## UQ Winter Research Project Description

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Review and report on the outcomes of Enduring Design Masterclass June 2021</th>
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<tbody>
<tr>
<td>Project duration:</td>
<td>4-5 Weeks</td>
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| Description: | The aim of the Winter Research Project is to report on the outcomes of the Enduring Design Masterclass being sponsored the Prince’s Trust and run by UQ School of Architecture as a student and professional development activity Winter School in June/July 2021. The masterclass will be a week-long event where traditional design techniques and approaches from Indigenous and settler cultures are discussed in terms of their enduring lessons for architects now.  

*The research project will involve:*  
  - helping with the masterclass activities (1 week)  
  - collect and analyse feedback from participants to measure impact (1 week)  
  - write up/report on the activities (1-2 weeks) |
| Expected outcomes and deliverables: | By participating in the Enduring Design Masterclass the student will gain experience in the principles of vernacular design and its benefit to the process of sustainable urbanism. They will also gain skills in data collection and analysis of participant’s feedback. The students will be asked to produce a report on their findings at the end of their project. |
| Suitable for: | This project is open to applications from students in either their third year of the Bachelor of Architectural Design or the Master of Architecture. |
| Primary Supervisor: | Dr Cathy Keys |
| Further info: | Students should apply by explaining their experience in the above topic, including courses undertaken at UQ or elsewhere that deal with cultures and architectures other that settler Australian culture, but also vernacular and settler architectures in Australia and beyond. Students should include with their application a short piece of writing that demonstrates their skills in written communication e.g. an essay or report written for a previously undertaken course. |
**UQ Winter Research Project Description**

<table>
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<th>Project title:</th>
<th>Robotic FRP fabrication with a customized non-standard geometry</th>
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<td>Project duration:</td>
<td>4 weeks</td>
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<td>Description:</td>
<td>Recent studies on topology optimization have found that material efficiency can be significantly improved by using irregular sections to replace the conventional sections in some structural members. The optimized structures are also tended to be with changing cross-sections along the member span or height, such as the tree-like structure used at the Qatar National Convention Centre and the Art Nouveau Apartment by Flying Concrete in San Miguel De Allende Mexico. FRP is found to be a promising material for the irregular profiles because of its high flexibility. However, as above mentioned, conventional manufacturing techniques have their limitations on irregular shapes. The fabrication method proposed to investigate is developed inspired by the novel hybrid double-skin tubular arch bridge system developed in UQ, in which prefabricated FRP tubes are used both as formworks for concrete casting and as reinforcement to construct a hybrid bridge structure.</td>
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Based on this system of construction, our research is introduced to explore the potential to use robotic technology for robotic fabrication of structural members with greater formwork flexibility to reduce the cost of transportation and to increase the material and structural efficiency of the building structure.
## Expected outcomes and deliverables:

Scholars may gain skills in basic industrial robot control, non-standard geometry design optimization, robotic fabrication path planning, prototype fabrication experience.

The scholars are expected to deliver an adaptive path planning for robotic fabrication with non-standard FRP tube geometry. Design and fabrication of a jointing system between robotic fabricated subassemblies will also be required. A final customized concrete-filled FRP tube prototype will be fabricated if applicable.

There will also be an opportunity to generate publication based on the prototype geometry design pattern and the robotic fabrication method.

## Suitable for:

This project is open to senior undergraduate and master students with a background of civil engineering or architecture. One for civil engineer and one for architecture are preferred.

Students owning previous experience with FRP/concrete or rhino/grasshopper will be in higher priority. The students must gain access to the structure lab and industrial robotic arm by completing all relevant inductions before the research program.

## Primary Supervisor:

Dr. Dan Luo

## Further info:

Dan Luo d.luo@uq.edu.au
Please contact the supervisor prior to submission
UQ Winter Research Project Description

| Project title: | Design and Fabrication of Timber Structures: Prefabrication and digital fabrication strategies for large-scale timber construction, and alternative uses for under-valued sawmill products in innovative timber structures. |
| Project duration: | 4-5 weeks part-time over the UQ Winter Break - on site only. |
| Description: | Proposal: This project will investigate the design and fabrication of innovative structural timber systems and digital fabrication technologies. It will involve fabrication of large scale timber to timber connections and include processes that adapt non-standard and ‘low value’ timber products. A key research focus will be the development of sophisticated manual and digital fabrication techniques, that investigate alternative timber construction systems to conventional stud framing and roof truss construction. It will involve design and prototyping processes that involve the physical construction of 1:1 prototypes. 

This approach seeks to add value to the ‘low value’ timber members by combining them together in a novel way in order to achieve overall physical and mechanical properties where the whole is greater than the sum of its parts.

The research objective will be to investigate the assembly of small member sizes arrayed in 3-dimensional Mass Timber structures and connections that employ novel configurations to achieve large spans and stiffness through inherently stable geometric configurations and interconnections between aggregated members. |
Articulated Timber Joint using mass timber
- Shigeru Ban

CNC routed Hooked scarf Joint
- Kim Baber and Joe Gattas - Centre for Future Timber Structures

An interdisciplinary architecture and civil engineering student cohort will be the major contributors to the project, with Kim Baber providing supervision.

Background:
The current softwood timber framing market is dominated by the demand for a narrow range of domestic structural framing member sizes in the range of: 90mm x 45mm, 90mm x 35mm, 70mm x 45mm, and 70mm x 35mm. Only a certain volume of timber milled from each log can yield these member sizes at a certifiable structural grade. The yield of framing sized members depends on the diameter of the log, and where the timber is cut from. Timber cut from the heartwood has low strength, and timber cut too close to the sapwood is frequently prone to visual and dimensional defects such as wane and warp. The profile of the log also necessitates that timber sections be cut thinner toward to the sapwood.

In order to yield the most efficient amount of sawn timber from given log, there will always be a significant volume of timber that is low strength heartwood, a quantity of boards that are relatively thin, as well as a certain percentage of the framing sized members that have some defects along their length. These all fall into the ‘low value’ category and cannot be certified for use as structural framing.

Figure: Much of a typical log ends up too thin or with too much heartwood to be used for certified structural framing.

Much of what is categorised ‘low value’ is due to it not meeting the minimum dimensional and physical requirements of the construction industry’s domestic framing market. Similarly, much of the ‘low value’ timber that has been rejected to defects, may actually be of a certified structural grade, but has visual defects such as waning, warping or discoloration, so is deemed unsatisfactory by the market. Members with structural defects such as knots or checks are often only affected by less than 20% of the length of the member, allowing the remainder
to be perfectly usable, but this is perceived to be too short (e.g., at lengths 1.8m or less) and deemed unsatisfactory by the market.

The key issues driving the de-valuing of these timber products, is the ubiquity of one standard of domestic framing system, and the industry’s perception of what is visually and dimensional acceptable and convenient to use. A successful demonstration to industry of alternative systems that adapt low value timber products could change this.

**Significance:**

In the context of a growing demand on both construction materials and natural resources, developing alternative methods of timber framed construction that add genuine value to these ‘low value’ timber products has significant potential to improve economic sustainability in the industry.

Maximising the net yield of usable structural timber from harvested logs will increase the proportion of timber products that are available to meet demand from the construction industry, thus increasing the availability of renewal materials and enhancing sustainable practices in the industry.

The construction of a demonstration project to showcase the innovative use of this undervalued product is a direct and tangible method to increase awareness in the industry, and can be an effective format to encourage change of practices.

| **Expected outcomes and deliverables:** | Students will actively participate in the design development, documentation, modelling and fabrication of a series of timber prototypes and the construction of full scale timber structures. These structures will demonstrate the development of novel fabrication techniques and test structural application that increase the use of under-valued timber products. |
| **Suitable for:** | This project will be suitable to students already who have some experience in working in the School of Architecture Co-Lab and/or the School of Civil Engineering Structures Lab. Students should have capacity to model in Digital 3D software such as Rhino, Grasshopper Revit or Autocad 3D. Students are to have completed the requisite safety induction prior to commencement of the project. |
| **Primary Supervisor:** | Kim Baber, Fellow in Civil Engineering and Architecture  
*School of Architecture* |
| **Further info:** | There are positions for 2-3 students Part time in this research project. Please Contact Kim Baber for further information k.baber@uq.edu.au |