Working with Bamboo in Australia

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Abstract

Bamboo in architecture and design is currently being driven by projects in emerging countries. The easy access to materials, low labour costs and strong vernacular traditions provide opportunities not available to those wanting to work in developed countries such as Australia. Cave Urban's practice is a response to this challenge and an opportunity to examine different ways that bamboo can be used to encourage its use and propagation. Through examination of several of Cave Urban's most recent projects, this paper aims to explore how Bamboo can be utilized as a material in a developed country using art, education and research as a medium to expose its material properties to the wider public.

Keywords

Art, Education, Research, Collaboration

Theme: Architecture, Engineering and Social Housing

Introduction

Cave Urban is an architectural collective based in Sydney, Australia. In 2011, its founder Nici Long was asked to do a research PHD on indigenous and lightweight housing, instead Nici chose to establish Cave Urban as a research and development branch to her existing architectural practice. Its aim was to investigate traditional vernacular building methods, to build upon these design principles in relation to contemporary sustainable building design.

The research was to be carried out as a series of three research folios, the first of which was on Bamboo and lightweight structures. The subsequent investigations carried out by Cave Urban member Juan Pablo Pinto Messa paved the way for our current use of bamboo as both an artistic and architectural medium.

Being based in a developed country with no history of bamboo craft, Cave Urban addresses a unique set of challenges different to the majority of bamboo work underway in the world today. Faced with high labour costs, limited access to materials, no traditional craft based knowledge and strict Occupational Health and Safety requirements our goal is to establish a vibrant culture of bamboo within Australia.

As a solution to these problems Cave Urban makes use of cross cultural exchanges, education, art and collaboration with festivals in order to create an environment supportive of our work in bamboo.

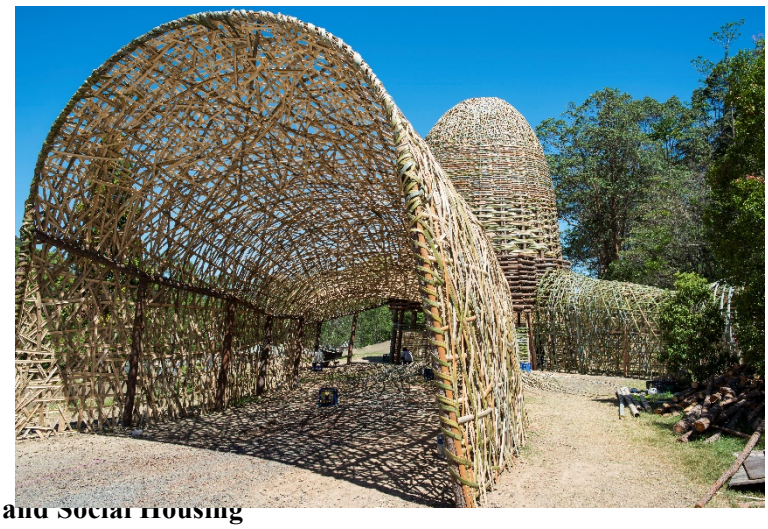
This paper will highlight several of Cave Urban's most recent projects and there significance to furthering bamboo design within Australia.

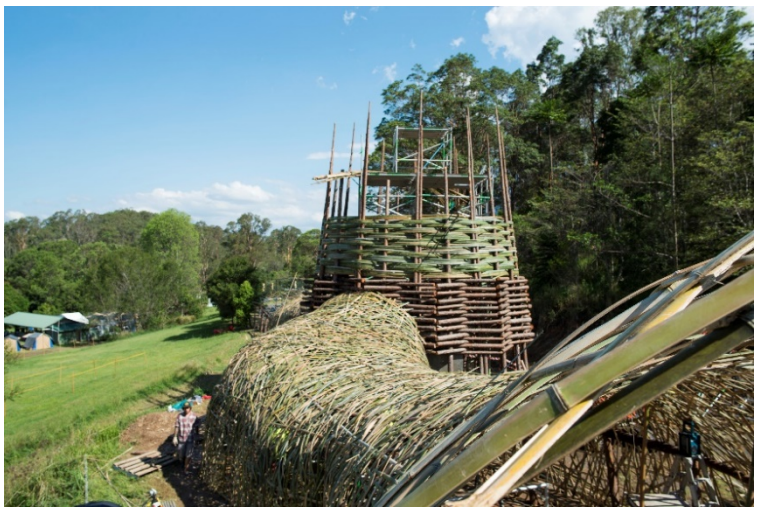
Cross Cultural Collaboration

The absence of a bamboo skill set in Australian craft, ensured that the next step once Cave Urban had completed its research folio was to gain practical skills through collaboration with existing bamboo practitioners. These where gained through workshops in Thailand with BambooRoo and Portugal with Canya Viva, as well as artistic collaborations with Belgium artist Georges Cuvillier and Taiwanese master weaver Wang Wen-Chih.

The most significant of these projects was the collaboration with Taiwanese Artist Wang Wen-Chih and the creation of Woven Sky at the Woodford Folk Festival in 2013. The invitation to Wang Wen-Chih to participate established a strong connection that has subsequently resulted in the invitation of Cave Urban members, Nici Long, Juan Pablo Pinto Messa and Lachlan Brown to assist in the construction of Hidden Heaven in Nantou County, Taiwan and the return of Wang Wen-Chih to Australia for the construction of Woven Cloud.

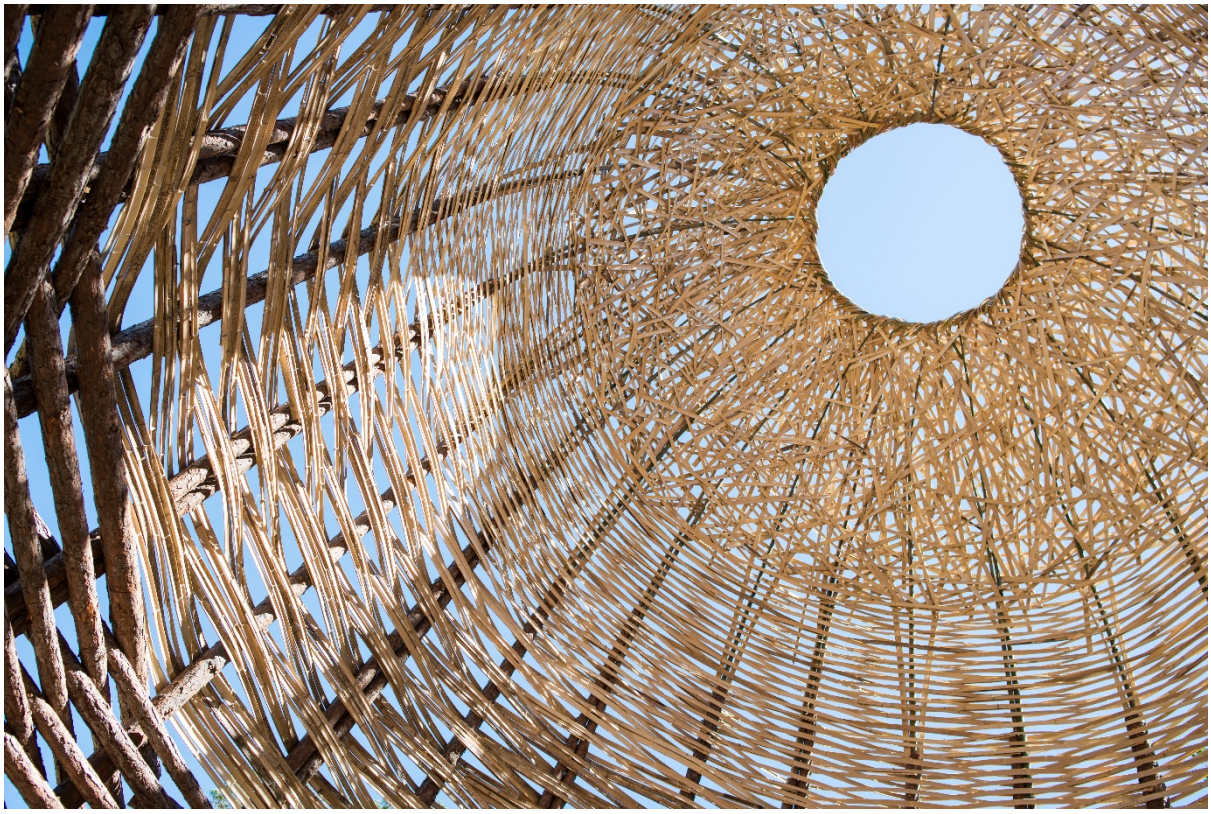
Woven Sky is a 100m long woven bamboo tunnel that includes a central gathering space that rises to 15m high. The work makes use of 600 poles of bamboo and 70 slash pine logs, all of which was harvested within a 20km radius of the site. The work aimed to showcase bamboo as a building material and locally available resource, to the 120,000 patrons of the festival. (Figure 1)





Working with Wen-Chih and his team of Taiwanese artisans, 40 local volunteers were able to gain practical experience through all stages of construction, including harvesting, splitting and weaving the bamboo. The resulting structure sits as an entry point to the main stage of the festival. Patrons must travel through a 70m tunnel, constructed from woven bamboo that spans 7m and is entirely self-supporting. Its strength comes from the style of weaving used by Wen-Chih and is strong enough to support the weight of several adults. (Figure 2)

Woven Sky is a temporal work. The materials are cut and used immediately. We did not treat the bamboo and as such it is susceptible to borer insects. However this is part of Wen-Chih's ethos. As the split bamboo is exposed to both sun and rain, it will degrade regardless of treatment. The aging and weathering of the piece, fits with Wen-Chih's desire to create works that capture our imagination and wonder, but also highlight natural change over time. For Wen-Chih, all works are ephemeral. Whether considered temporary or permanent, they are all finite when set against the scale of eternity. (Figure 3)



The completion of Woven Sky had many positive outcomes for the festival and for those involved. Those involved took away a great sense of empowerment and as a result Cave Urban was able to begin a relationship with the Queensland University of Technology. This subsequently led to the establishment of a bamboo design course, culminating in a student led construction of a bamboo pavilion in Brisbane's Botanic Gardens.

Theme: Architecture, Engineering and Social Housing

Education and Bamboo

The limitations created through high labour and material costs are alleviated through investigating how you may educate in exchange for labour. Much of Cave Urban's work is made possible only through the generous donation of time by the many enthusiastic volunteers who assist us. Therefore connections with University are vital, as a means to educate and to increase people's awareness of bamboo as a building material.

Students who have participated on our projects often return to their own design courses carrying an alternative set of design principles that are based upon their own confidence in knowing that they were able to create these forms with their own hands.

The haptic transition of knowledge is what makes bamboo such a powerful material. Its flexible and lightweight properties allow it to be a material that can be worked regardless of age, gender or skill. By teaching volunteers a set of basic joining techniques and design strategies, it empowers them, especially when at the completion of the work they can look at it with the knowledge that they helped create it.

Whilst a large number of our volunteers tend to be architecture and design students, we receive people from all walks of life. The build team for Woven Cloud ranged in age from 16 to 60 with an equal mix of gender and many different educational and professional backgrounds. Constructed in a similar fashion to Woven Sky, Woven Cloud sits as the entry point for the Woodford Folk Festival. Its woven canopy acts as a shade structure and a meeting place for those entering the festival. Wen-Chih's aim was to create a sense of wonder for those who entered and perhaps a quiet place to sit and escape the demands of the festival. A gulp of fresh air, an instant of eternity in the uninterrupted flux that is our lives. (Figure 4)

Standing at the centre of the work is a 10m diameter 'cloud' of bamboo that sits 15m above the ground. Woven in situ the cloud marks a point of tranquillity within the space.

Woven Cloud and Woven Sky should not be seen as end products. Rather they are part of a process. The construction phase is built into them, but so too is the memory that will linger when they are gone.

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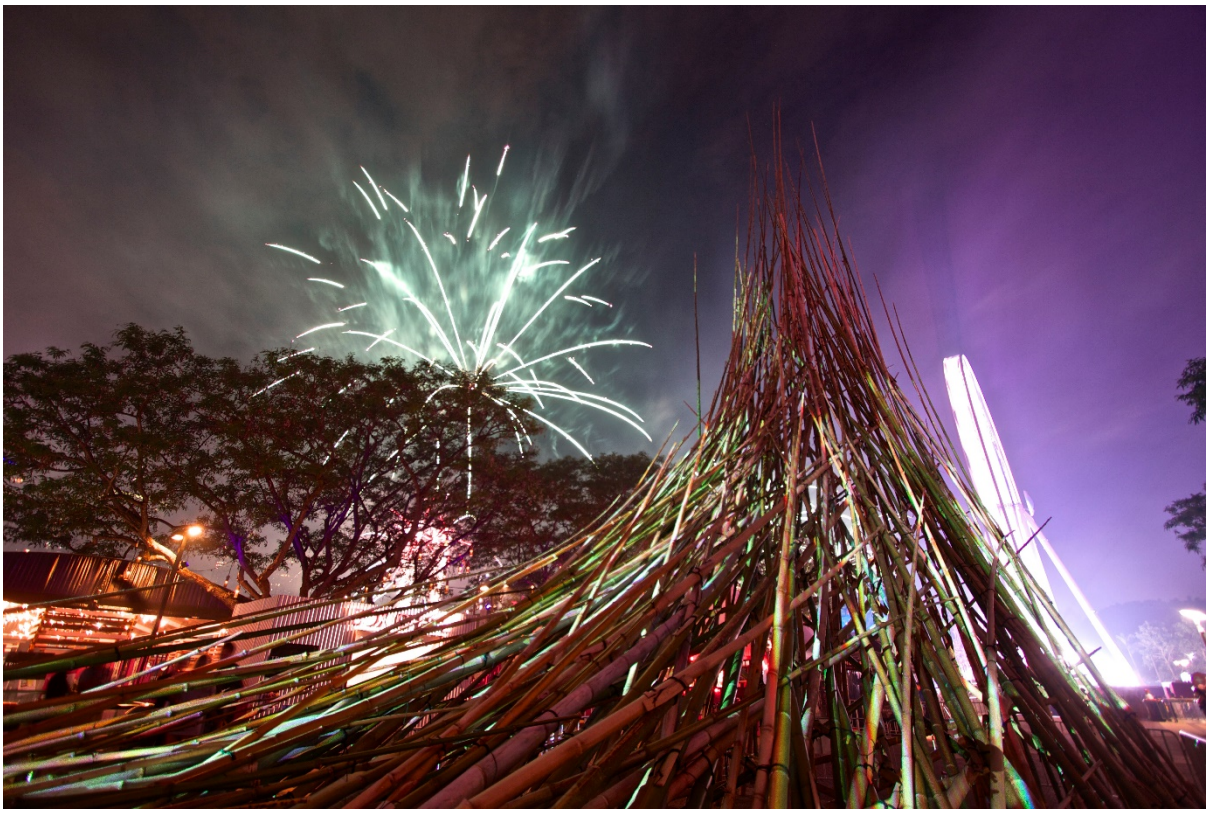
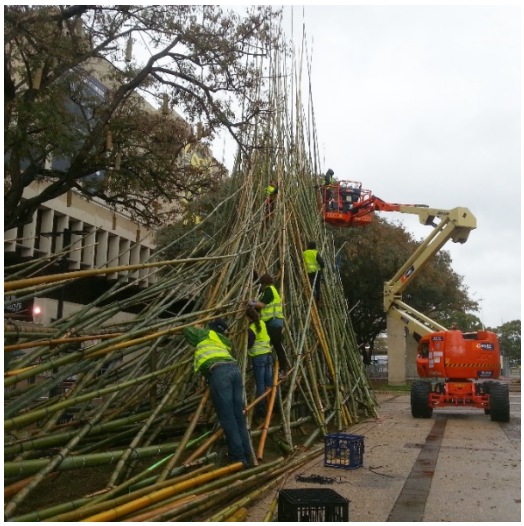
Research and Development

Cave Urban's ethos is not purely about hands on education. There is also the desire to increase our knowledge of the structural capacity of Bamboo. Working closely with Event Engineering, Cave



Urban prototypes and load tests connection methods, in order to provide engineering certification on our works. (See appendix A)



The Light Garden installation for the Brisbane festival provided an opportunity to load test various rope and wire joining methods. (Figure 5)

We settled upon a lashing tie with a draw stick for the majority of the work as it provided a strong connection that was easily assembled and disassembled with little to no waste. (Figure 6)

As an additional design challenge we were unable to connect the structure to the ground and so had to create a self-supporting structure with enough weight to ensure it could not topple. This was achieved through a structural system consisting of two overlapping parabolic grids that created a central shell to build the structure of. These grids in turn where connected to 5 concrete cubes weighing in total 1 tonne.

By resting the feet of the bamboo on the ground, it created a friction, best described by a comparison to the bristles of a broom that reduced the works ability to move laterally.

Upon deconstruction we load tested the work in-situ by exerting a horizontal load upon the entire structure. Using a load cell we were able to measure a force of 1.1 tonne acting upon the structure.

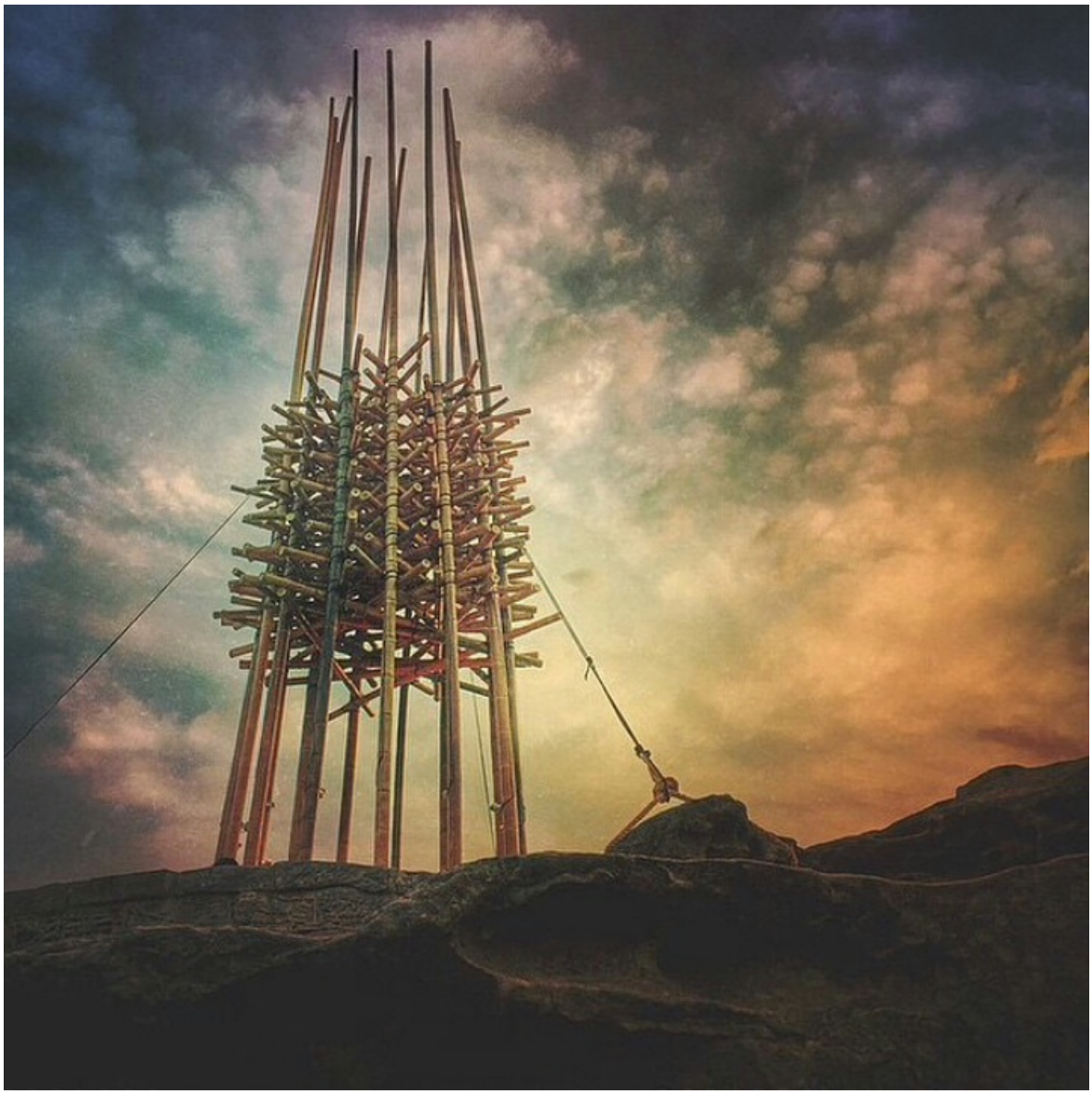
What we observed was a deflection in the structures overall shape. The far side of the structure, compressed as a force was exerted. However there was little structural failure of the bamboo, rather the rope connections had slipped, allowing for the movement. Observation of the concrete ballast, showed that the 200kg blocks had slid up to 300mm and one had been lifted 100mm of the ground.

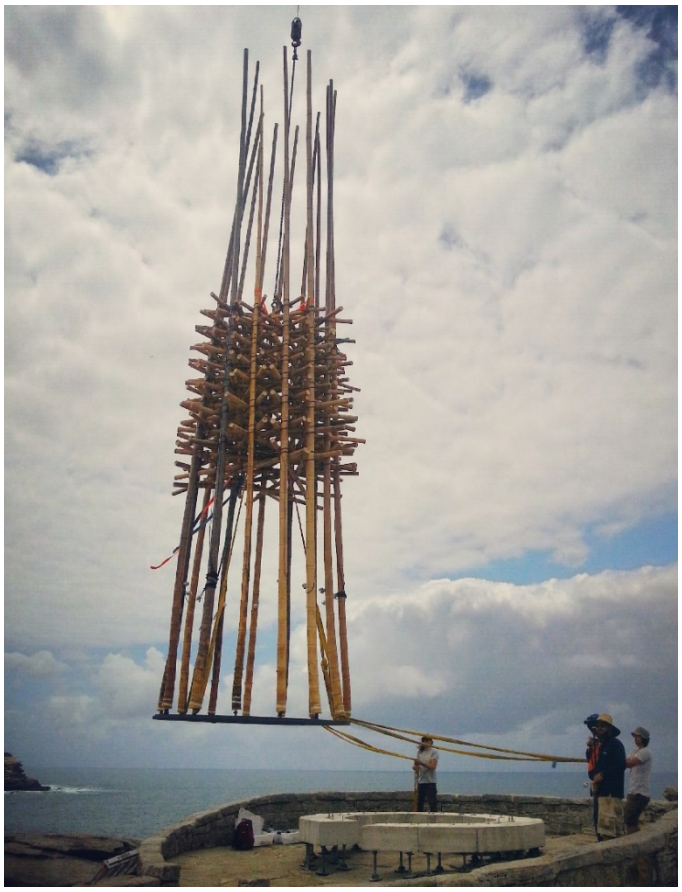
Art and Bamboo

Rather than waiting for Australian Standards to allow for the construction of bamboo, we continue to use our own practice as a means to prototype and test bamboo structures. Art provides a strong medium for such experimentation.

Cave Urban's latest work for the 2014 Sculpture By The Sea exhibition at Bondi, provided an opportunity to further test the structural investigations that we had begun for our work at the Brisbane Festival. Combine bamboo with concrete and steel we aimed to create a work that pushes structural limits.

'Save Our Souls' is a 12m high bamboo tower that stands upon the headland at Marks Park in Bondi. Unable to connect to the ground it is a free standing structure that must resist some of the harshest climatic conditions found in Sydney. (Figure 7)





Sitting upon a 4 tonne concrete base, 12m long bamboo poles are attached to it by a steel ring. These poles are joined laterally halfway up the structure with smaller horizontal bamboo members that spiral upwards as a series of triangles.

The bamboo is connected to the steel ring by a 500mm steel flat bar that is welded to the ring and is inserted up the bamboo culm. Bolted to the bamboo, concrete is used to strengthen the joint.

In contrast to this fixed joint method the bamboo above is connected by rope, using the lash and draw stick method.

In order to reduce installation time, the entire work was built off-site and installed by a crane in a single day. The steel in the structure and the horizontal members created a single solid object that could be easily transported. (Figure 8)

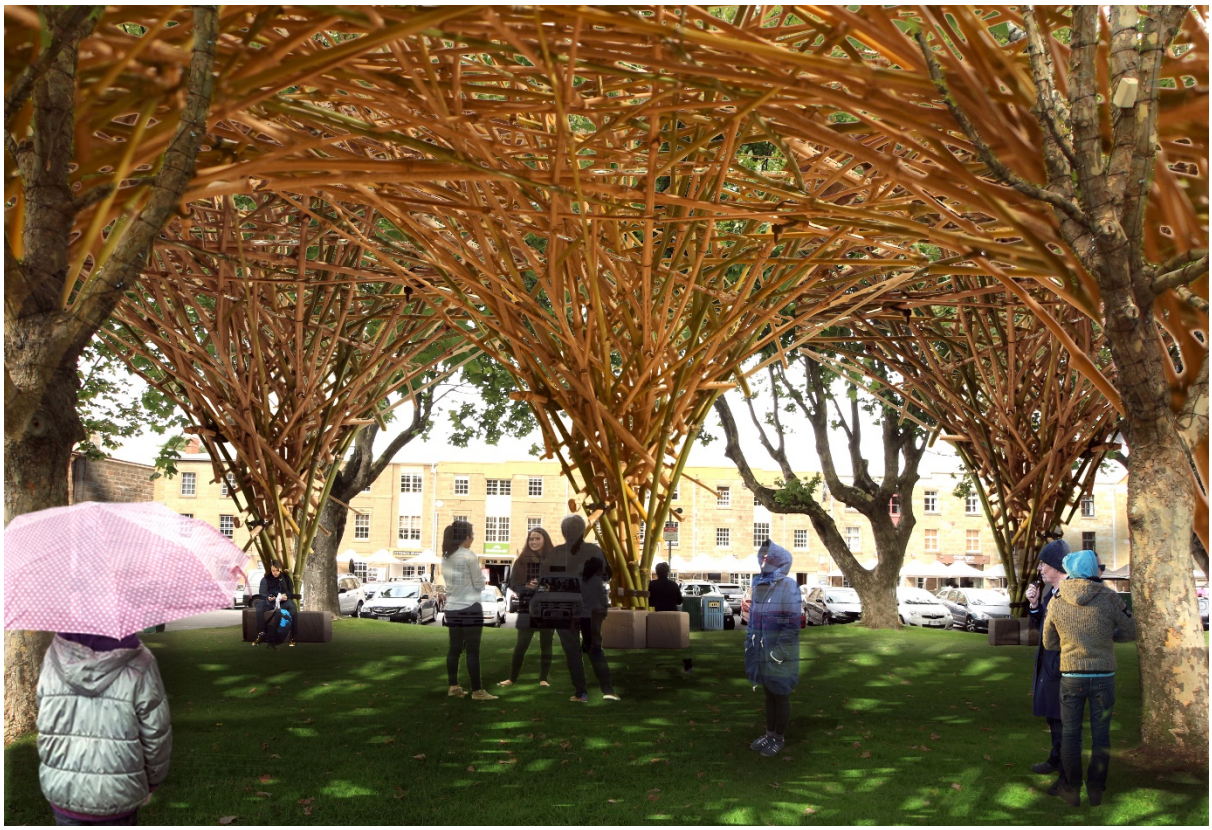
In-Situ tests allowed us to laterally load the structure. Using ratchet straps we caused the work to deflect a significant distance horizontally, simulating large wind loading. Upon releasing the lateral strain, the work showed its elasticity in returning to its original position.

These load tests were necessary in order to ascertain the strength of the bamboo and the ability of our structure to withstand wind-loading. During the exhibition the structure was exposed to wind gusts of up to 100km/h, with no structural damaged observed. This was enabled by the use of 3 outrigger ropes attached to the structure that could be deployed during storms in order to tie down the structure and provide a reduction in deflection.

Art provides the opportunity to bring awareness to the public domain. Exhibiting in an event like Sculpture by the Sea, exposes the work to 500,000 visitors over the course of 3 weeks. By taking the opportunity to create a work that pushes structural boundaries, Cave Urban is showcasing Bamboo as a structurally robust material that can be used in conjunction with other ‘high tech’ materials.

Moving Forward

Cave Urban latest collaboration is with the University of Tasmania (UTAS) and the Museum of Old and New Art (MONA), for the construction of the *Hothouse* in Salamanca Place in Hobart. Designed as a temporary pavilion, the Hothouse will be the largest roofed bamboo structure built in Australia. (Figure 9)



It sits as an intersection of art and architecture and continues to develop the notion of bringing the user in contact with the materiality of structure. Its design echoes the surrounding trees and looks to continue the notion of the forest with an urban setting.

The project aims to promote interaction and collaboration with the local community. It is being run as a design studio for Masters of Architecture students at UTAS. This has provided the opportunity to further educate future designers on the benefits of working with bamboo. As part of the design project, students were required to build prototype model at various scales in order to introduce them to material properties of bamboo. Ultimately it will be these students under the guidance of Cave Urban members, who will construct the project. (Figure 10)

Theme: Architecture, Engineering and Social Housing

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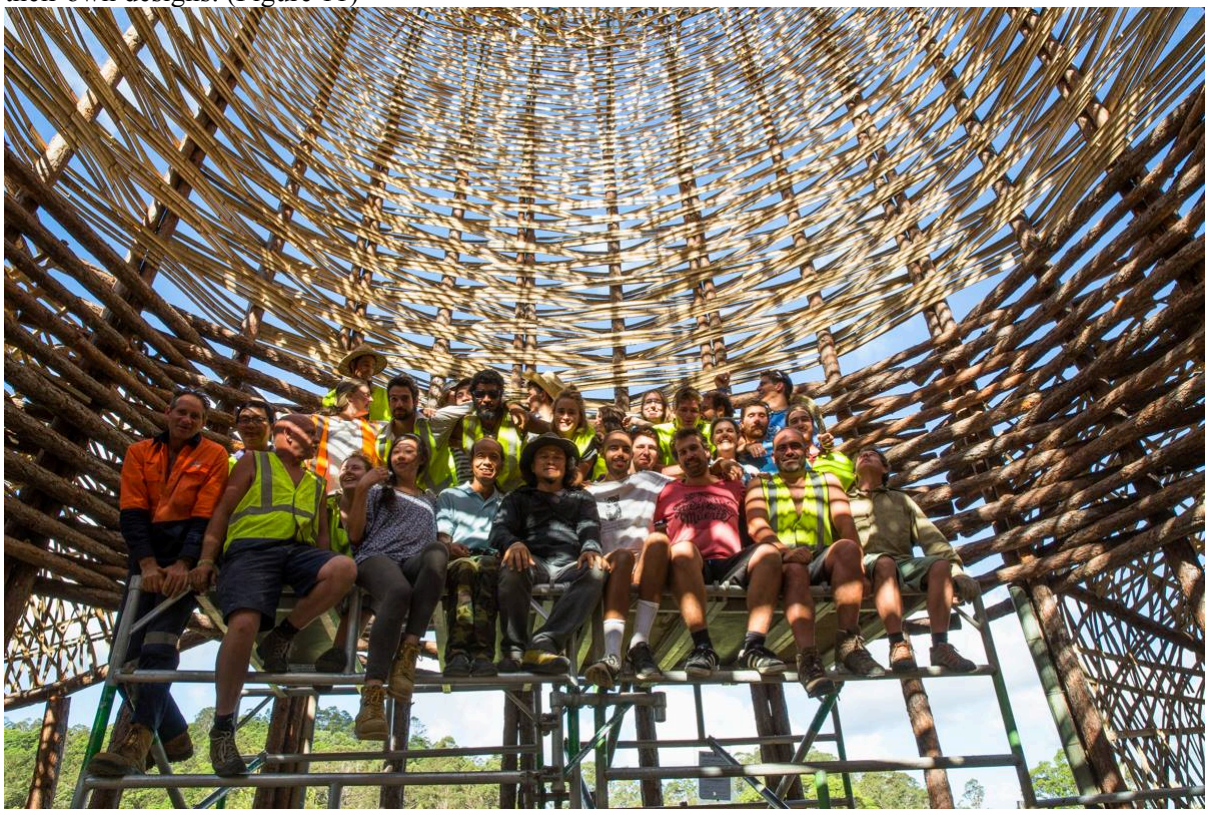
Conclusion

The Australian public have had little contact with Bamboo and it is our aim to provide a means to allow for a tangible connection to the material that may redefine previous held prejudices on what it is capable of.

There is a flexibility and materiality to bamboo that makes it a marvellous addition to the material pallet of contemporary design. By understanding its material and structural characteristics, we are able to create works that show off its ability to be used in creating awe-inspiring structures.

Working upon precedence allows for us to navigate a highly regulated building sector, with the ultimate goal of establishing regulated guidelines for bamboo construction within Australia.

By using education as an exchange for labour we are able to not only reduce the costs of our projects, but also expose young designers to bamboo as a material so that they too may begin to use it within their own designs. (Figure 11)



Collaboration is key to Cave Urban's practice. We believe it is only through sharing knowledge and working with other artists locally and internationally that we may work in unison to establish bamboo as a viable material in design. The works outlined in this paper, have taken place over the last year, in a number of different settings throughout Australia. We hope to build upon the momentum that we have now established and continue to showcase Bamboo to the Australian public and collaborate with other artists upon a global scale.

Figure 1: Woven Sky

Figure 2: Woven Sky under construction

Figure 3: Inside Woven Sky

Figure 4: Inside Woven Cloud

Figure 5: Brisbane Festival Light Garden

Figure 6: Installing the Brisbane Festival Light Garden

Figure 7: Save Our Souls with tie-ropes in place after a strong thunderstorm

Figure 8: Save Our Souls being installed at Marks Park at Bondi

Figure 9: Render Image of The Hothouse

Figure 10: 1:3 Prototype Model of The Hothouse

Figure 11: The Woven Sky build team with Cave Urban and Wang Wen-Chih

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Appendix A

The following tests where undertaken by Event Engineering and Cave Urban. The strength of the joint was tested by attaching the lower member to the concrete slab with rope. The upper member was lifted by a pulley. This load was recorded using a load link dynamo-meter.

Bamboo Joints Resistance test

This test was carried out to determine the resistance of three types of bamboo joints. To test the joints we built a set of triangles each one with a different type of joint. Weight was applied using a pulley and measured with a load link dynamo-meter. Pressure was applied in the Z axis.

The types of nodes were :

A)

Triangle 1 (T1) 900x900x900 : Lashing shear joint

Materials:
3500 mm of 6mm polyester double braided cord

B)

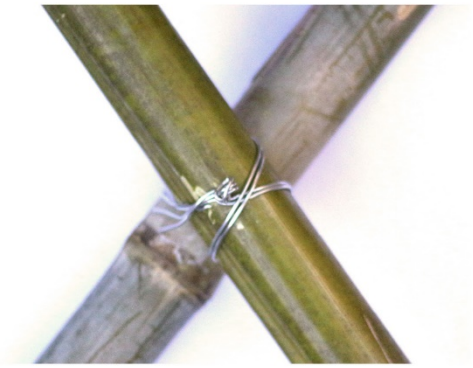
Triangle 2 (T2) 800x900x900 : Split joint

Materials:
300mm bamboo split
1800 mm of 6mm polyester double braided cord
1100 mm of 2mm polyester double braided cord

C)

Triangle 3 (T3) 800x900x1000: twisted wire joint

Materials:
800m of 2mm Galvanized wire

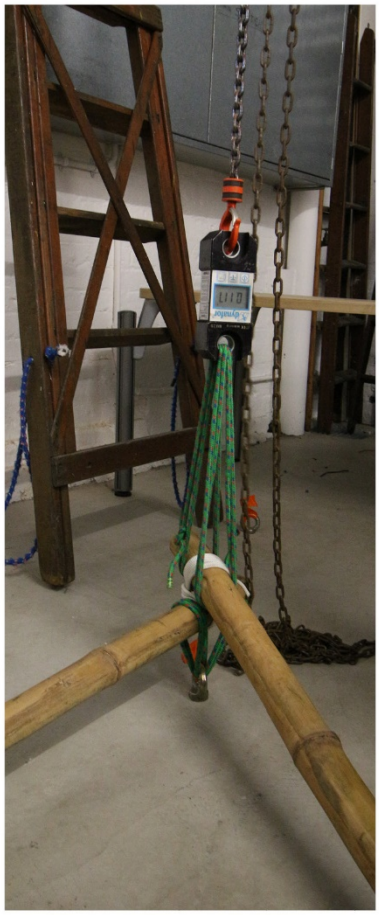


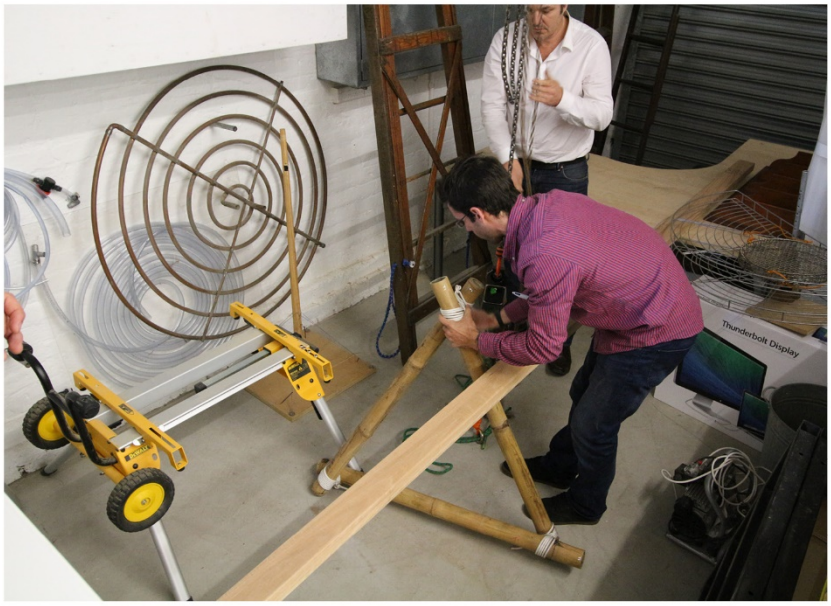
Results:

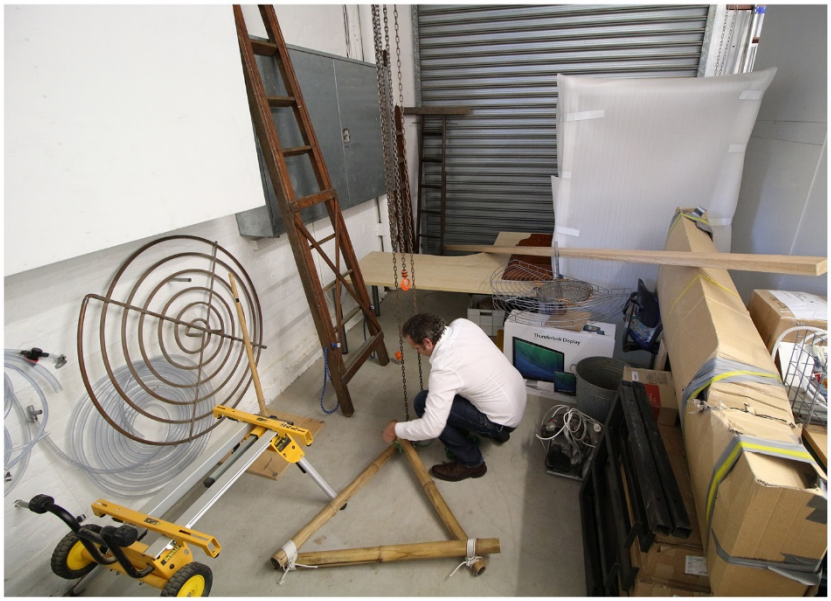
A)

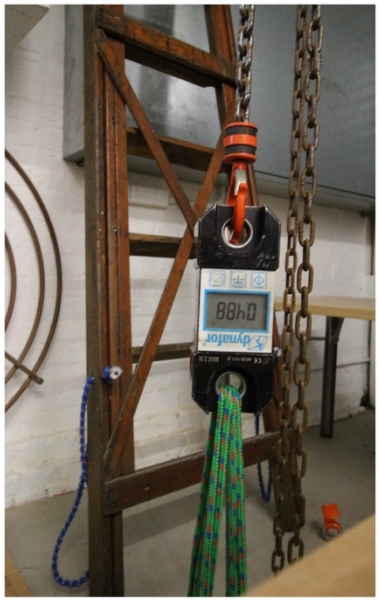
Triangle 1 (T1) 900x900x900 : Lashing shear joint

Weight was applied in the Z axis constantly until it reached 500 kg the weight applied decreased approximately 12 kg due to the rope's elasticity





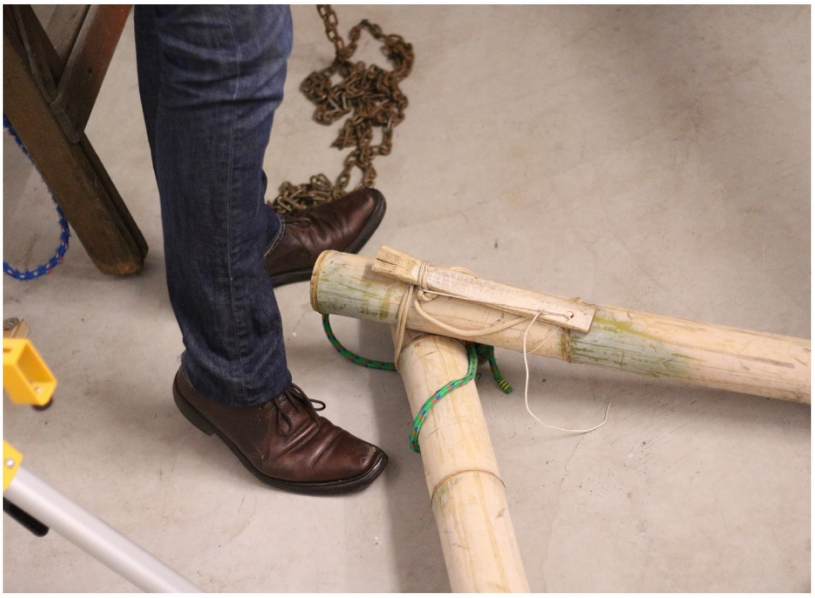


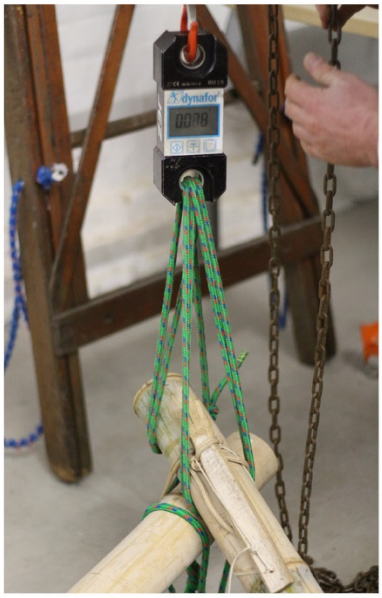


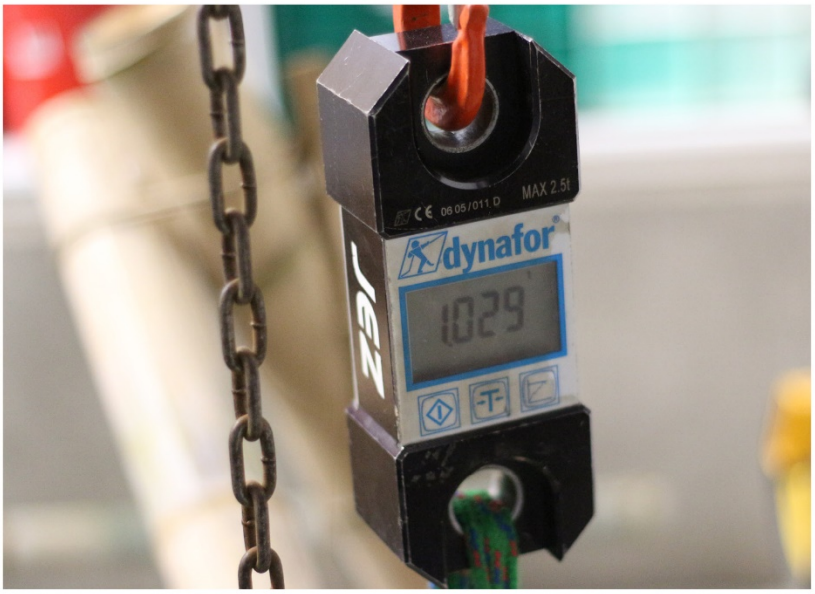
B)

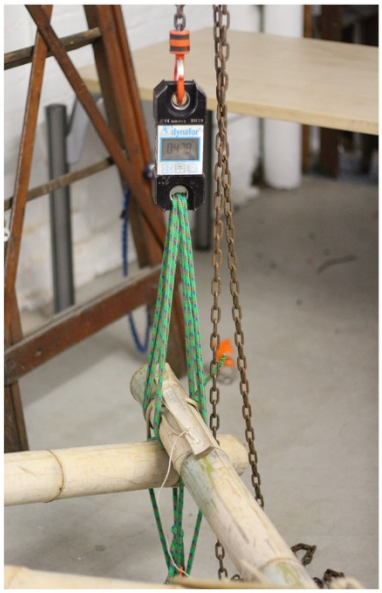
Triangle 2 (T2) 800x900x900 : Split joint

Weight was applied in the Z axis constantly until it reached 1050 kg the weight applied decreased approximately 21 kg due to the elasticity of the rope









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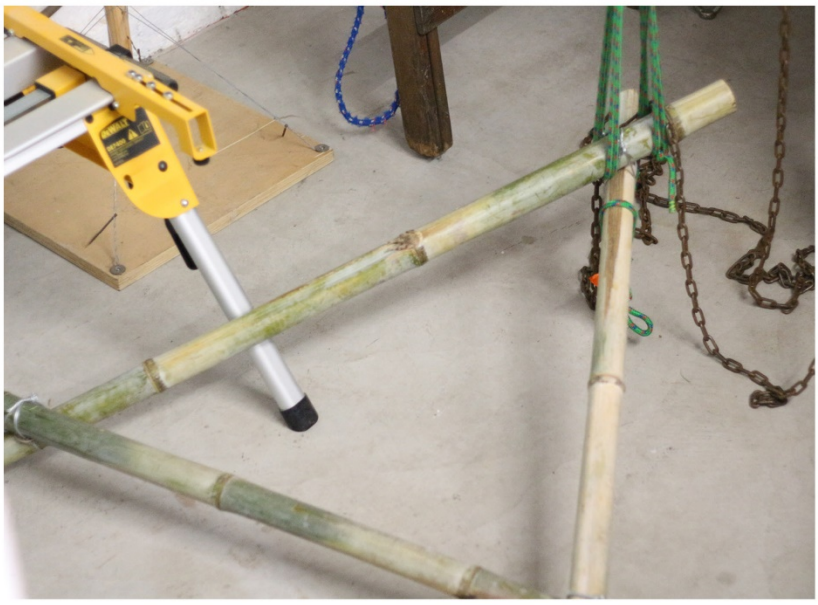
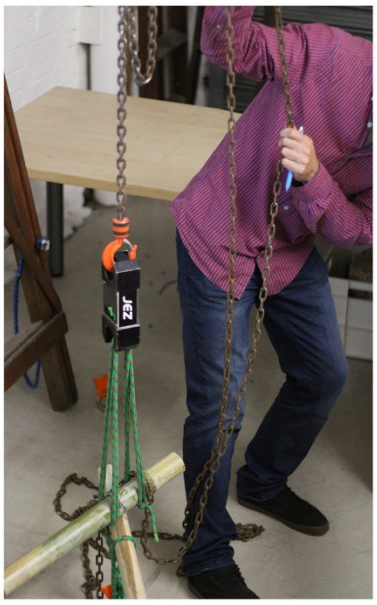
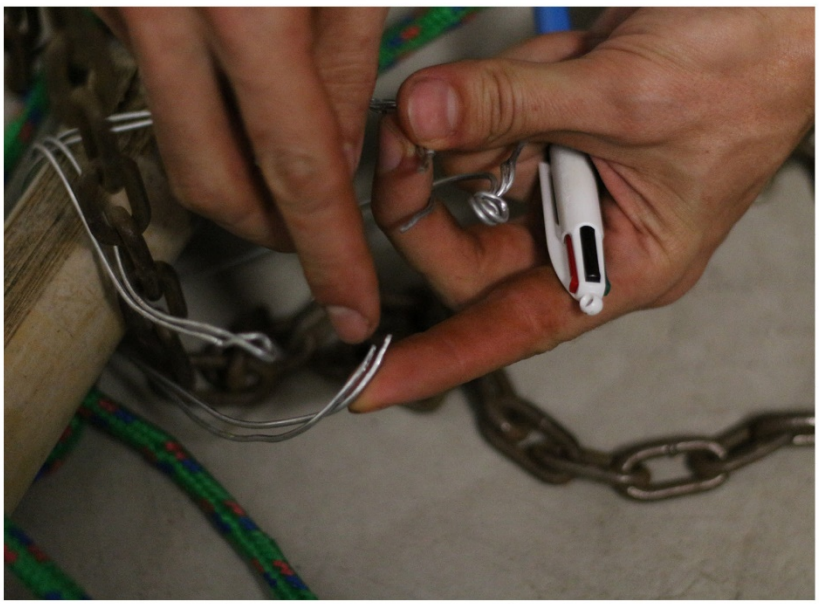
C)

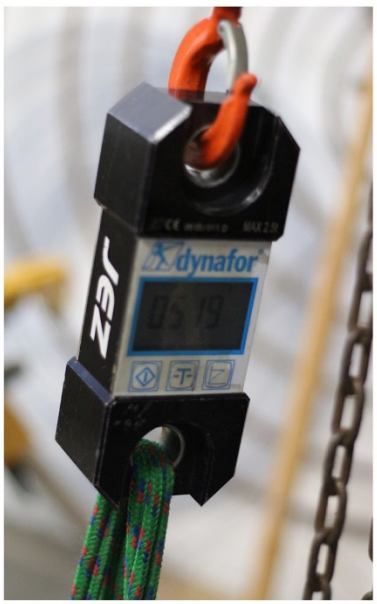
Triangle 3 (T3) 800x900x1000: twisted wire joint

Weight was applied in the Z axis constantly until it reached 519 kg the wire used for the connection reached its maximum elasticity point and it did brake.









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