UQ Summer 2021-2022 Research Project Description

Project title:	**Pavilion for 2022 Asia Pacific Architecture Festival (APAF)**
Project duration, hours of engagement & delivery mode	10 weeks duration 36 hours per week In-person - on-site attendance is required
Description:	*Since 2016, APAF has successfully delivered a thought-provoking program of exhibitions, installations, symposia, lectures and workshops, promoting and celebrating architecture's pivotal role in the culture, sustainability and economy of the Asia Pacific region. Based in Brisbane, the festival encourages exchange and networking across the region.* *Within this event our team has been asked to design a pavilion (4x4x6m) developing ideas around a cultural exchange with South Korea, focused on building techniques and materials. The research builds on an installation designed and constructed by a team from the UQ School of Architecture for the 2021 Seoul Biennale of Architecture and Urbanism.*
Expected outcomes and deliverables:	*Students will gain experience in collaborative design and construction techniques working directly with UQ researchers and industry partners (Phorm architecture + design) on design, construction, logistics and media.*
Suitable for:	*Architectural students or engineering students with an interest in innovative building design*
Primary Supervisor:	Dr Silvia Micheli, Paul Hotston, Nicola White and Associate Professor Antony Moulis
Further info:	Applicants can contact s.micheli@uq.edu and a.moulis@uq.edu.au for further information. Please note the supervisor team wishes to be contacted by prospective applicants prior to submitting an application.

UQ Summer 2021-2022 Research Project Description

Project title:	**Queensland Digital Heritage Partnerships and Strategies**
Project duration, hours of engagement & delivery mode	Project will be six weeks duration at 3 days (or equivalent) per week. Some remote work is possible but one of the aims of the project is to be embedded in the offices of a partner organisation at one day per week, on site in Fortitude Valley. Other work where possible will be at Zelman Cowen building and a computer will be provided. The project will not operate over the Christmas-New Year period when the University will be closed. The exact working weeks and days will be negotiated with the successful scholar.
Description:	The project asks the summer scholar to assist in the development of case studies for the Digital Heritage Strategy for Queensland Government, a current research project in the School of Architecture. The tasks will involve working with partner organisations, both remotely and in person, to develop the project plan for the case studies that will test and demonstrate the requirements for digital documentation of heritage places in Queensland. Partners will include software engineers, heritage managers, architects, government and other organisations. The summer scholar will research and collate heritage material on the case study place/s, test the inclusion of heritage documentation data in the partner's software system, and help to analyse and document this process. Further the scholar will assist with organising several online partner workshops to share ideas and develop the work, which the scholar will also record, document and analyse.
Expected outcomes and deliverables:	The chosen scholar will gain skills in digital heritage documentation, including 3D laser site scanning if Covid-restrictions permit. They will also learn skills in project planning, research, transcription analysis. They will work alongside software engineers and gain familiarity with digital workflows, data governance and the development of data standards.
Suitable for:	This project is open to students in Bachelor of Architecture who are moving into their third year of study, or Master of Architecture students. Students who have skills and experience in 3D BIM modelling and /or excellence in heritage study withing the course are particularly encouraged to apply. Please supply your two most recent semesters marks, and details of any digital modelling or heritage expertise (no more than 1 A4 page for this information please.)
Primary Supervisor:	Dr Kelly Greenop
Further info:	For further information please contact the advisor.

UQ Summer 2021-2022 Research Project Description

Project title:	**4D Construction Learning Environment AR Enhancement**
Project duration, hours of engagement & delivery mode	The project will be six weeks duration at 3 days (or equivalent) per week. The project aims to embed the Summer Scholar in the offices of a partner organisation in Fortitude Valley for at least one day per week. Other work will be in the Zelman Cowen Building and a computer will be provided. The project will not operate over the Christmas-New Year period when the University will be closed. The exact working weeks and days will be negotiated with the successful Scholar.
Description:	The 4-Dimensional Construction Learning Environment is an existing eLearning digital platform designed to provide contextualised learning, and a safe, practical and pedagogically consistent alternative to work-integrated learning through traditional job placements and site visits. The 4D Environment uses 3-dimensional photographic surveys captured at weekly intervals to provide interaction with a 'live' construction project. This project seeks to expand the functionality and usability of the eLearning platform through the creation of interactive virtual reality self-guided tutorials using photographic surveys and CAD models of two recent UQ construction projects, the Advanced Engineering and Andrew N Liveris buildings. The project will involve working with the partner organisation to develop an initial project plan and then a series of demonstration self-guided tutorials. Partners will include software and emerging technology engineers, and UQ eLearning designers.
Expected outcomes and deliverables:	The successful Scholar will gain skills in architectural construction and technology, 4D virtual and augmented reality, and project planning and self-directed research. They will work alongside software engineers to develop digital workflow, data governance and standard skills, and eLearning designers to develop educational design and delivery skills. Outcomes will include a series of self-guided tutorials that integrate digital photographic surveys and CAD documentation from 'live' construction projects into a 4D virtual and augmented reality experience.
Suitable for:	This project is open to students who are moving into Year 3 of the Bachelor of Architectural Design, or in the Master of Architecture. Students with high level skills in 3D CAD/BIM modelling and an interest in building construction and project management are encouraged to apply. Please supply your two most recent semesters marks, and details of any digital modelling or construction expertise (maximum 1 x A4 page).
Primary Supervisor:	Associate Professor Chris Landorf at c.landorf@uq.edu.au
Further info:	For further information please contact the primary supervisor.

UQ Summer 2021-2022 Research Project Description

Project title:	**Investigation on robotic fabrication approach of structure with FRP composite material**
Project duration:	*10 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.designbuild-network.com/projects/qatarnationalconvent/ 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. Some preliminary research has been conducted on FRP formwork fabrication by industrial robot in Figure 2. Based on this experience, next step will upgrade fabrication system and explore more geometrical design with higher flexibility.

	 Figure 2 Robotic FRP formwork fabrication
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 scholar will also gain more skills in lab work and be more familiar with hand tools. The scholars are expected to deliver a fabricated prototype at the end of the project and evaluate the system. There will be opportunity to generate publication based on the outcome of the research.
Suitable for:	The project is open for senior undergraduate and master students in Civil and Architecture. Previous experience with FRP composite material or related CAD software (Rhino&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:	Dan Luo d.luo@uq.edu.au Please contact the supervisor prior to submission

UQ Summer 2021-2022 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:	4-6 weeks part-time over the UQ Summer 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 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.

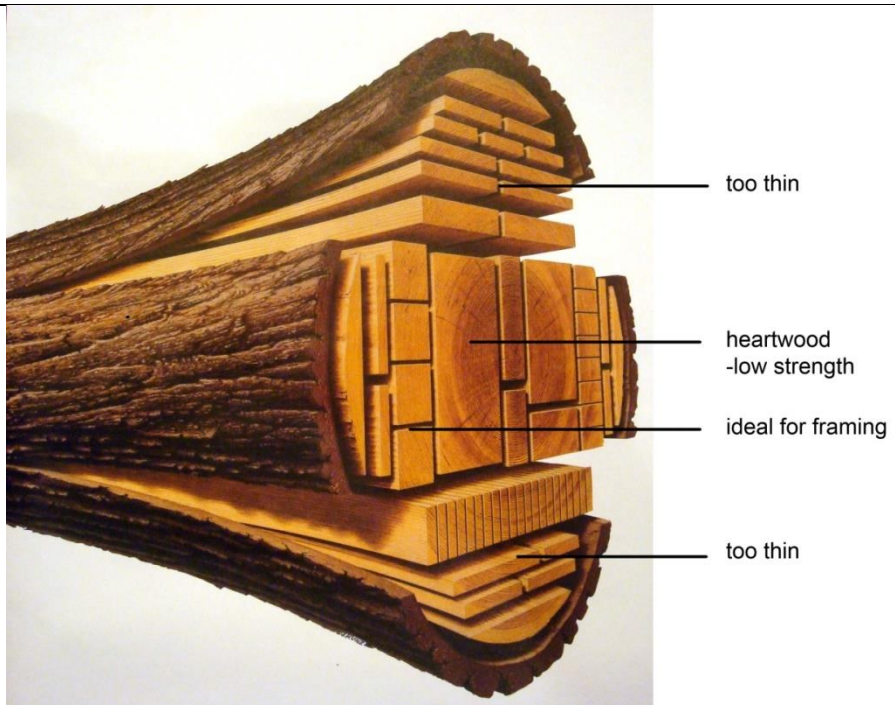

Figure: Much of a typical log ends up too thin or with too much heartwood to be used for certfied structural framing.

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 2-3 students Part time in this research project. Please Contact Kim Baber for further information k.baber@uq.edu.au