meetings the design ideas were presented to almost exclusively male representatives but, as projects were developed, industry collaborators began to promote their own female representative.

This provided senior female role models to students and encouraged industry partners to consider who could provide the best support for the students and where they could demonstrate promotion of woman in the construction industry. Key role models during this design presentation stage included female representatives from PrefabNZ, key organizers from the 2017 Buildnz expo and representatives from Carter Holt Harvey, Knauf Insulation and Proclima.

4.3 Fabrication

The younger generation of architectural students demonstrated a greater capability to learn technology quickly - specifically how to run the CNC router. This can be attributed two factors- the first is how much technology was already integrated successfully into their lives and the second factor was the constantly increasing amounts of available resources – whether in online communities, amongst the student cohort, available technicians, or lecturers - for the students to consult with. The practice of prototyping allowed the students to formulate solutions and an understanding of materials and unfamiliar construction methods. Every decision from scale, shape, and placement on site, through to construction details were decided through the creation of prototypes.

4.4 Beyond the original showcase

The second iteration of the pods was adapted and displayed at the Unitec 2017 Festival of Architecture exhibit. The design was placed in the atrium space of the Mason brothers building. The installation displayed architectural drawings, furniture, scaled architecture models and books. The digital model was copied and developed to allow the addition of further plywood structures and the replacement of some key plywood panels to include interactive tables.

The replacement of panels was simple, as the digital models provided all the information to reprint the replacement panels that needed to be added to the pod structure. It was clear the new-found confidence many of the female students gained meant there was a push in further design development with the focus on the experimentation of connections and components.

The pods were again assembled and adapted in the open forecourt of the Unitec student ‘Te Puna’ Hub for the special harvest edition of ‘Life and Leisure Magazine’. New components were printed to replace the original components to allow for the housing of plants and herbs.
5. CONCLUSION:

The built projects provided students with the opportunity to rapidly gain understanding of the requirements, to not only learn new concepts but also how to apply them in a variety of given situations.

The projects occurred in team and mentoring environments. Women in Fabrication created a supportive network for young female students to encourage and learn from each other in the construction industry. Having female representatives and industry leaders gave the students role models look up to and supplied much needed mentorship. The projects became an opportunity for students to gain respect and assume responsibility for the whole construction process, whether it be through digital or handcraft making methods.

With interest growing with each new project, more and more students at different levels of experience, wanted to collaborate with Women in Fabrication. This resulted in the more experienced students helping the younger female students to improve their limited skill sets. This transfer of knowledge was useful in providing younger architectural students with post-graduate role models; encouraging the younger students to learn and develop skills beyond what was taught in the mainstream curriculum. Women should support other women. Power derives from sharing information.

Students involved with Women in Fabrication were recognized for their efforts on a number of platforms – being featured in magazines, the PrefabNZ newsletter and website platforms. Key female students who worked within Women in Fabrication have now continued to mentor others; many are still active in the community, presenting their learnings from the projects, speaking at high schools and conferences. They are continuing to utilize and expand their skills: working on other projects such as housing prototypes, straw bale construction research and furniture making.

Ultimately, as an industry, our long-term goals should be focused on education. In the short term, we should be trying to maximize the options available to our female designers and provide better access points and opportunities in industry and mentorship.

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