

Timber Structures by Architecture Students





The role of Wood. Naturally Better.™ is to provide information about Australia's forest and wood products. Our aim is to further the understanding of the natural advantages of sustainably sourced wood and its positive contribution to reducing the effects of climate change.

Wood. Naturally Better.™ is resourced by Forest & Wood Products Australia (FWPA, www.fwpa.com.au). It is a collaborative effort between FWPA members and levy payers, supported by industry peak bodies and technical associations.

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Introduction

In a study funded by Forest & Wood Products Australia (FWPA) senior architecture students from the University of Queensland were presented background information on hardwood plantations, principles of wood science and elements of timber design. Using this information and with support from their lecturer they worked individually and in teams to produce designs and models for roundwood structures.

Critical design considerations related to timber use in construction, for example durability in-ground, above ground, corrosion of fasteners, strength, stiffness, roundwood properties compared to sawn wood, and implications of untreated sapwood, were presented to the student architects. Industry inputs came from Outdoor Structures Australia, Queensland Primary Industries Fisheries and Timber Queensland in addition to the inputs from the academics coordinating the student research project.

Initial design ideas and possibilities were generated during a full group brainstorming session. Through discussion it was decided that the range of possible solutions would be best packaged into four defined project types based around scale and use. In simple terms the categories established were as follows:

- Small sized buildings / structures
- Medium sized buildings / structures
- Large sized buildings / structures
- Infrastructure projects, systems and structures

Within the group each student decided to take on a design within one of the broad project categories so that there was an even spread of designs across categories. These initial concepts are presented from *page 5*.

The proposals that were deemed to have greater market potential or were better resolved were developed through large scale models and 1:1 prototype studies. These developed proposals are presented from *page 19*.

The park pod design featured on *page 25* is based on a simple circular geometry using the stems in a vertical configuration. The pod can be scaled to perform as a simple shelter all the way to a small bush cabin. The specific aim of the design was to create a cladding challenge hence the structure was presented to students as a structure only with no development of secondary systems to support cladding.

For information on designing with wood visit www.naturallybetter.com.au

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Preliminary Design Proposals: Small Sized Buildings and Structures



Anya Meng

Bus Stop Shelters: Anya Meng

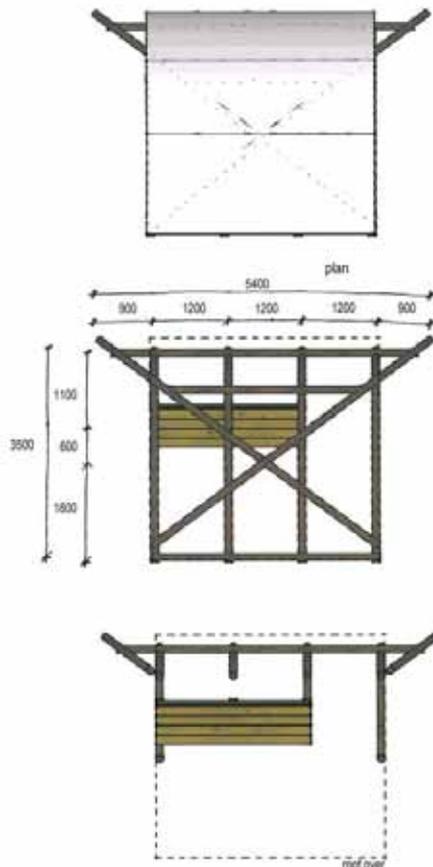
Bus stops are ubiquitous through our cities. Though the quality of shelters has improved in recent years, the materials and technology used in their construction is generally energy intensive. Though the scale of the round wood is perhaps not appropriate as a universal solution to bus stops, it is useful in those locations where there is a larger traffic throughput and a larger community focus. Such structures could incorporate signage as well as other community information and facilities such as public toilets, bicycle storage and rental or newspaper and coffee kiosks.

Sustainability

- Utilises the smallest thinning in the construction
- Utilising a resource with a strength to weight ratio similar to steel
- Utilising a resource that is underutilised and stores carbon
- Can help create a distinctive community focus and “way-finding” structure

Competing Technologies / Building Types

The intention would be to replace the medium to larger scale bus stop shelters and to work towards the smaller scale from there. It would not replace the standard Adshell type structure but would reduce the total number of shelters made with high embodied energy materials.



Preliminary Design Proposals: Small Sized Buildings and Structures



Briohny McKaige

Umbrella Structures for Transport Interchanges and Public Parks: Briohny McKaige

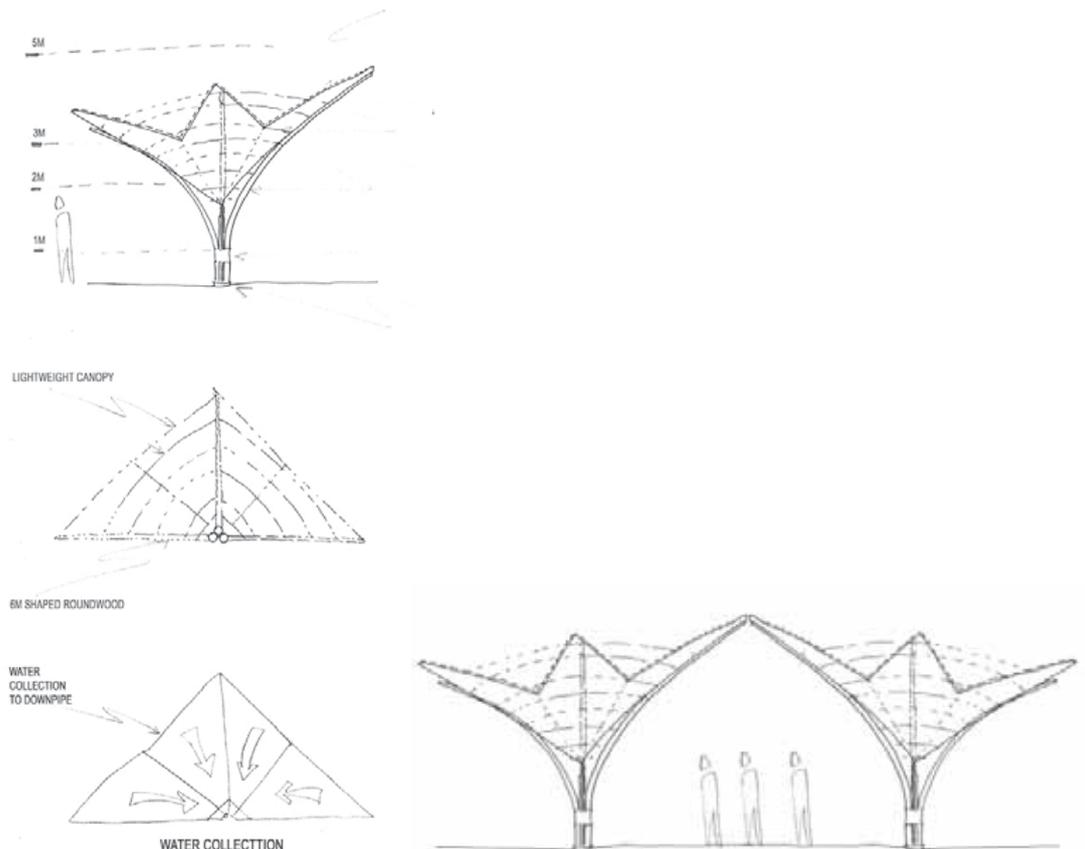
Shade is a critical factor in Queensland. Our outdoor lifestyle coupled with one of the highest incidents of skin cancer in the world makes the provision of shade in our outdoor spaces of important consideration. The proposed design looks at a system that can be deployed as a module to suit the specific location and need. It is imagined that the system could be used for public transport stops, park shelter, playground shelter or any public gathering place. The intention is that the vertical structure that curves out to form the shelter will be sympathetic to a natural tree form making this an ideal application for hardwood thinning as it is the most “tree like” in appearance. The intention is to combine the shelter with solar generation capacity for lighting and advertisements and community announcements as well as the capture and storage of water.

Sustainability

- Design that captures water
- Utilising a resource with a strength to weight ratio similar to steel
- Utilising a resource that is underutilised and stores carbon.
- Creation of attractive tree like structures that blend in with the natural environment.

Competing Technologies / Building Types

Most “umbrella” type structures of a similar scale are bespoke designs and mainly use steel in their construction. As a prototype that can be added to in a modular way, the system can provide shade in a variety of different contexts.



Preliminary Design Proposals: Small Sized Buildings and Structures



Will Gray

“Gunyah” Shelters for National Parks: Will Gray

Gunyah is based on indigenous shelters that utilise small scale round timber. The shelter is intended for use in nature reserves and national parks where the intention is for the shelter to blend and disappear in the setting. The structure is a modular unit that can be combined in a number of ways to create single or grouped shelters with shared outdoor spaces. Depending on the context the shelter can be used as a picnic shelter or as overnight accommodation for hikers and their swags.

Sustainability

- The design utilises the smallest diameter thinning
- Utilising a resource with a strength to weight ratio similar to steel
- Utilising a resource that is underutilised and stores carbon
- The shelter is a discreet element in the landscape

Competing Technologies / Building Types

The shelter is intended to augment current timber structures used in national parks by being of a slightly smaller scale and used in more remote locations, especially where patrons are walking into locations for an extended hike.



Preliminary Design Proposals: Medium Sized Buildings and Structures



Andrew Carter

Off Grid Housing: Andrew Carter

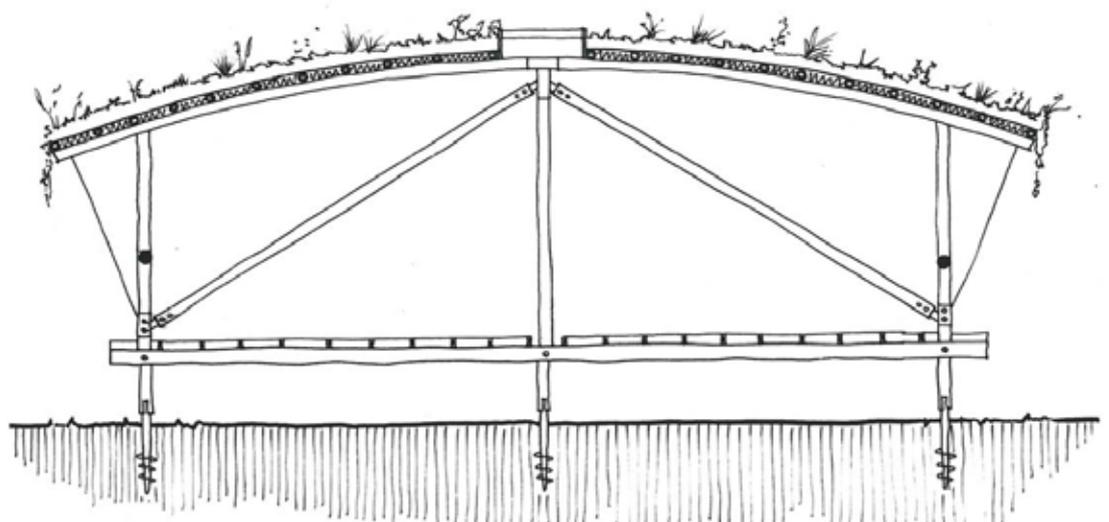
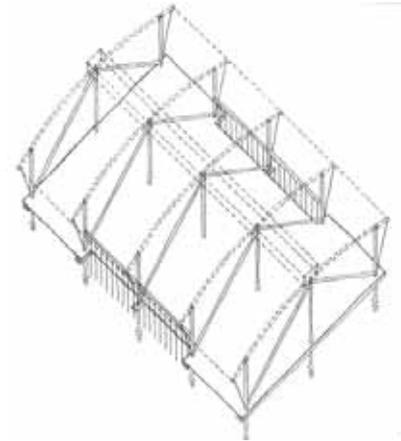
This proposition is focused on the owner builder in remote or outer urban locations. The intention is to try and use the resource as close to the final location as possible to save on embodied energy in transport and log processing. The inherent strength of the round wood system means that a large and simple structure could be erected quickly and slowly completed over time. The system is focused primarily on sharing the technology and knowledge of the resource in combination with specific connectors and foundation technologies.

Sustainability

- Leveraged by utilising resources close to the site
- Utilising a resource with a high strength to weight ratio
- Utilising a resource that is underutilised and stores carbon
- Utilising a material that can be reworked on site with reasonably simple tools

Competing Technologies / Building Types

Though it is not intended to compete with mainstream housing it is aimed at a reasonably sized market that is currently serviced to a greater degree by simple shed technology utilising primarily steel.



Preliminary Design Proposals: Medium Sized Buildings and Structures



Daniel Crocker

Housing Prototype: Daniel Crocker

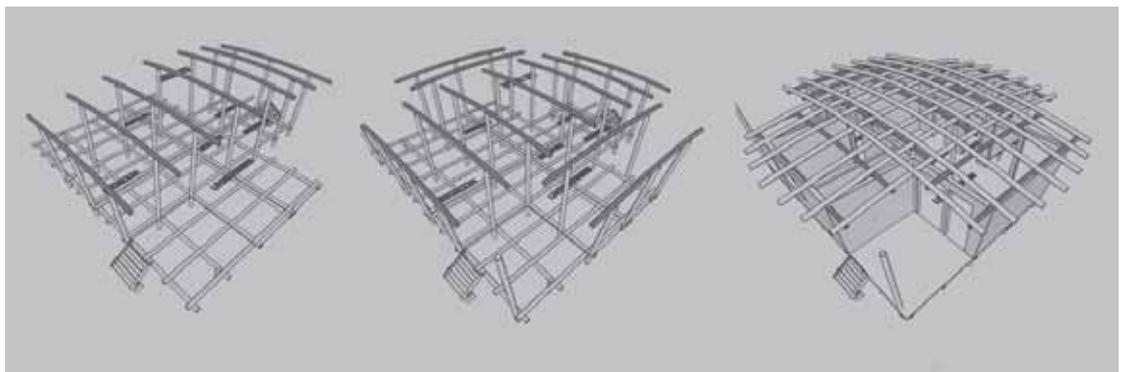
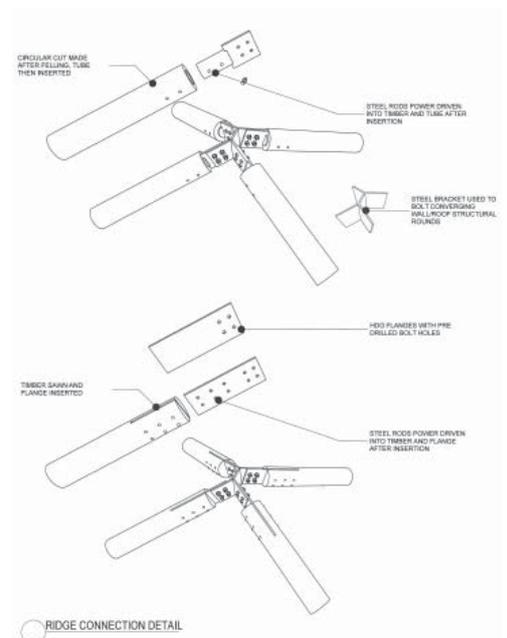
The intention is to provide a house that can be erected quickly and one that is focused on providing large clear span spaces to provide flexibility of layouts. The scale of the structure would work for residential uses as well as small regional offices or holiday accommodation. It is not intended to become a mass market product but will focus on a market that needs flexibility and adaptability, ease and speed of construction as well as final fitout by owners in a DIY approach.

Sustainability

- Niche market could be appropriate for adaptable public housing or indigenous housing
- Utilising a resource with a high strength to weight ratio
- Utilising a resource that is underutilised and stores carbon
- Utilising a material that can be reworked on site with reasonably simple tools

Competing Technologies / Building Types

Though it is not intended to compete with mainstream housing it is aimed at a market that demands flexibility and adaptability based on the clear spanning potential of the material.



Preliminary Design Proposals: Medium Sized Buildings and Structures



Kerry Martin

Woodland Hideaway: Kerry Martin

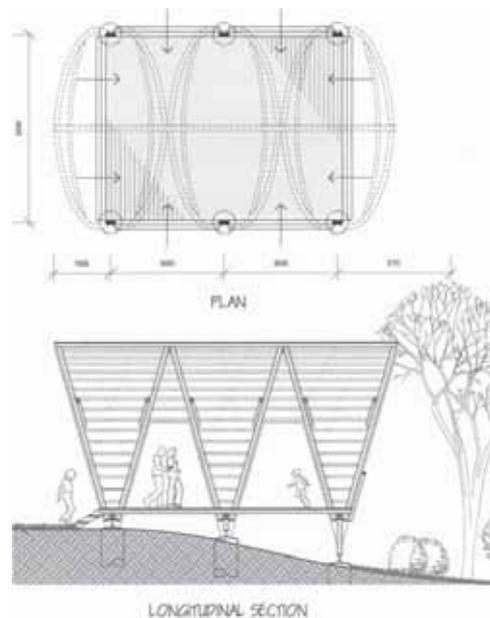
The woodland hideaway is a structure that is intended for medium to larger scale domestic construction. The modularity of the structure lends itself to a range of uses from simple single family houses, guest houses, galleries and studios, rest stops and so on. The unique form and character of the structure would mean it is not aimed at mass market but at a smaller niche that need the flexibility and certainty of a modular system but want a form that is organic and suited to natural environments.

Sustainability

- The scalar nature of the system means it can be utilised in a broader range of building types
- Utilising a resource with a high strength to weight ratio
- Utilising a resource that is underutilised and stores carbon
- Utilising a material that can be reworked on site with reasonably simple tools

Competing Technologies / Building Types

Unlike other modular systems that are generally rectilinear and boxy, this system offers a unique and organic solution. Similar roof forms are typically executed with steel at this scale so the timber resource would replace a material with high embodied energy with a low embodied energy resource that stores carbon.



Preliminary Design Proposals: Medium Sized Buildings and Structures



Karl Ho

Community Scale Sports Stadia Structure: Karl Ho

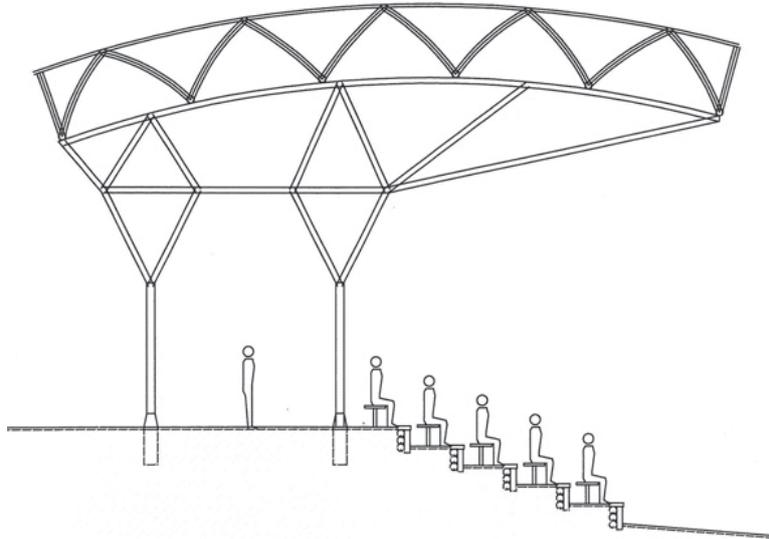
Though the proposition is aimed at providing shade for spectators at community scale sports ovals it can also be adapted to provide shade for more generic applications such as car parks, swimming pools and children's playgrounds. The structure was developed as a truss system with curved top and bottom cords. This was later developed into a simpler structure that utilised the inherent strength of the thinning themselves.

Sustainability

- The application from community stadia to car parks means that the structure is more universal and in turn can use more of the resource
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon
- In combination with a variety of roof cladding the shelters can collect rainwater, generate solar energy and increase vehicle efficiency if used to keep parked cars cool
- Shade on large areas of bitumen can reduce the amount of radiant heat and cool the ambient temperature in cities

Competing Technologies / Building Types

Most shade structures used for car parks are steel based. The aim is to directly compete with these systems whilst opening up other applications for shade in outdoor events.



Preliminary Design Proposals: Large Sized Buildings and Structures



Will Downes

Linear Railway Platform Shelter: Will Downes

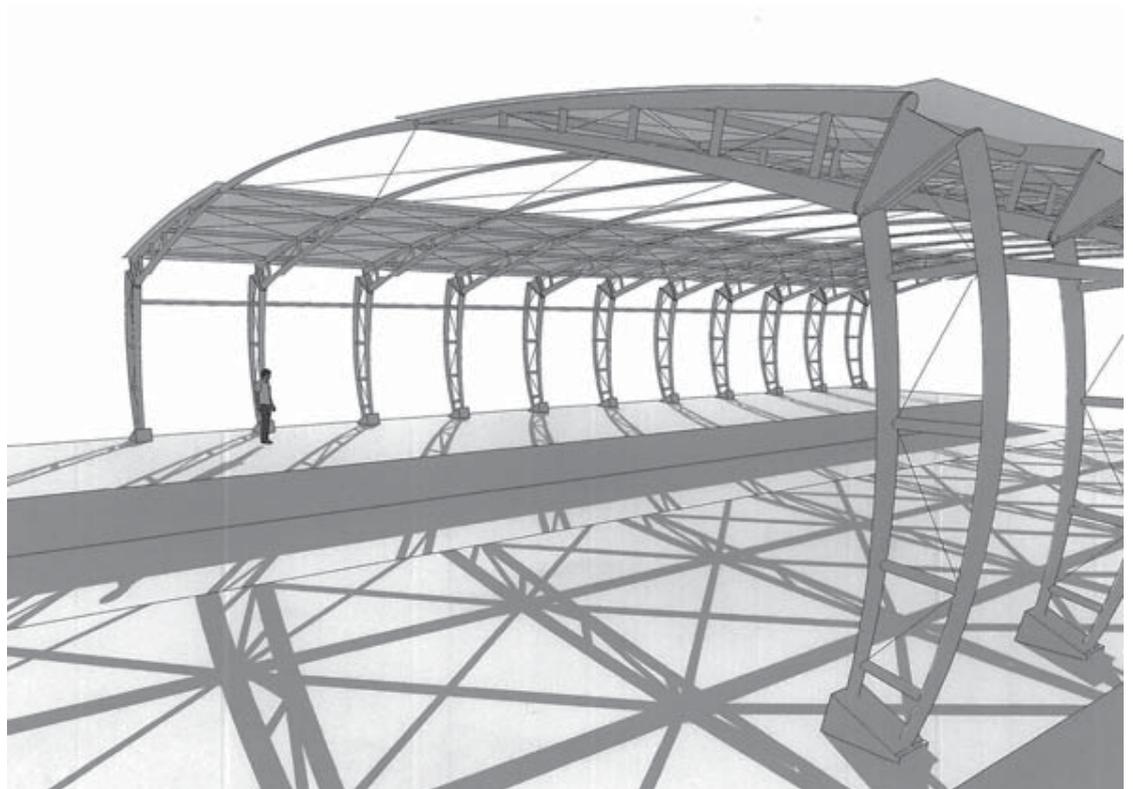
This proposition looked specifically at railway platform shelters. Though such a building type is not a common building project it is generally a bespoke design that involves a high degree of finish durability and aesthetic appeal. Typically such structures are executed with steel however a timber round wood structure with a similar strength to weight ratio could equally be considered. Timber in such applications is not unheard of and the aesthetic would provide commuters with a brief contact with nature as part of their everyday routine. The development of such structures would not preclude their application to other more generic building types such as storage facilities, sports halls or industrial buildings.

Sustainability

- Similar high value structures are typically constructed from steel, the aim here would be to replace that with a more sustainable resource without affecting the fire and BCA ratings
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon
- In combination with a variety of roof cladding the shelters can collect rainwater and generate solar energy

Competing Technologies / Building Types

Similar structures are steel based and one would assume that if a system could be devised for railway platforms that other similar linear building types could be constructed using the system.



Preliminary Design Proposals: Large Sized Buildings and Structures



Mathieu Levesque

Quick Assembly Structure for Temporary Applications: Mathieu Levesque

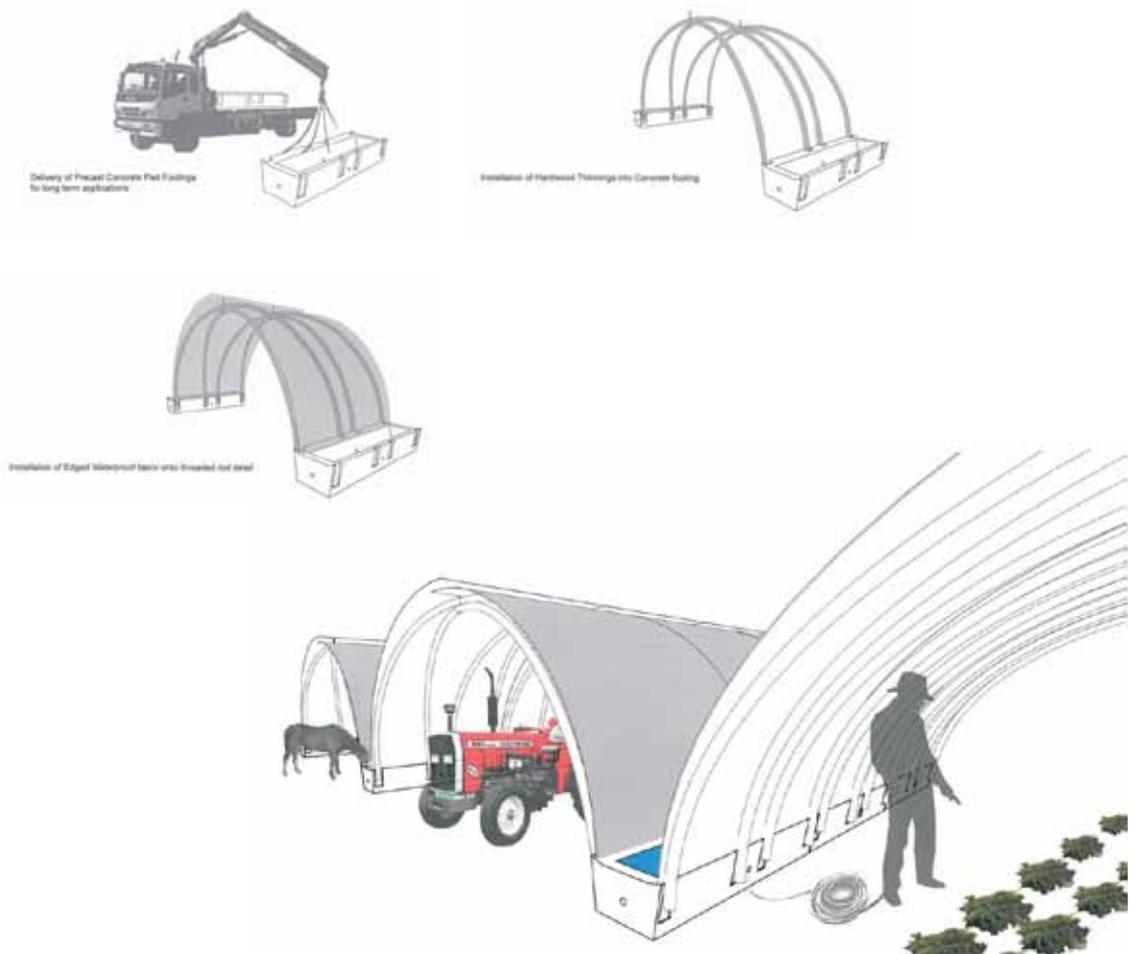
There are many festivals that need to provide quick and cost effective shelter for people and goods. Such constructions could be in use for some time but at the end need to be dismantled and relocated. Similar applications may be for large construction sites where plant and machinery needs to be kept under cover. The basis of the translocation of structures is that the footings provide adequate tie down but are not permanently fixed into the ground. This design proposes a system of footings that can be weighted down with ballast such as sand, water or rubble.

Sustainability

- Similar structures utilise steel
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon
- The intention is that the structure captures rainwater and feeds this into storage tanks to help tie down the structure and provide capacity for general water use

Competing Technologies / Building Types

Though the demand for special relocatable structures of this scale may be limited, it would find an application in agricultural and remote area mining townships where the structure is on site for an extended period of time but ultimately would need to be removed.



Preliminary Design Proposals: Large Sized Buildings and Structures



Jeremy Slater

Large Scale Sheds Utilising Round Wood Truss System: Jeremy Slater

Simple shed structures are ubiquitous in industrial and logistics settings. These structures need to be quick and easy to erect as well as being affordable. Though steel is a dominant material used in these applications, the proposition here is that in a world where carbon capture and storage has a dollar value, then timber construction can be one small way for a company to decrease their carbon footprint. As a pre engineered system it has similar conveniences to steel construction. Typically larger structures are erected by specialist fabricators therefore they can become accustomed to the specifics of the resource. The large span structures are well suited to the properties of round wood and a similar jointing technology to steel fabrication can be adopted.

Sustainability

- Similar structures utilise steel
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon

Competing Technologies / Building Types

If even a small percentage of the market could be transformed from steel to wood then huge savings in greenhouse gases and carbon storage would result as well as a viable market for the resource.



Preliminary Design Proposals: Large Sized Buildings and Structures



Clare
Chippendale

Large Scale Shade Pavilions: Clare Chippendale

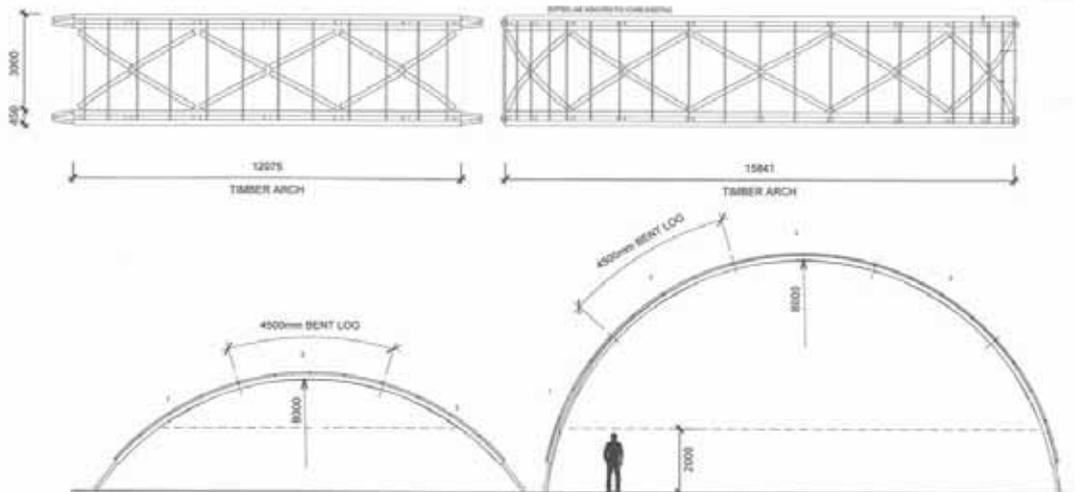
The proposition is for a simple shade structure that can be scaled up or down using the same log geometry. The application is geared towards linear shade structures for swimming pools and sports facilities. Industrial and agricultural building applications also come to mind. The main benefit of this system is the elegance of the resolution and the fact that the geometry is simple and standardised.

Sustainability

- Similar structures utilise steel
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon
- The simplicity of the structures geometry would translate into savings during manufacture

Competing Technologies / Building Types

Shade structures of this nature are typically constructed with steel. The intention is to compete with these steel prototypes.



Preliminary Design Proposals: Infrastructure Projects, Systems and Structures

Curvier, Roadside Sound Barrier System: Sean Gill, Michael Lineburg

Typical roadside sound barriers are generally simple slab wall construction that can be seen as blight on the landscape. The proposal is to use more organic geometries of the steam bent round wood logs to create a flowing and aesthetically pleasing structure. In simple terms the system works on closely spaced vertical round wood posts with patterns of triangulated plywood acoustic panels to deflect sound. The triangulation is used to help generate the curved geometries. With the use of drive by scanning and CNC cutting technology, the unique surface pattern can be produced using industrial technologies the same as standardised systems, but with a geometry that is better integrated to the natural landscape and specific urban context.

Sustainability

- Similar structures utilise steel structure and concrete panels.
- The high strength to weight ratio of the material has a good match to the use.
- Utilising a resource that is currently underutilised and stores carbon.
- The volume of potential application could result in a lot of the thinning stock to be used dramatically increasing the yield of plantation forests

Competing Technologies / Building Types

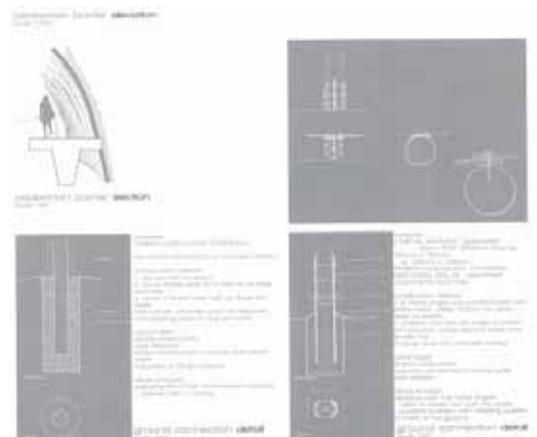
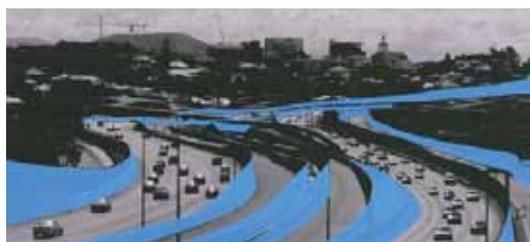
Sound barrier structures of this nature are typically constructed with steel vertical posts with plywood or concrete infill panels. The intention is to compete with these steel prototypes with timber only systems.



Sean Gill



Michael Lineburg



Preliminary Design Proposals: Infrastructure Projects, Systems and Structures



Nicholas Vella

Universal Roundwood Connector System: Nicholas Vella

This design is pitched as a system of connection rather than as a building prototype per se many round wood constructions adopt a space frame type approach with consistent timber lengths and three dimensional connectors. The proposed system is similar to these proposals but adapts a system that uses simple off the shelf steel profiles to create the three dimensional connectors rather than expensive specially made or cast metal connections. The result is a system approach to building warehouses, towers and bridges utilising a small repertoire of connector types.

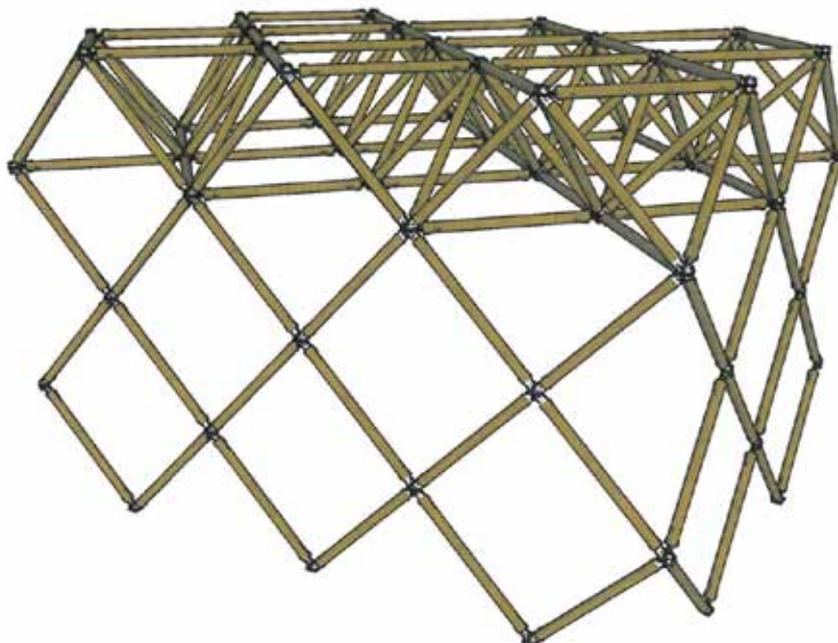
Sustainability

- The connectors allow a variety of constructions to be devised, offering modularity and flexibility
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon

Competing Technologies / Building Types

The system is intended to provide an open ended range of applications. Typical space frame structures utilise steel.

CONNECTION ELEMENTS



Preliminary Design Proposals: Infrastructure Projects, Systems and Structures

Wind Barriers for Rural and Remote Communities: Lasan Nguyen

In open rural settings the impact of top soil removal due to the effects of wind can be significant. In addition to the loss of soil, evaporation and the healthy propagation of crops can be significantly increased through the provision of wind barriers. In remote townships that are exposed to winds across open plains would also benefit from a wind barrier to protect common open space between buildings to provide respite and allow shade trees to establish.

Sustainability

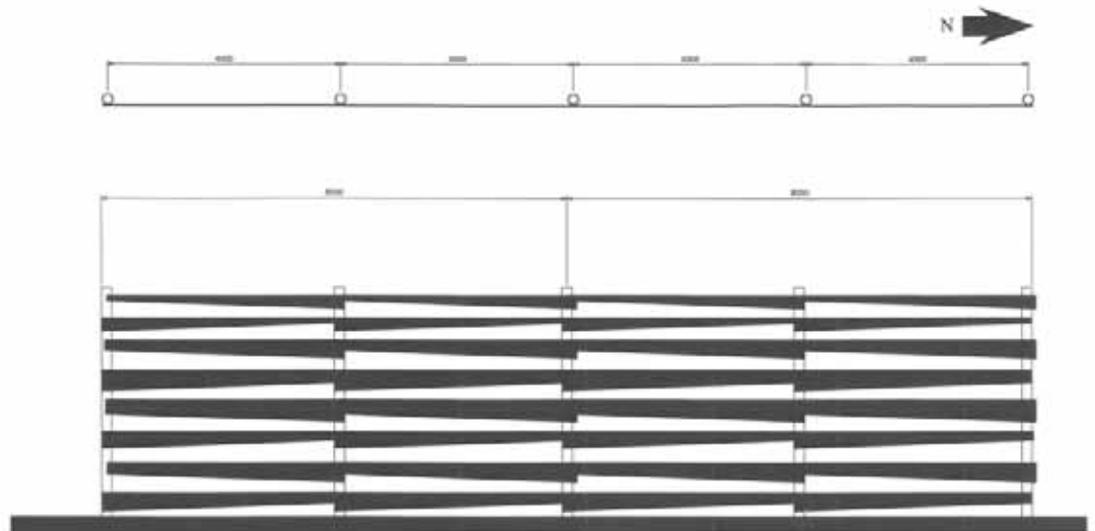
- The system is constructed utilising sustainably materials but the effect on the environment in turn helps maximise sustainability.
- The high strength to weight ratio of the material has a good match to the use
- Utilising a resource that is currently underutilised and stores carbon

Competing Technologies / Building Types

The deployment of wind barrier systems to not common place in Australia at present, though with changing climate the need for large scale climate controls will become more apparent.



Lasan Nguyen



Developed Design Proposals: Small Sized Buildings and Structures

Umbrella Shelters: Brihony McKauge, Anya Meng and Karl Ho

Though the preliminary design in principle presented a reasonably simple development phase, in reality the proposal proved more difficult to resolve. The scale of the model was the largest of all the groups and hence the dowel diameter was the greatest. The amount of curvature was difficult to achieve resulting in a significant number of breakages.

The amount of cover provided was also constrained by the natural catenary of the fabric roof. The initial design had proposed a rigid roof cladding such as metal or plastic however the difficulty lay in resolving the position of the ends of the curved members so that a stable secondary roof structure could be set out.

The final aspect that proved problematic was attributed to the scale of the model whereby the four supporting members were intended to be separated to allow a down pipe to pass through the middle, in the final model the four elements were joined too close together. In all the process of model making revealed the construction difficulties of the proposal however it was agreed that these were not insurmountable. Time permitting the model would have been remade and these issues resolved prior to a full scale prototype being constructed.



Above and Left: Umbrella structure. Brihony McKauge, Anya Meng, Karl Ho.
Images by M Dickson

Developed Design Proposals: Medium Sized Buildings and Structures

Woodland Shelter: Kerry Martin, Will Gray

The woodland hideaway proposal translated quite easily from the preliminary poster presentation. The integrated wall roof "A Frame" type structure is aesthetically closer to the nature of trees in the forest and hence appeals to peoples general aesthetic sensibilities.

The unique cladding system relies on a shingle like approach so that the overlap provides adequate tolerance to account for both imperfections in the structural setout as well as settlement over time. Even during the model making phase it was found that the tolerances between the primary bent thinnings and sawn wood purlins needed some kind of adjustability to ensure that there is an adequate mechanical connection between elements as well as straightness.

The shingle cladding is intended to be a combination of timber and recycled clear plastic. It is unclear how the clear recycled plastic could be easily sourced but the end result is quite pleasing. Further work on both the cladding itself but more importantly on the secondary connection systems between the round-wood and sawn wood purlins needs development that could lead to solving issues of round-wood construction in general.



Above: Woodland Hideaway. Kerry Martin, Will Gray.
Images by M Dickson

Developed Design Proposals: Medium Sized Buildings and Structures

Off Grid Housing: Andrew Carter, Daniel Cocker

Many of the precedent structures discovered during the literature review were structures that were in rural or woodland settings, often in remote locations. The use of round-wood in these situations is efficient so long as the resource can be easily obtained and worked within a close distance.

The use of an earth roof both helps with natural insulation of the structure as well as providing a solution that can adequately cope with an irregular and moving structure. Other aspects of this developed scheme that need further work is the detail of the floor joist connection to round-wood and the wall panel connections to round columns. In order to get an even and consistent finish specialist fixings are needed that allow a certain level of adjustability. Such systems will need further investigations if this scheme were further developed.



Above: Off Grid Housing. Andrew Carter, Daniel Cocker.
Images by M Dickson

Developed Design Proposals: Large Sized Buildings and Structures

Industrial Building: Will Downes, Jeremy Slater, Nicholas Vella

Though the poster and model proposition was aiming towards an industrial application, the final uses for such a structure are perhaps more varied and limited in equal measures. The round-wood structure here has been used without steam bending. The triangulated structure is both elegant to look at but also quite tough with a significant amount of inherent bracing. The diagonal outward cambered columns give another aesthetic element to the overall construction however it is to the detriment of flexibility in an industrial application, for example when installing large access doors for trucks.

The resolution of the end infills has not been demonstrated in the model and the way that the sawn wood purlins connect to the round wood structure has not been shown.

In reality there would be a more limited application in industrial settings with this system however the quality and aesthetic of the structure are well suited to indoor sports facilities or warehouse retail stores.



Above: Industrial Building Prototype. Will Downes, Jeremy Slater and Nicholas Vella.
Images by M Dickson

Developed Design Proposals: Large Sized Buildings and Structures

Re-locatable Shelter: Clare Chippendale, Mathieu Levesque

This proposal is also aimed at industrial or storage buildings however it is also intended to be relocatable. This would be ideal for medium term installations for large building and infrastructure sites, festivals or remote community mining towns and so on.

The curved elements are important in this instance as they provide additional usable floor area and volume. The system relies on a simple clamp fixture similar to that employed in scaffolding. The intention was to both make the structure easy to assemble and adjust for varying terrain but more importantly it taps into a pre existing skill set in the building industry.

The footings are intended to be a variety of types. A simple concrete footing is shown here however the intention is that the channel in the footing can collect water for general use and additional ballast during inclement weather. The footings could equally be adapted to a water only design similar to temporary road crash barriers or metal cage gabbion blocks. Though the footing geometry is perhaps not ideal as shown in the model, it has the scope for adaptation and in a refined version could be easily amended.



Above: Relocatable Shelter. Clare Chippendale, Mathieu Levesque.

Images by M Dickson

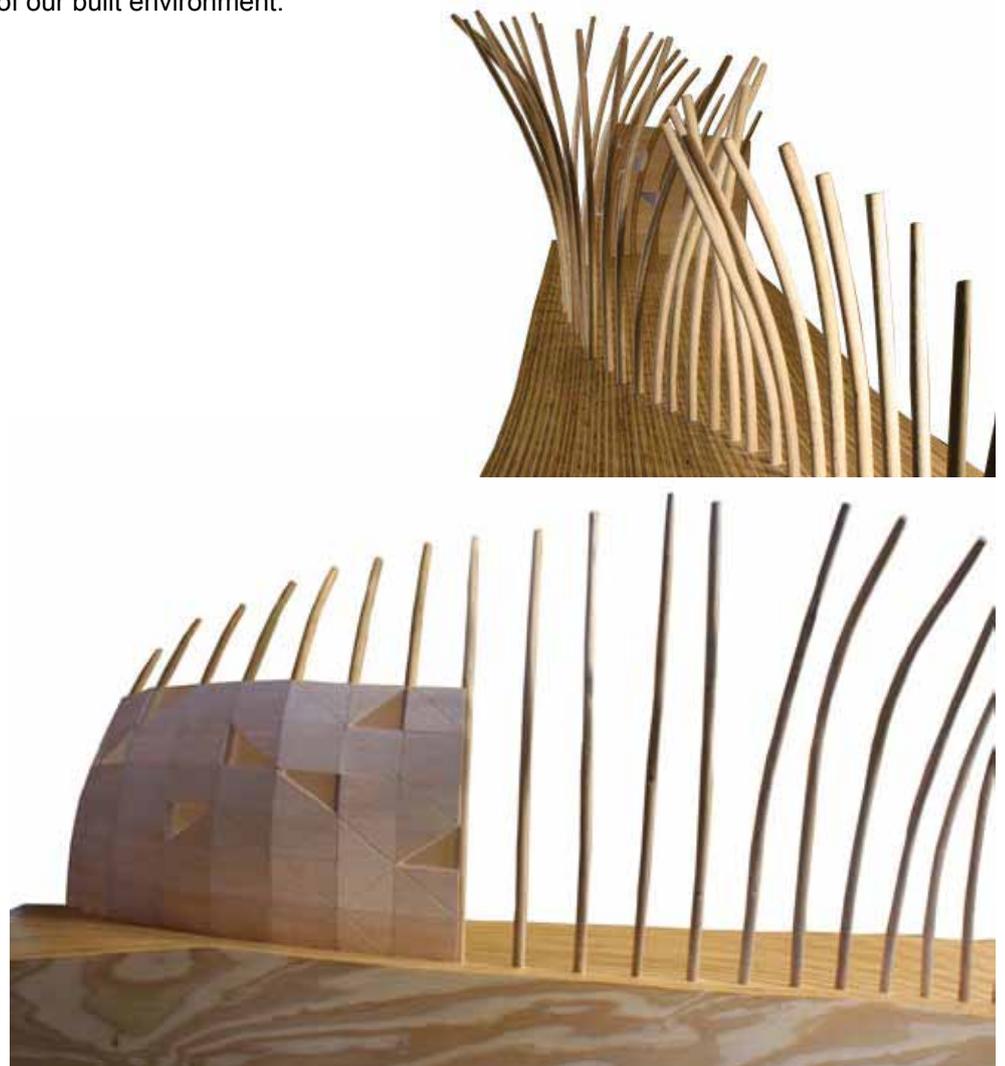
Developed Design Proposals: Infrastructure Projects, Systems and Structures

Curvuer: Sean Gill, Michael Lineburg, Lasan Nguyen

The use of round-wood for road side sound barriers is not necessarily new. Typical designs can be quite dull and most are in a simple vertical configuration. The proposal here is to elevate the humble road side sound barrier to a work of land art, whilst still remaining effective.

The intention is to provide a standard suite of curved vertical elements that can be configured according to the specific location. The technology of establishing the structure can rely on established technology that is used for suspended cable networks. The panel pattern and setout would be developed using drive by scanning technology after the primary structure is in place with automated CNC cutting in the factory. The combination of scanning and automation in the factory means that each installation can be specifically tailored to the structure geometry without being excessively more costly than simple rectilinear components.

This proposal presents unique but not insurmountable technical challenges that has the potential to use of a vast amount of the resource as well as improving the general state of our built environment.



Above: Curvuer Sound Barrier. Sean Gill, Michael Lineburg, Lasan Nguyen.
Images by M Dickson

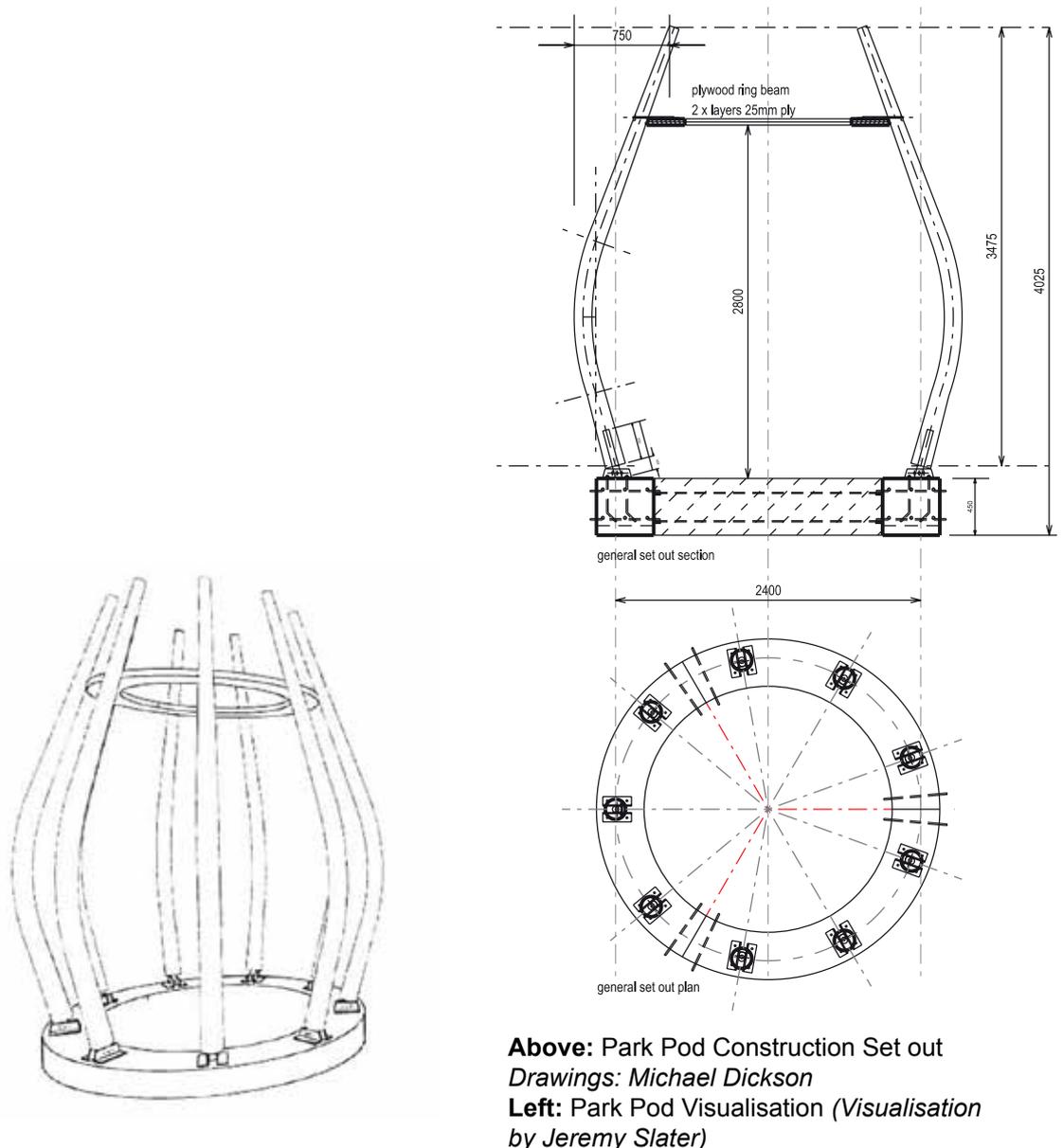
Park Pod Design: Small Sized Buildings and Structures

Park Pod: Michael Dickson

The intention of this prototype construction is mainly to test the limits of the bending capacity of the hardwood stems as well as developing cladding systems for a three way complex curve using standard flat sheet material.

The park pod is intended to sit in a parkland or woodland setting to provide shelter for a small group of people. The structure is intended to be prefabricated and mass produced. The elemental nature of the design means that it can be scaled up to provide larger structure for different applications. The structure shown here is a 9 pole park pod however the intention is to develop a 12 pole and a 15 pole structures. Larger structures could be used for small gatherings for say educational or religious ceremonies as well as providing a unique cabin design for woodland settings.

The design shown here is effectively a work in progress and the final design will account for the changes made during the prototyping studies.



Above: Park Pod Construction Set out
Drawings: Michael Dickson

Left: Park Pod Visualisation (*Visualisation by Jeremy Slater*)