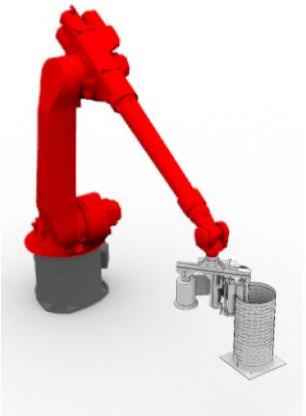
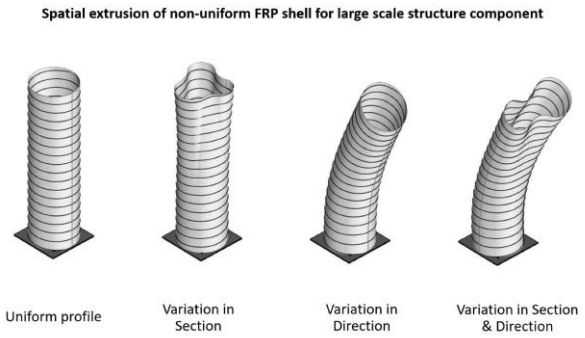
UQ Summer Research Project Description

Project title:	**Robotic FRP fabrication for large scale customizable structure**
Project duration:	6-8 weeks
Description:	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 (Figure 1) 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.  *Figure 1 Qatar National Convention Centre, Doha. https://www.bega.com/it/progetti/qatar-national-convention-centre-doha/* The fabrication method proposed to investigate is developed inspired by the novel hybrid double-skin tubular arch bridge system developed in UQ (Figure 2), in which prefabricated FRP tubes are used both as formworks for concrete casting and as reinforcement to construct a hybrid bridge structure.  *Figure 2 Hybrid double-skin tubular arch bridge system developed by Dr Dilum Fernando in University of Queensland.* 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:	The scholar will gain skills in geometrical optimization for robotic fabrication, basic industrial robot control and path planning for fabrication/construction, design and developing adaptive fabrication system for customizable building components. The scholars are expected to deliver a fabricated prototype at the end of the project (figure 3) and evaluate the system. There will be opportunity to generate publication based on the outcome of the research.   *Figure 3 Potential prototypes.*
Suitable for:	The project is open for senior undergraduate and master students in Civil and Architecture. Previous experience with FRP or Grasshopper is preferred. The students must gain access the structure lab and industrial robotic arm by completing all relevant inductions before the research start.
Primary Supervisor:	Dr. Dan Luo
Further info:	Dr Dan Luo (d.luo@uq.edu.au) Please contact the supervisor prior to submission.

UQ Summer Research Project Description

Project title:	**2021 Seoul Biennale of Architecture and Urbanism, Global Studio – Design Research for an Urban Refuge**
Project duration:	10 weeks
Description:	The research project is embedded in the program "Global Studios" as part of the 2021 Seoul Biennale of Architecture and Urbanism. Dr Silvia Micheli has been invited as a studio leader to participate in the program, which is structured as a design collaboration with Phorm architecture + design and UQ researchers. The project will involve the design of an Urban Refuge, to be exhibited in the Seoul Biennale program. If shortlisted, it will be built as a temporary pavilion during the period of the event. The project explores the potential of 'The Flat Shop' in the Post Pandemic City, through the design of a physical spatial device that will re-negotiate the domestic refuge and its adjacent public edges. Activities will involve design collaboration, prototyping, modelling and testing innovative solutions.
Expected outcomes and deliverables:	Students will gain skills and experience in architectural research covering typological studies, design delivery and collaboration and practices of lightweight construction. They will have the opportunity to work across industry and academic contexts with leading practice, Phorm architecture + design, and lecturers and design researchers, Silvia Micheli and Antony Moulis (UQ) on a live studio project. The project offers the unique opportunity to be directly involved in the Seoul Biennale – a premier international event for the disciplinary discussion of architecture and urbanism globally.
Suitable for:	This project is open to applications from students with a background in architectural design and construction with excellent graphic and physical modelling skills and an interest in pavilion design and construction in the urban context. Applicants should also have interest in a global discussion in architecture and be keen to work between academia and practice and in a collaborative environment.
Primary Supervisor:	Dr Silvia Micheli with Paul Hotston (Phorm Architecture + Design) and UQ Associate Professor Antony Moulis
Further info:	Dr Silvia Micheli (s.micheli@uq.edu.au)

UQ Summer 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:	6-8 weeks part-time over the UQ Summer Break 2020
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 x45mm, 90mmx35mm, 70mmx45mm, and 70mmx35mm. 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 efficeint 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 realtively 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 certfied for use as structural framing.

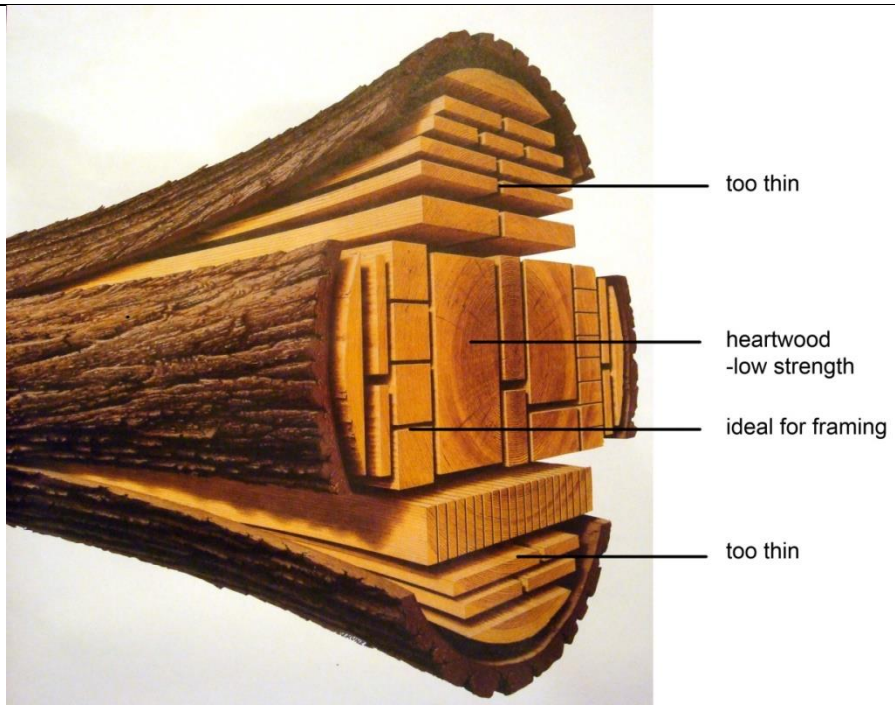


Figure: Much of a typical log ends up too thin or with too much heartwood to be used for certfied structural framing.

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 (eg 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 2-4 students Part time in this research project. Please contact Kim Baber (k.baber@uq.edu.au) for further information

UQ Summer Research Project Description

Project title:	**Aboriginal Environments Research Centre projects and archive maintenance**
Project duration:	8 weeks
Description:	Agreed tasks and target outcomes to be selected and negotiated from the following: (1) Maintenance of selected data sets in the Aboriginal Environments Research Centre archive (2) Assisting with current architectural and urban planning consultancy and research projects (3) Assisting with current research grants (Health Architecture, Wild Australia Show history) (4) Working on new edition of *Gunyah, Goondie + Wurley: The Aboriginal Architecture of Australia* (5) Working on the new publication with Aboriginal scholar Alison Page on Indigenous design.
Expected outcomes and deliverables:	Skills in accordance with tasks from following: (1) Referencing and digitising data sets; compilation of data guide (2) Historical place research in archival and online collections for current Brisbane urban planning contracts (3) Literature collection and analysis General: Familiarisation with operations of a research centre and current range of research projects by staff and postgraduates.
Suitable for:	M. Arch students with high grades and intending to do an M. Arch thesis or RHD status.
Primary Supervisor:	Professor Paul Memmott
Further info:	Please contact Linda Thomson at AERC office to discuss your interest and submit an application. Phone: (07) 3365 3660 Email: l.thomson@uq.edu.au