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## Plastic Bottles In Architecture: A How To Guide On Life-Cycle Through Reuse

Crystallyne Landram

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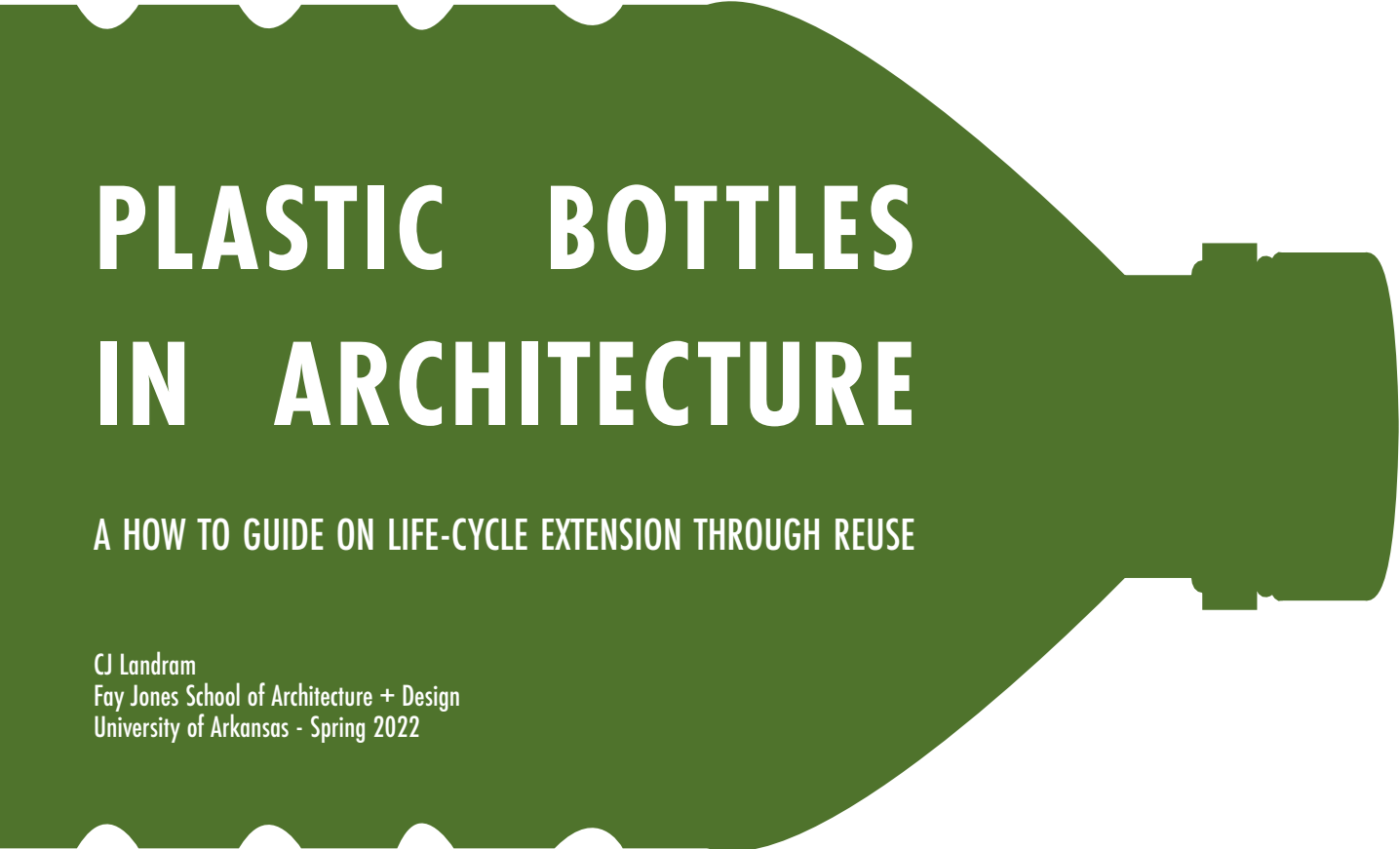
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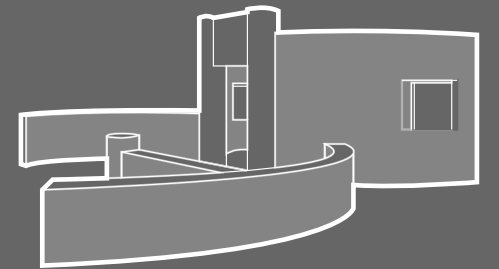
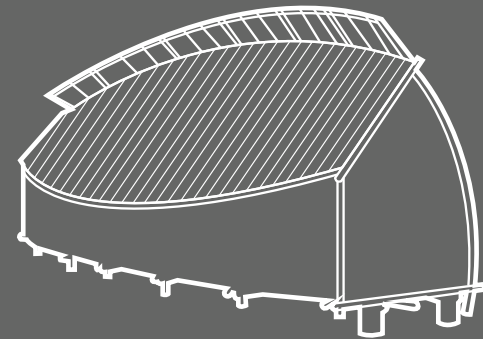
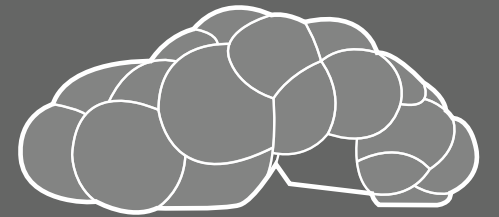
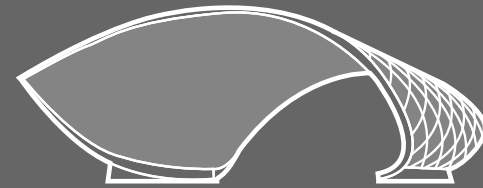
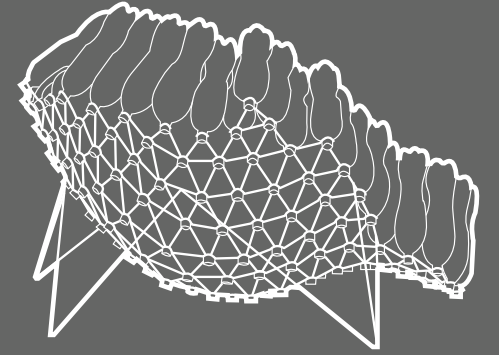
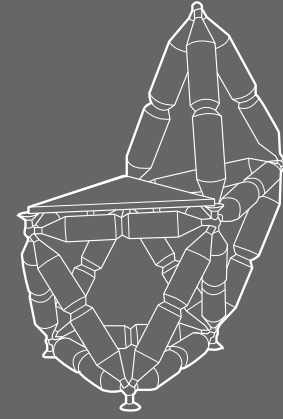
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# PLASTIC BOTTLES IN ARCHITECTURE

A HOW TO GUIDE ON LIFE-CYCLE EXTENSION THROUGH REUSE

CJ Landram  
Fay Jones School of Architecture + Design  
University of Arkansas - Spring 2022



**“Development that meets the needs  
of the present without compromising  
the ability of future generations to  
meet their own needs.”**

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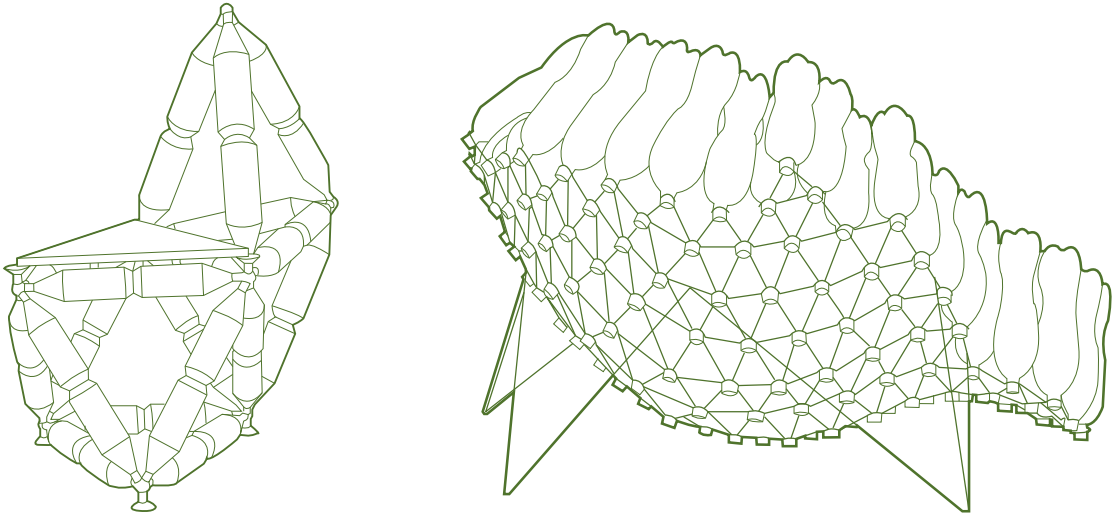


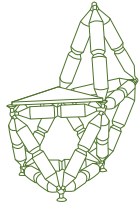




# Small Scale Works

The small-scale works section examines projects that are predominantly smaller than the average human. This scale of work demonstrates how a person can occupy a design by being ON it. Specifically, this includes two furniture case studies where the project is experienced as an object within a space rather than a space itself. The furniture category of bottle architecture is particularly accessible to a wide group of people considering most of the population has or needs furniture. Material collection, availability, and cost are major factors in why the TrussFab and SIE43 chair processes are the most replicable projects for the public.



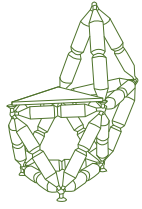


# TrussFab

TrussFab is a plugin for SketchUp that allows the operator to fabricate structures that are sturdy enough to withstand their weight, plus that of a person.<sup>28</sup> TrussFab was created by Robert Kovacs and his team for the Human Computer Interaction Lab at the Hasso Plattner Institute in Potsdam, Germany. The plugin is an end-to-end system allowing users to fabricate sturdy, large-scale structures using plastic bottles and 3D-printed connections. It has the embodied engineering knowledge within the program to allow users to validate their designs using integrated structural analysis. It has the option to automatically convert existing models into a TrussFab structure or build one from scratch. Once designed, 3D files for all the connection hubs are converted and ready to send to the 3D printer. For façade designs, connector files are created and converted for a laser cutter. Each piece is labeled with a unique ID so the user can easily assemble the structure according to its digital counterpart. The plastic bottles are treated as beams within a triangular truss system.<sup>29</sup> Whereas a freestanding bottle tends to fail easily, the truss system prevents deformation of the structure, not the individual bottle.<sup>30</sup>



Photo by: Hasso Plattner Institute



# Starter Kit

## Preparation:

Download SketchUp, install the TrussFab plugin, collect plastic bottles (all of the same size, quantity depends on the design), adjust the bottle lengths in the software to match those collected

## Parts:

Plastic bottles, 3D printed connections (treaded connectors, snap-fit connectors, wood screw connectors), 3D filament, wood screws, dowel screws (optional), wide tape (optional), shrinking tube (optional)

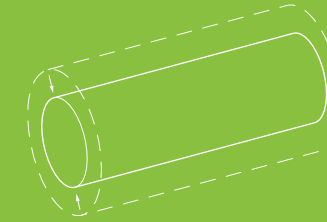
## Tools:

long screwdriver, drill, 3D printer, heat gun (optional), box cutter

## Parts:



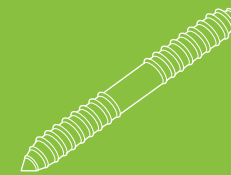
Plastic Bottle



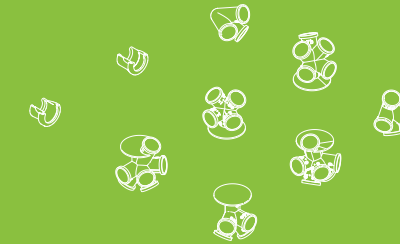
Shrink Tube



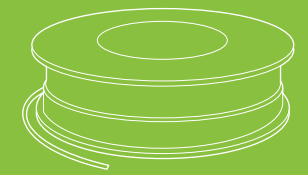
Wide Tape



Dowel Screw

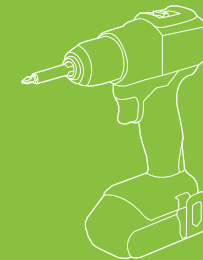


TrussFab Connections

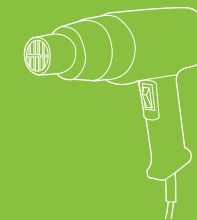


Printing Filament

## Tools:



Drill



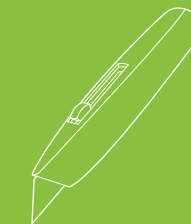
Heat Gun



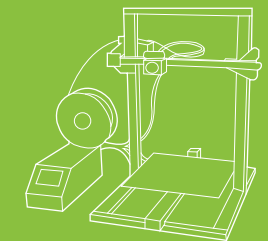
Long Screwdriver



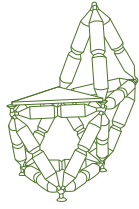
Computer



Box Cutter



3D Printer



# Production

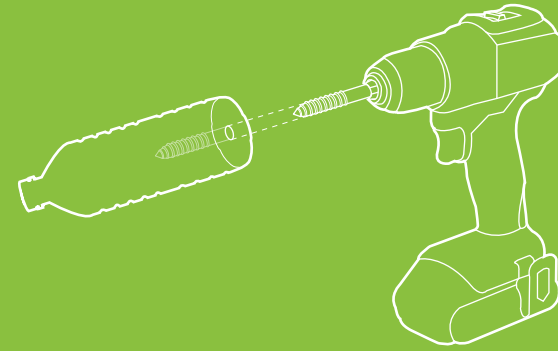
## Modifications:

For option 1 – drill a hole in the bottom of the bottle just smaller than the selected screw. This could either be a wood screw or dowel screw. For option 2 – cut the shrinking tube so that it covers 2/3 of each bottle while they are placed bottom to bottom.

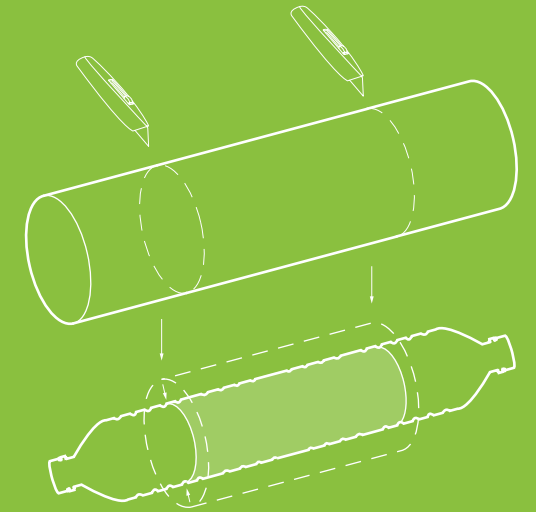
## Creations:

Create a 3D model in SketchUp using the TrussFab plugin. 3D print all the necessary connections. For façade designs, do the same step but laser cut the connection out of wood.

## Modifications:

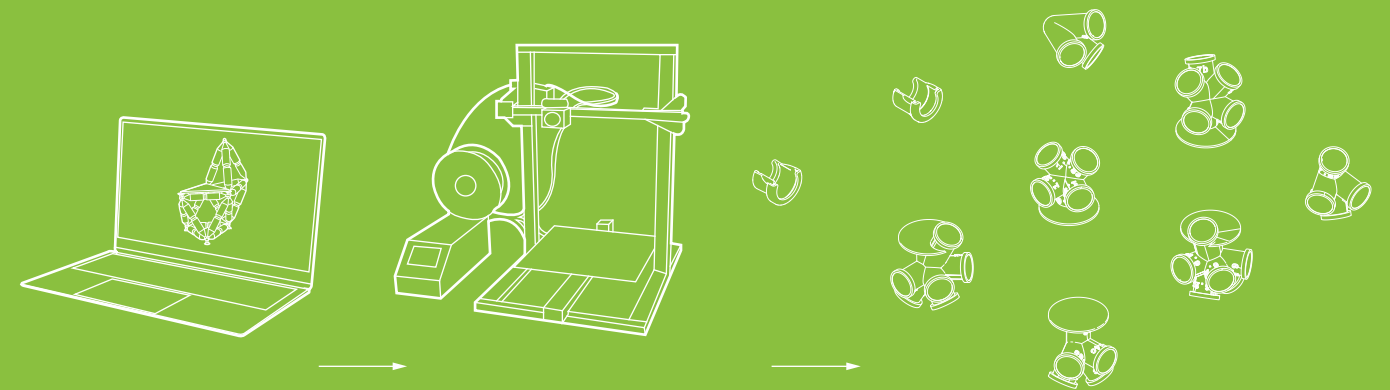


Option 1: Drill a hole in base of the bottles that will have a screw connection

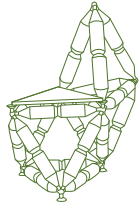


Option 2: Cut the shrink tube into the appropriate lengths relative to the bottles

## Creations:



3D print all connections from the digital model



# Production

## Assembly:

There are multiple options for assembly that can be chosen based on the structure's design, material availability, and personal preference. By this point, the appropriate connectors have been printed for the design. For threaded connections, the bottle is screwed into the connector as if it were a cap. The snap-fit connector is used by inserting the connector into the mouth of the bottle. A locking pin is then inserted through the connector and into the bottle and expanding the piece for a tight fit. With the wood screw connection, a hole is drilled in the bottom of the bottle just smaller than the selected wood screw. The wood screw is then placed within the bottle where the tip is on the exterior where it will be screwed into the 3D printed connector with the flat platform. For optimal fastening, drill a pilot hole into the connector as well as the bottle. To create the truss beams, the bottles need to be bound together in one or two ways. An option is to drill a pilot hole into the bottom of two bottles. From here a dowel screw can be inserted into the bottle from the top and screwed into the second bottle using a very long screwdriver, or a dowel or double-ended screw can be manually screwed into both bottles from the bottoms. A second option is to cover two bottles that are arranged with the bottoms touching with a shrinking tube. The tubing should cover most of the bottles before applying heat to shrink it using a heat gun. Although fast, another less sturdy method of binding would be to use wide tape instead of shrink-tubing. Once all beams are created, the full trusses can be assembled using the connectors to complete the structure.

## Assembly:



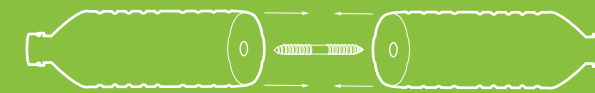
Threaded Connection



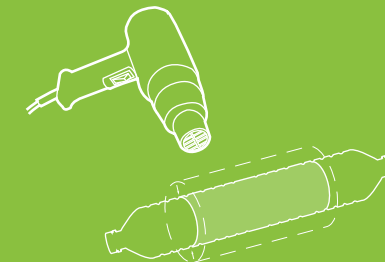
Snap Connection



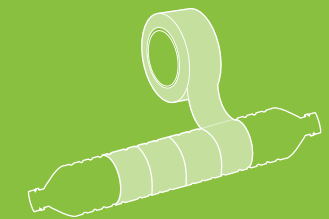
Screw Connection



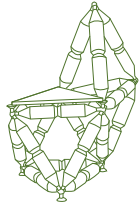
Screw a bottle onto each end of the dowel screw to where the bottles are connected at the bases



Use a heat gun or hair dryer to shrink the tube around the bottles



Wrap wide tape around the two bottles



## Post Production

### **Waste:**

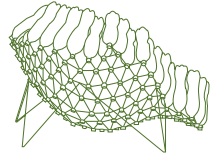
Potential waste includes the bottle caps, plastic shavings, and scraps of shrink tubing, 3D filament, or tape.

### **Maintenance:**

Depending on the wear and tear of the design, the 3D printed connectors may need to be replaced over time. If a bottle needs to be replaced, it can be unfastened from the connector and a new bottle can be fitted instead. This method would be suitable for outdoors, but long term should be kept indoors away from extreme conditions.





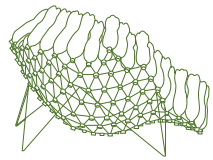


## SIE43 Chair

The SIE43 Chair, by Pawel Grunert, was constructed for the 'Eco Trans Pop' exhibition at the Edizioni Galleria Colombari in Milan, Italy.<sup>31</sup> It is roughly 150 x 80 x 90 cm, composed of a stainless-steel frame, and populated by reused PET bottles.<sup>32</sup> The bottles are secured into the frame from the bottle tops. The bottoms-up arrangement is in an organic floral pattern representing the appearance of a flowing meadow while the caps form the base of the chaise lounge.<sup>33</sup> The eco art piece calls attention to the opportunities for material reuse. Although the framework of this chair is complex in form, the combination of a socket frame, used soda bottle, and cap fastener is a simple process to replicate.



Photo by: Pawel Grunert



# Starter Kit

## Preparation:

Collect and clean approximately 200 PET bottles (for a chair around 150 x 80 x 90 cm in scale). Verify that the cap and mouth of bottles are all the same size.

## Parts:

PET bottles, Stainless steel rods (amount varies for desired design)

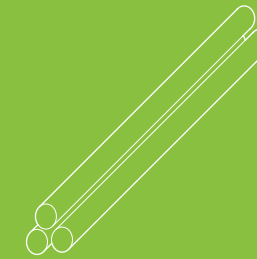
## Tools:

Rubbing alcohol, Small towel (or equivalent), Scissors, Welder of choice, Angle grinder (or equivalent)

## Parts:



Plastic Bottles



Steel Rods

## Tools:



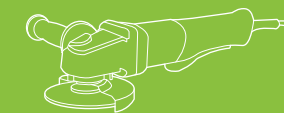
Scissors



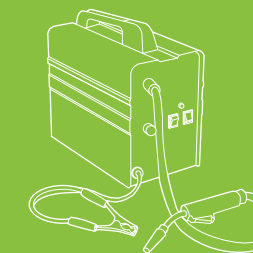
Towels



Rubbing Alcohol

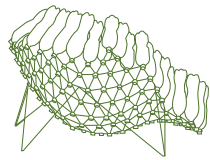


Angle Grinder



Welder





# Production

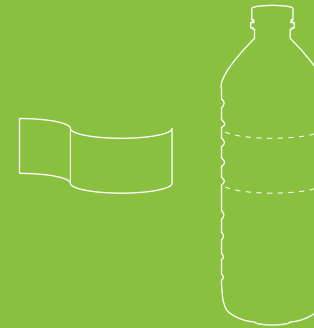
## Modifications:

Remove labels and residue (step optional). Cut many stainless-steel rods into pieces a few inches long with the angle grinder (or equivalent) to become the socket spacers in the frame. Next, cut many stainless steel rods into pieces where the length is equivalent to the diameter of the bottle top, then work them into rings that will become the frame sockets. Cut remaining rods to the desired leg size for the chosen design.

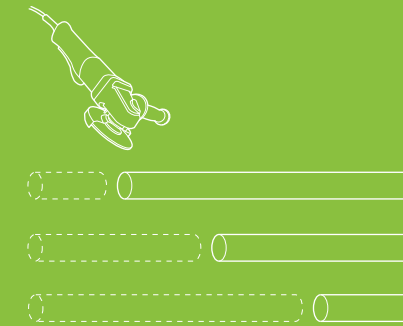
## Creations:

Create a frame in the shape of the desired furniture by welding the stainless-steel rods into a triangular grid around the circular sockets which are large enough to house the mouth of the bottle. Shape the overall frame to the desired furniture design. Once the frame is assembled, weld the longer rod pieces to create the legs beneath it.

## Modifications:



Remove labels

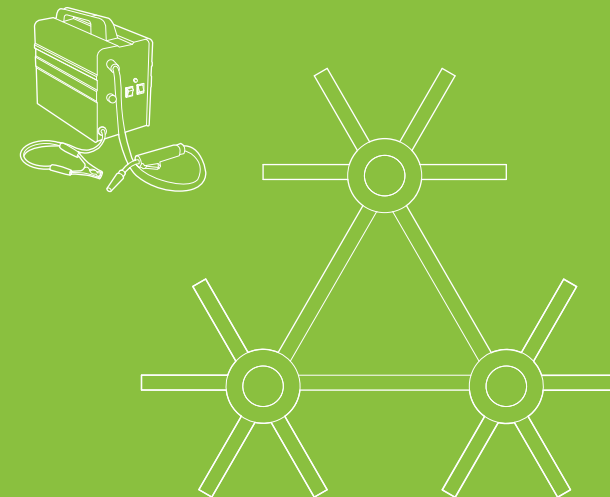


Cut rods into the required lengths



Bend rods into rings for the frame

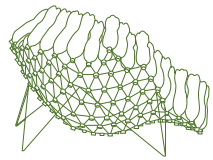
## Creations:



Weld the rods and rings into a triangular grid



Shape the grid into the chair frame, then weld the legs into place



# Production

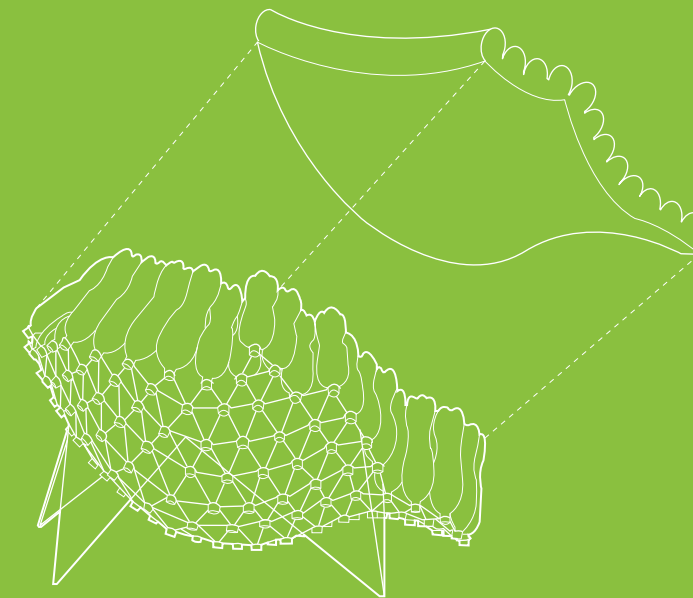
## Assembly:

After the total frame is completed, screw the PET bottles into the frame sockets. The bottles should be organized 'bottoms-up' on the top side of the furniture frame and secured by the caps fastened to the underside. In the question of comfort and utility, pillows or padding can be added over the chair to increase the user experience.

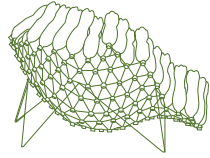
## Assembly:



Insert the bottles into the rings and screw the caps on to secure it in place



Apply padding to chair if desired



# Post Production

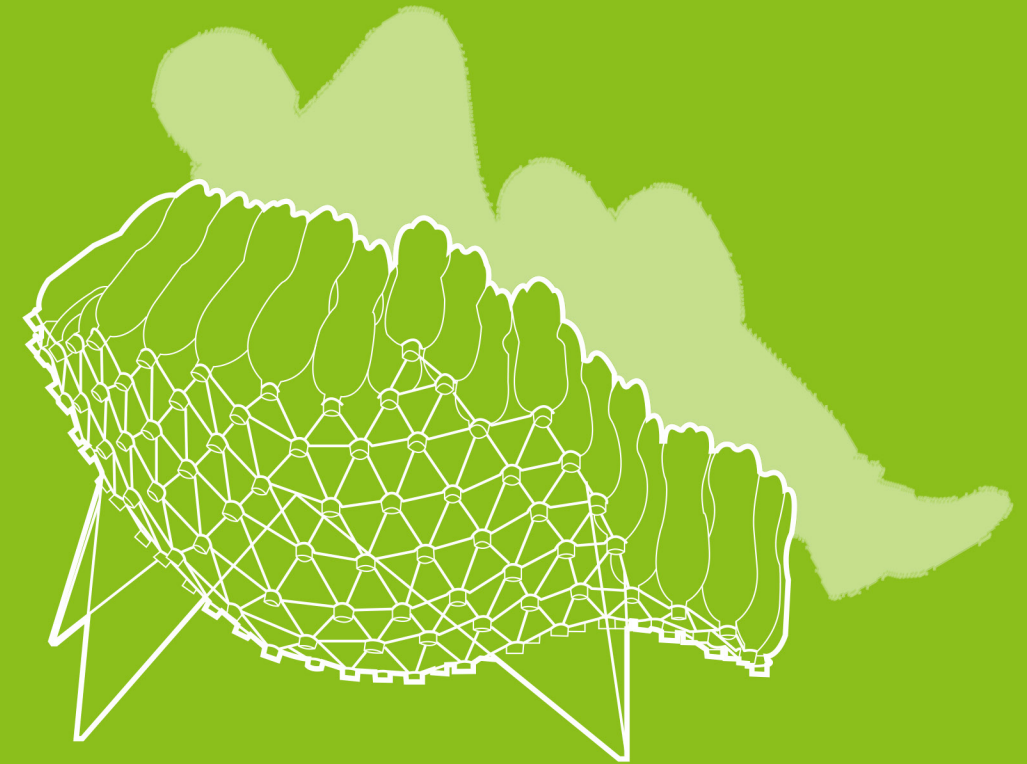
## **Waste:**

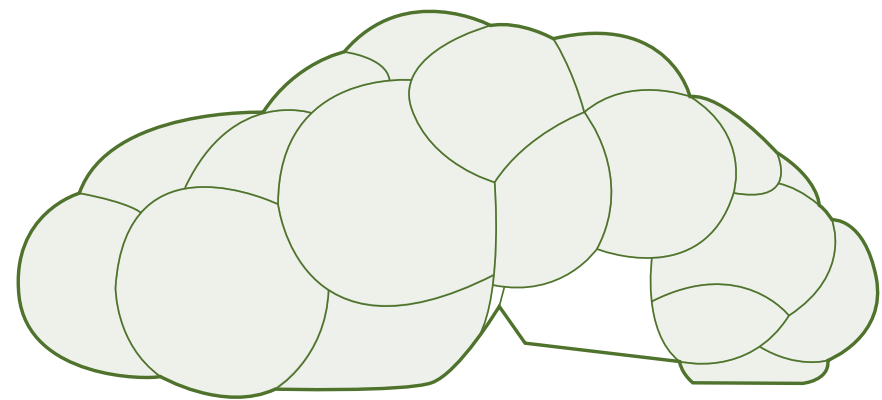
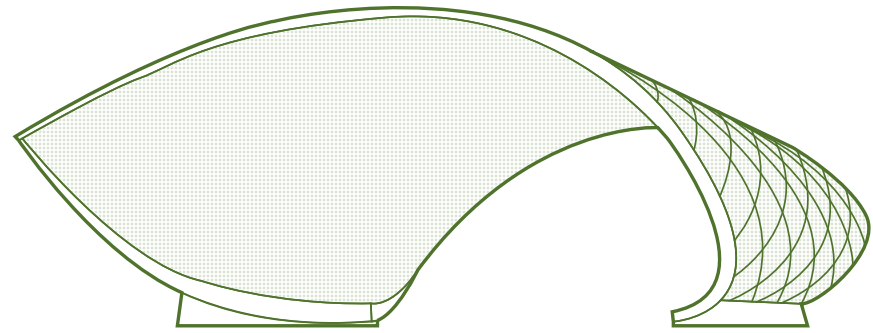
Potential waste includes metal scraps, shavings, and discarded bottle labels including the cleaning materials utilized.

## **Maintenance:**

The design of this chair allows for easy bottle maintenance. When a bottle becomes damaged, it can be collected for recycling and replaced by a different bottle.

The overall chair can become subject to melting in areas of high sun or heat exposure. The bottles may also lose their color in these conditions. Stainless steel does not rust easily, but it can in the right conditions over time. For peak lifespan, it is recommended that the chair remains indoors, but is functional in almost all environments.





## Medium Scale Works

Medium scale work includes pavilions, think pieces, and sculptures. The work is now much larger than that of a person. The two pavilions represented in the following section demonstrate how a human occupancy occurs UNDER architecture and design. In scale, the medium case studies are the same as the large projects, but they differ in longevity and envelopment. The Cola-Bow and Head in the Clouds projects are both temporary exhibits used to raise awareness to the growing plastic waste crisis. They are open air structures that lack the full enclosure of the large-scale building case studies, but can be occupied by many individuals at once. Works such as this are very public making it easy to engage with, but there is less of a common need to replicate them.



# Cola-Bow

Penda's Cola-Bow was designed and built-in 2013 for the 2nd Beijing University Creation Expo where it remained standing through Beijing Design Week. It is made from over 17,000 recycled plastic bottles forming a pavilion inspired by the shape of the swings on the Coca-Cola logo. A joint initiative by Beijing Universities and Coca-Cola collected the bottles by offering one free Coke for every 10 empty bottles returned.<sup>34</sup> The bottles are secured to a mesh panel fixed to a steel structure. It was created to reclaim plastic waste, bring awareness to the issue, and promote the brand itself.<sup>35</sup>



Photo by: Penda



# Starter Kit

## Preparation:

Collect plastic bottles, the quantity depends on the scale of the intended design. The bottles must still have caps and can remain with their labels on. In this design the bottles are consistent in size, but this can be altered.

## Parts:

Plastic bottles, mesh (metal or plastic) with gaps large enough to insert the bottle mouth, metal rods, fasteners appropriate to structure material

## Tools:

Drill, miter saw, welder of choice, ladder

## Parts:



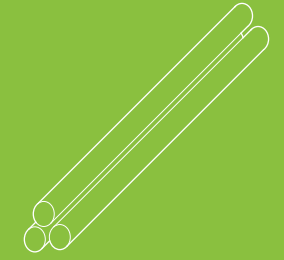
Plastic Bottles



Fasteners



Plastic Mesh



Steel Rods

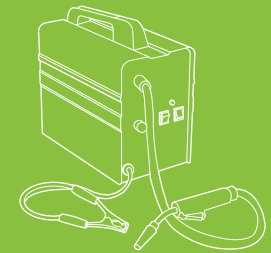
## Tools:



Drill



Miter Saw



Welder



Scissors



Ladder



# Production

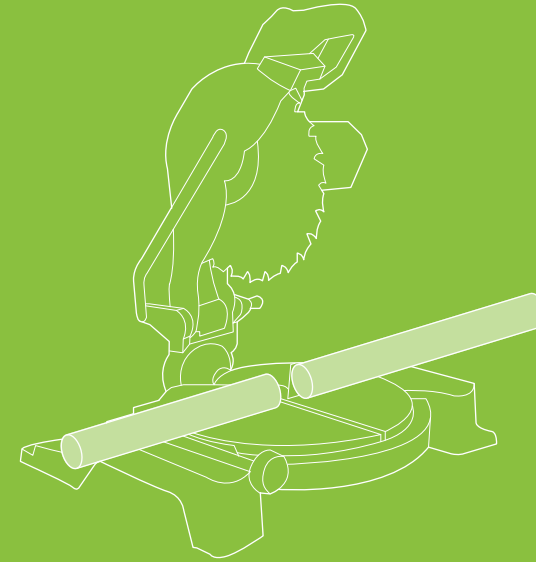
## Modifications:

Cut the metal to scale with the miter saw, (the metal may be substituted with other building materials such as wood and secured with the appropriate fasteners). The size and quantity of the structure parts is determined by the design chosen. Cut the mesh into panels large enough to cover the underside of the structure.

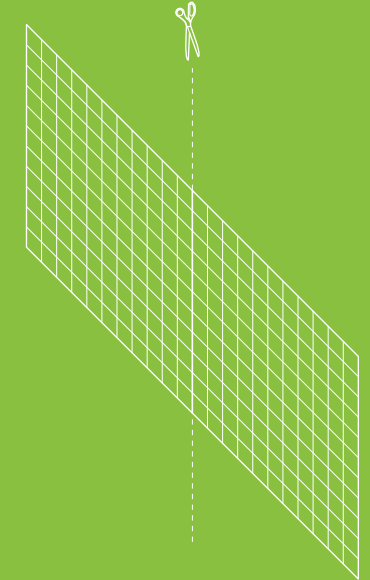
## Creations:

Fasten the structure pieces with screws and a drill. If the primary structure is made of metal, the joints can be welded into place instead.

## Modifications:

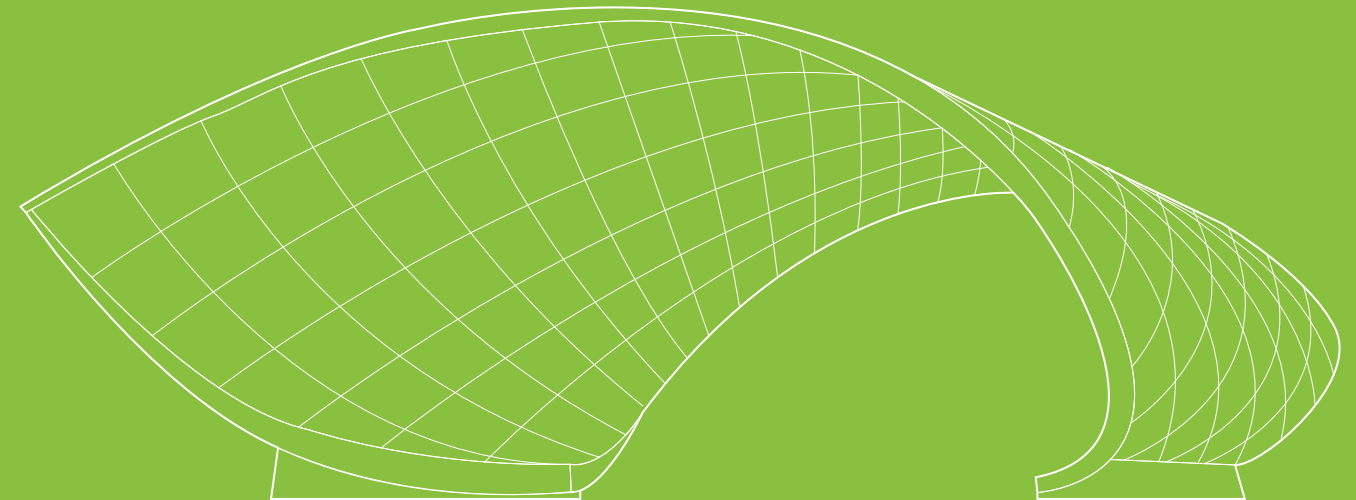


Cut rods to size



Cut mesh to size

## Creations:



Assemble the structural frame





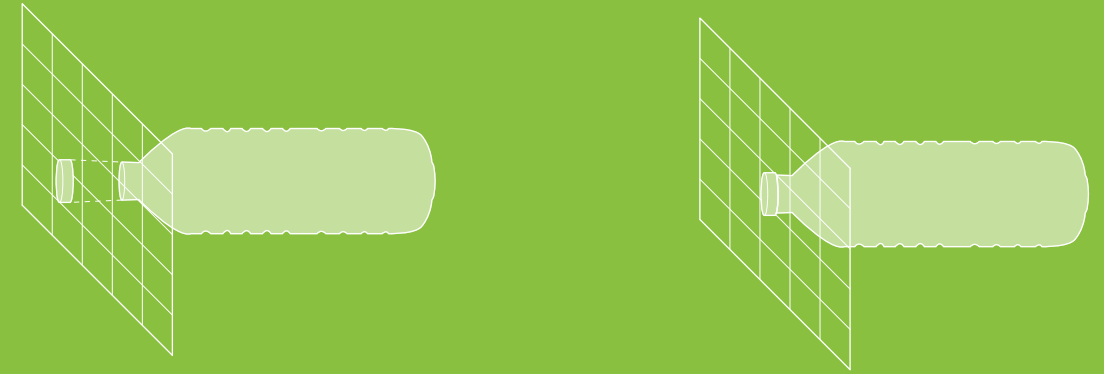
# Production

## Assembly:

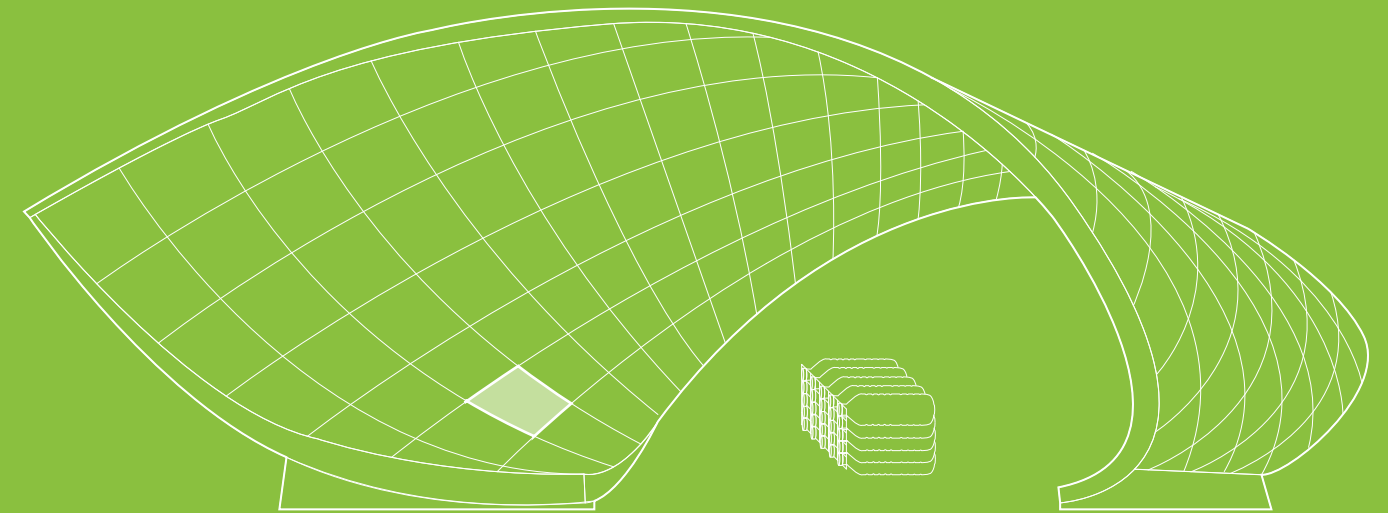
Once the structure is complete, insert the mouth of the bottle into the mesh gap.

Screw the cap onto the bottle from the other side to secure it in place. When the mesh panel is full populated with bottles, lift into place and secure to the structure with the appropriate fasteners.

## Assembly:



Insert the bottles into the mesh and screw the caps on to secure it in place



Secure the mesh panels with the bottles to the structural frame





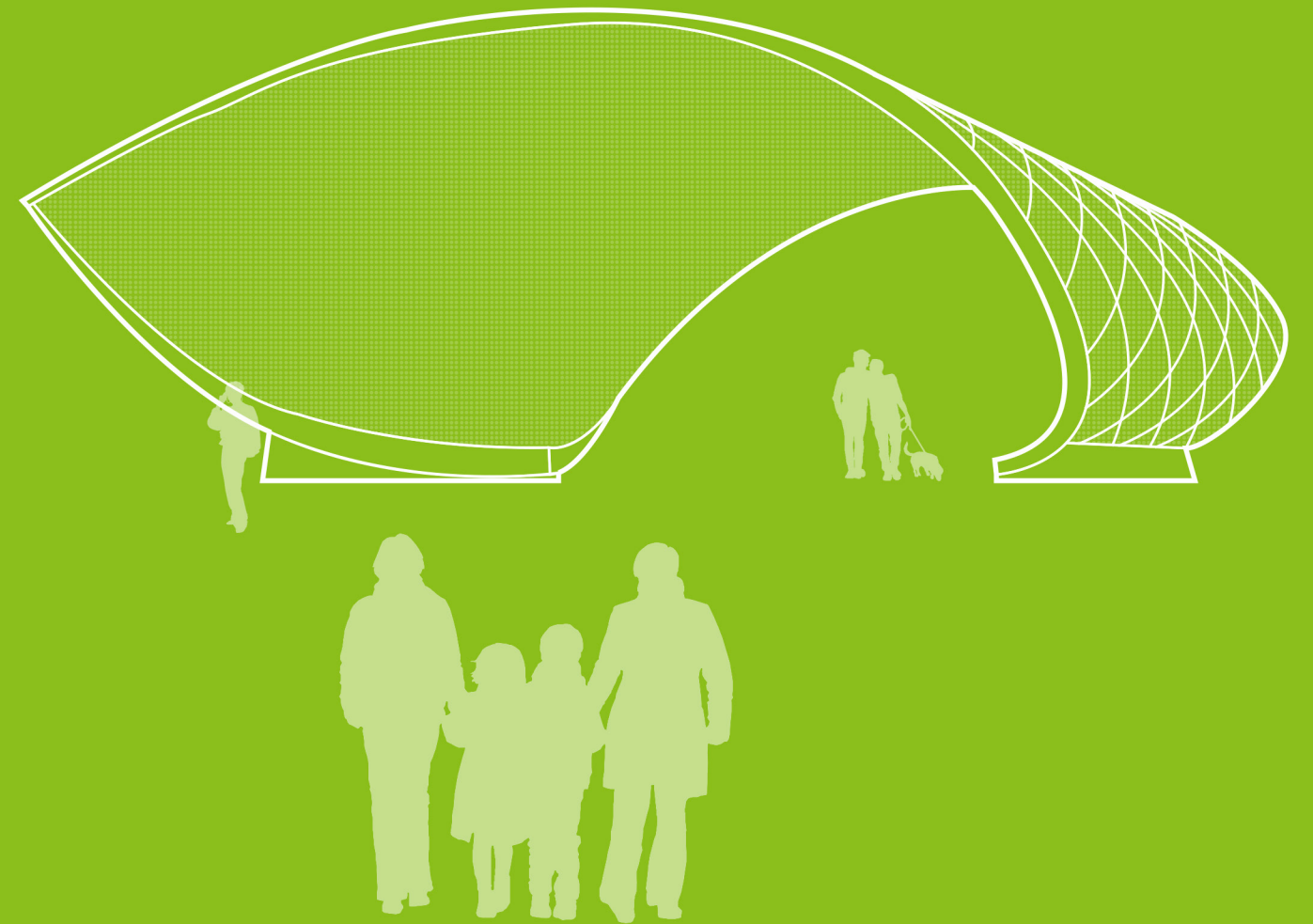
# Post Production

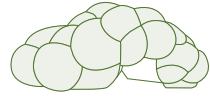
## **Waste:**

Potential waste includes scraps and shavings from the structure materials or mesh.

## **Maintenance:**

Depending on the structure materiality, a sealant may be required to prevent weathering over time. If the mesh needs to be replaced, the panel can be removed, bottles collected, and replaced by new mesh. The previous bottles can be reinserted, and the panel can be reattached to the structure. Bottles may weather over time and lose color. If it is deemed necessary, then a bottle can be easily unscrewed and replaced.



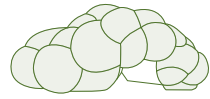


# Head in the Clouds

The Head in the Clouds pavilion was Studio Klimoski Chang Architects' response to the question "What would an art pavilion made out of recycled materials and based around the idea of 'The City of Dreams' look like to you?" posed by FIGMENT's 2013 art festival on Governor's Island in New York City. STUDIOKCA decided that an earthy cloud made of recycled water bottles was "A place to dream, in the 'city of dreams'." The pavilion is made of curved aluminum tubes supporting 120 'pillows' of one-gallon jugs and interior cladding of blue-dyed plastic bottles. There are 53,780 bottles used which is the number of plastic bottles thrown away in NYC every hour.<sup>36</sup> They were collected by local schools and organizations.<sup>37</sup> The structure is 40 feet long, 18 wide, and 15 high at its peak.<sup>36</sup> A wooden seating platform filled with sand acts as the base of the aluminum structure while the water in the dyed bottles adds additional weight and stability. Because of this, a foundation is not necessary.<sup>38</sup>



Photo by: Lesley Chang



# Starter Kit

## Preparation:

Collect 16oz and 24oz plastic bottles and white 1 gallon jugs that possess a cap, the quantity is determined by the size of the design.

## Parts:

16oz and 24oz plastic bottles, white 1 gallon jugs, water, food dye, plastic mesh, aluminum tubes, zip ties, wood, sand, fastener of choice

## Tools:

Miter saw, drill or hammer, welder of choice

## Parts:



24 OZ Plastic Bottles



16 OZ Plastic Bottles



Gallon Jugs



Water



Dye



Mesh



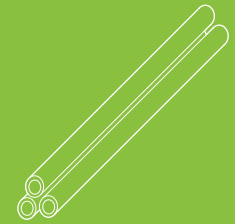
Fasteners



Sand

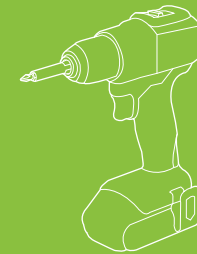


Zip ties



Steel Rods

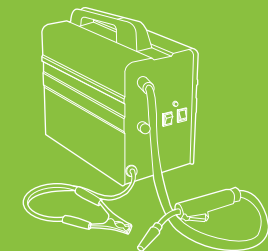
## Tools:



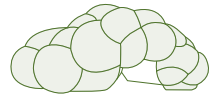
Drill



Miter Saw



Welder



# Production

## Modifications:

Partially fill the plastic bottles with water. It is optional to add food coloring to the water. Cut the aluminum tubes to size with a miter saw for the structural frame per design needs, (the aluminum may be substituted with other building materials such as wood and secured with the appropriate fasteners). Curve the tubes if desired.

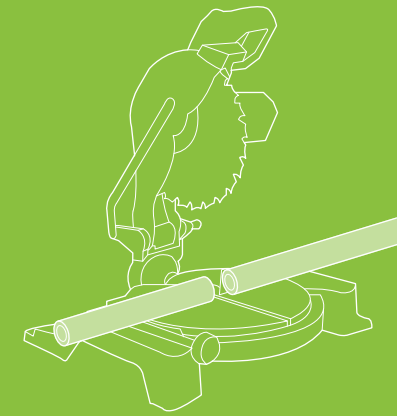
## Creations:

Assemble the aluminum tubes into the intended frame design. Build a base from wood that will secure the aluminum tubes. Fill with sand to ensure stability.

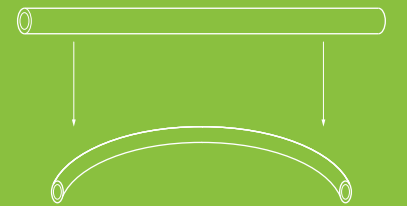
## Modifications:



Partially fill the bottles with water and dye



Cut tubes to size

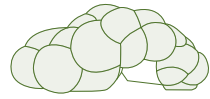


Curve the tubes for the frame if the design requires it

## Creations:



Assemble the structural frame and wooden base filled with sand

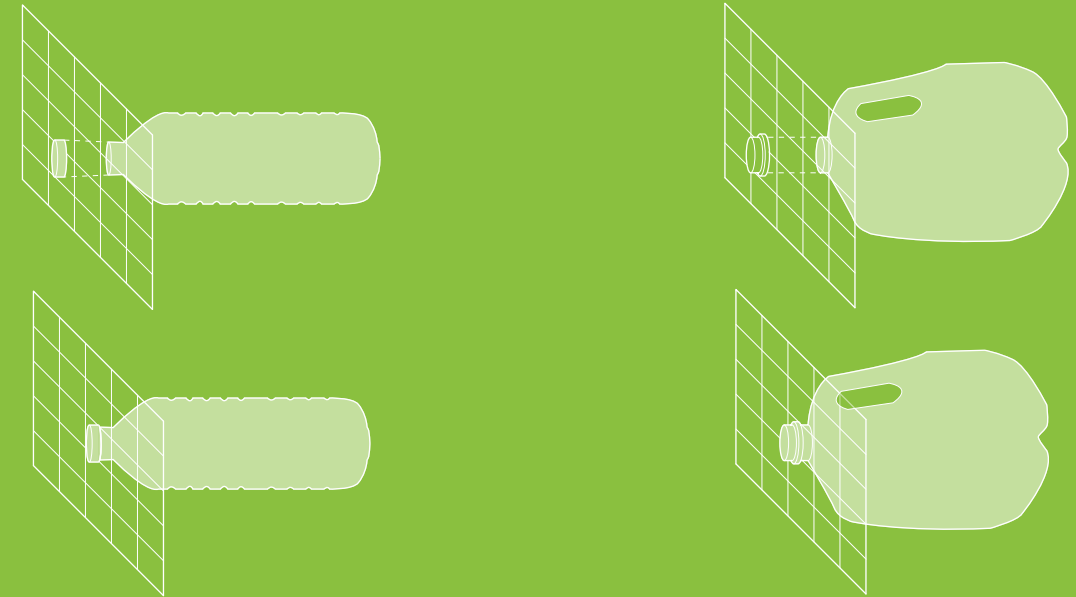


# Production

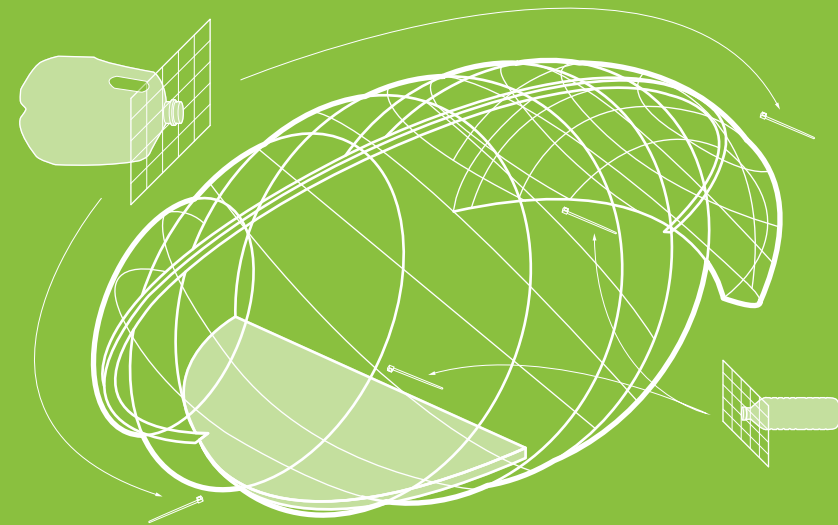
## Assembly:

After the structural frame is completed and secured to the wooden base, begin assembling the jug 'pillows' and bottle panels. For both, insert the mouth of the bottle or jug into the mesh and secure it on the other side by screwing the cap back on. The pillows will consist only of gallon jugs. The bottle panels can be a mix of 16oz and 24oz bottles. Once the panels are finished, secure the jug panels to the exterior of the aluminum frame with zip ties. Then, secure the bottle panels to the interior in the same manner. Depending on the design, a ladder may be required.

## Assembly:

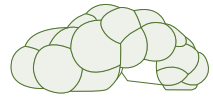


Insert the bottles into the mesh and screw the caps on to secure it in place



Secure the mesh panels with the bottles to the structural frame





# Post Production

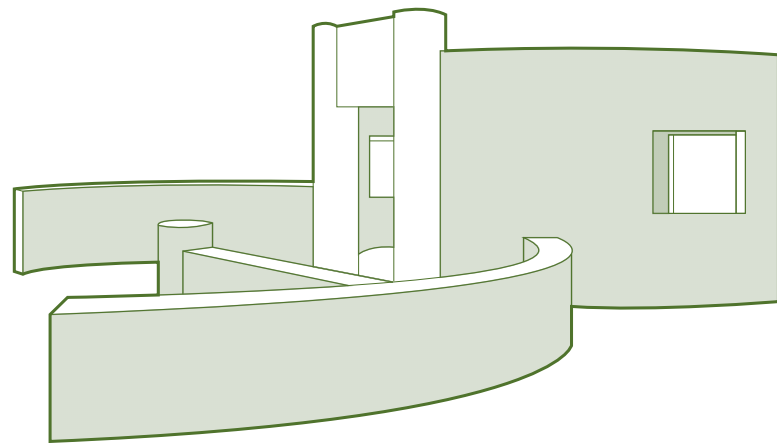
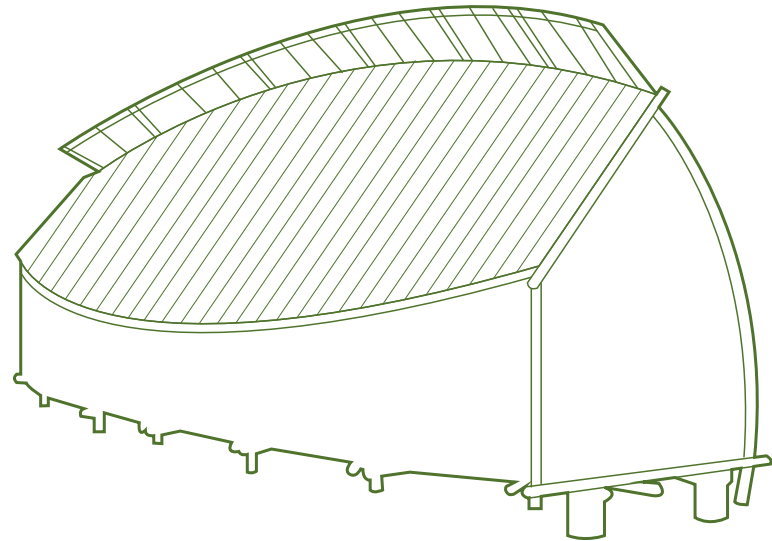
**Waste:**

Potential waste includes metal, wood, mesh, and zip ties scraps. It could also include waste from the food coloring packaging.

**Maintenance:**

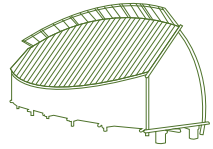
The wood platform should be finished with a protective sealant to prevent weathering. If necessary, a plastic bottle can be replaced by unscrewing it from the mesh and inserting a new bottle.





## Large Scale Works

Large scale work is focused on permanent buildings that maintain a level of full enclosure. Occupancy and engagement now occur WITHIN the structure. The Bottle Sail and Bottle House are two examples of projects that use plastic bottles to address the waste crisis in addition to other social issues such as housing and community cohesion. Housing crises are global issues that could successfully be addressed in a sustainable fashion while simultaneously reducing plastic waste. Because the plastic bottles are readily available, the material costs for social projects are much lower than standard building practices. Plastic bottle architecture presents a viable solution for such issues and thus is a very accessible construction alternative.



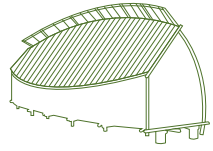
# Bottle Sail

1+1>2 International Architecture JSC collaborated with COHED in the Do Son district of Vietnam to create a structure for rural communities affected by HIV/AIDS aiming to improve the quality of agricultural and community connections to help people socially reintegrate. Hai Phong averages 12 typhoons each year, so the bottle seedling house was designed to withstand natural disasters and protect the plants. The foundation is a series of concrete piers embedded deep into the earth. Atop the foundation is a bamboo frame system that is approximately 1000sqft. It is roofed by 3000 plastic bottles which are strung together by bamboo rods. Each rod is run parallel to each other providing protection from rain, wind, and diffusing light on the interior. It serves roughly 10,000 tomato seedlings per season, as a place for farmers to relax, and as a location for after-school extracurriculars.<sup>39</sup>



Photo by: Vu Xuan Son





## Starter Kit

### Preparation:

Collect plastic bottles of the same size, the quantity is determined by the proposed design. The labels are optional, and the caps are unnecessary.

### Parts:

Plastic bottles, bamboo (can be substituted for metal tubing), string, concrete

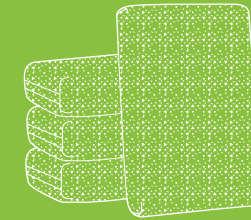
### Tools:

Box cutter, saw of choice, shovel or excavator, cement mixer or drill with mixing attachment

### Parts:



Plastic Bottle



Concrete

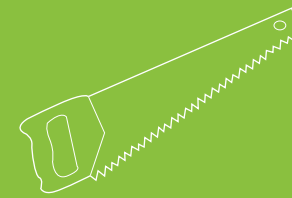


Bamboo

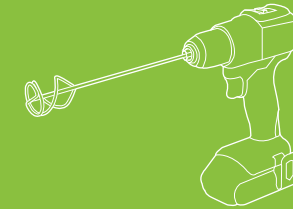


String

### Tools:



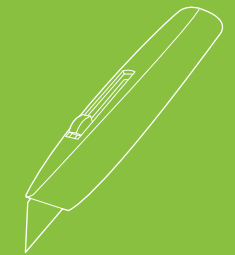
Hand Saw



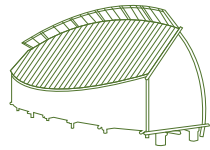
Cement Mixer



Shovel



Box Cutter



# Production

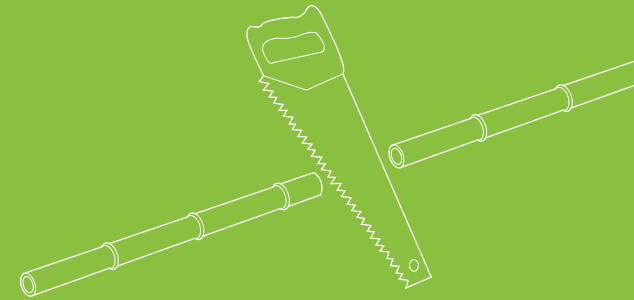
## Modifications:

Cut the bamboo to size with a saw for the structural frame per design needs, (the bamboo may be substituted with other building materials such as metal and secured with the appropriate fasteners). Cut the bottom of the bottles off with a box cutter at the point where another bottle can then be inserted inside. This point will vary based on the design of the bottle.

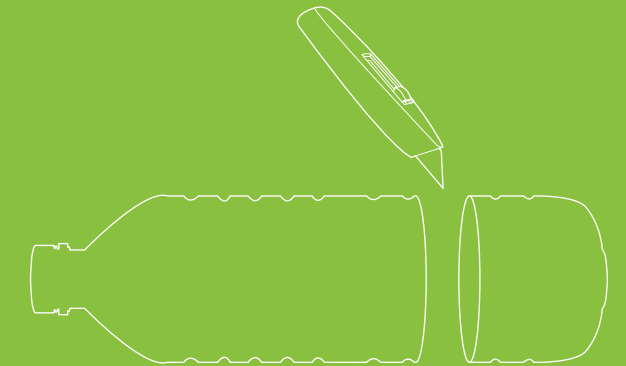
## Creations:

Due to the light weigh nature of the bamboo frame, a foundation will most likely be needed. Excavate the earth and bury a concrete footing that extends 6 inches to a foot above the ground so the frame may be secure to it. The depth of the pier should be determined by the environment that the structure is located in.

## Modifications:

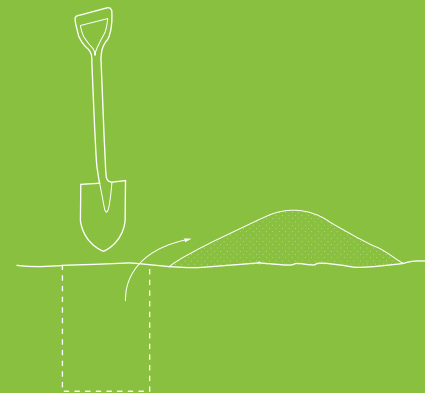


Cut bamboo to size

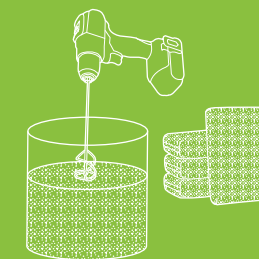


Cut the bottom of the bottles off

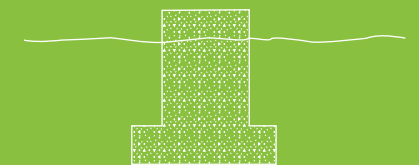
## Creations:



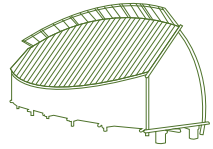
Excavate earth for the foundation



Mix the concrete for the foundation



Pour the concrete for the structural piers

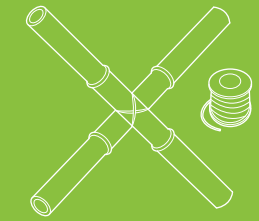
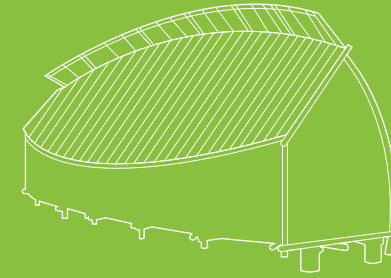


# Production

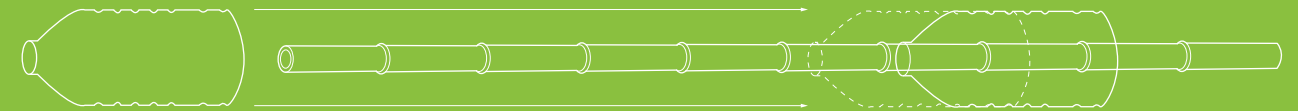
## Assembly:

Build the bamboo floor and frame securely to the foundation or other source of stability. Bind the bamboo with string at the joints. Once the structure is complete, thread the modified plastic bottles onto a bamboo rod where each bottle is inserted into the previous one. When the rod is fully linked with bottles, attach each end to the structure. The rods can run parallel or perpendicular to the ground; this is determined by the desired design. Repeat the bottle rod production and attach directly beside the previous one until the roof is complete.

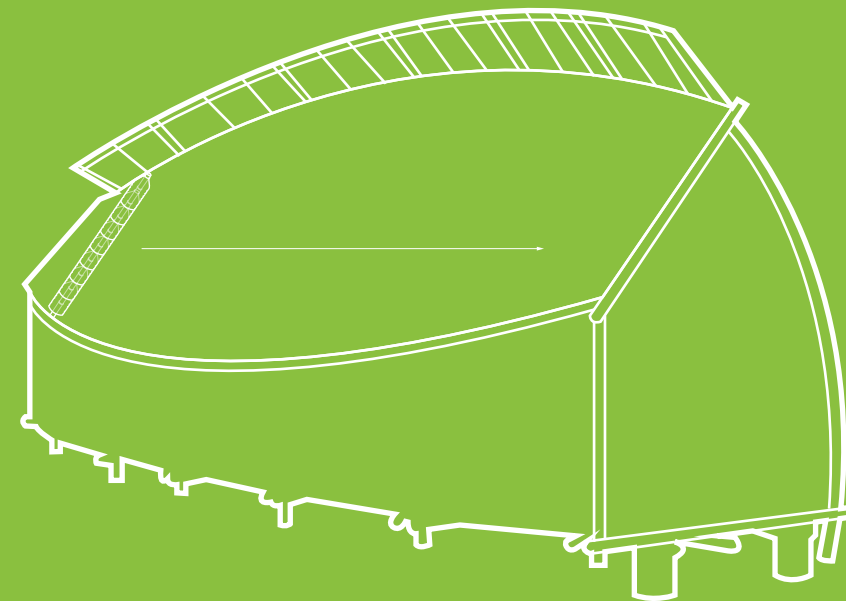
## Assembly:



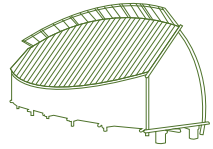
Build the bamboo structure and bind with string



Thread the modified bottles onto a bamboo pole



Attach the bottle rod to the structure parallel to each other



## Post Production

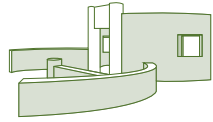
### **Waste:**

Potential waste includes the bottle caps, the bottoms of the bottles that are cut away, string and bamboo scraps.

### **Maintenance:**

The structure will be subject to the elements, so the bamboo may need to be finished with a sealant to combat weathering. Damaged string at the joints can be rebound with new string. If a bottle link needs to be replaced, the rod can be unbound from the structure, the bad bottle can be removed, and the new bottle can take its place with the other viable links.



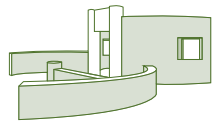


# Bottle House

This plastic bottle house was built in 2011 in Kaduna, Nigeria. The initiative was founded by a Kaduna-based NGO, Development Association for Renewable Energies (DARE), with the help of a London-based NGO, Africa Community Trust to help tackle the housing and waste crisis.<sup>21</sup> Nearly 20,000 bottles were collected from the garbage, streets, or eateries and used for the full structure. The bottles are selected by size then packed with sand, bound by string, and cemented in place with clay and mortar. They are earthquake, bullet, fire, and weather resistant while being 18 times stronger than regularly available bricks.<sup>8</sup> Due to the thermal capacity of the bottle bricks, the interior of the structure maintains a temperature of around 64 degrees Fahrenheit year-round.<sup>22</sup> After three stories the structure can no longer continue as a result of the weight of the sand-filled bottles. This building practice is about 1/3 the price of similar buildings due to the cost of materials and has a round design to emulate an African appearance.<sup>23</sup>



Photo by: Andreas Froese



# Starter Kit

## Preparation:

Collect plastic bottles of a consistent size (approximately 100 bottles per square meter of structure). Labels can remain on. Caps are needed.

## Parts:

Plastic bottle, string, sand or soil, cement, water

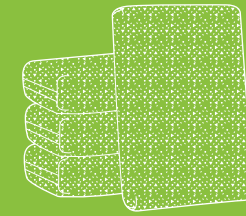
## Tools:

Dowel, sponge, level, trowel, shovel or excavator, scissors, cement mixer or drill with mixing attachment

## Parts:



Plastic Bottles



Cement



Water

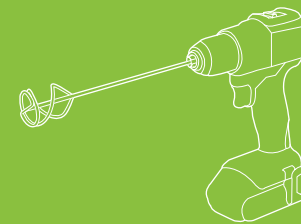


Sand / Soil



String

## Tools:



Cement Mixer



Shovel



Scissors



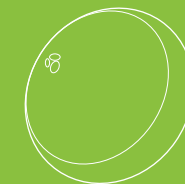
Trowel



Level

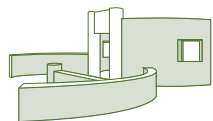


Dowels



Sponge





# Production

## Modifications:

Fill the bottles with sand or soil and compact them using a stick or dowel. Replace the cap securely.

## Creations:

Depending on the size of the structure, a concrete foundation may be required. The excavated soil can then be used to fill bottle bricks.

## Modifications:



Fill the bottles with sand

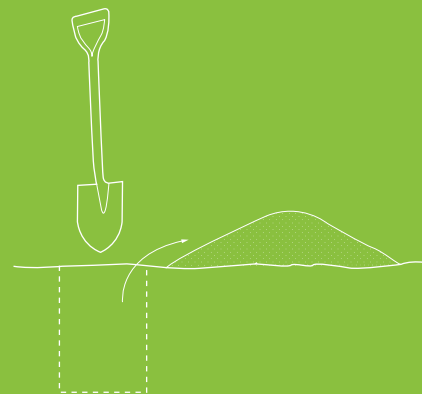


Compact the sand / soil

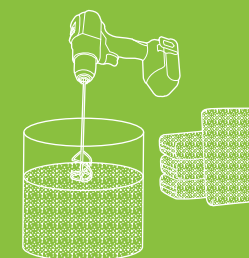


Replace the cap

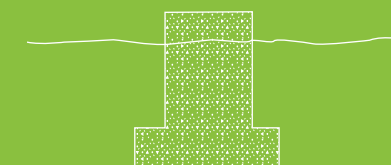
## Creations:



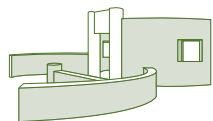
Excavate earth for the foundation



Mix the concrete for the foundation



Pour the foundation

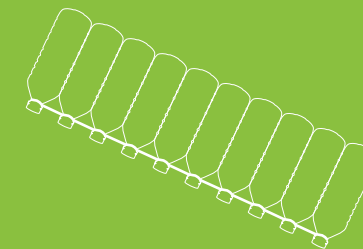


# Production

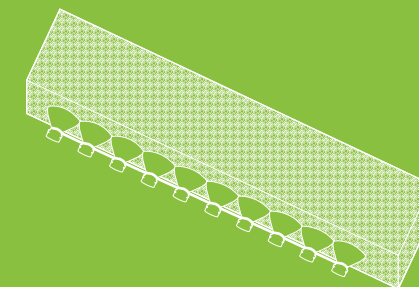
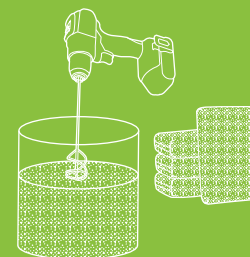
## Assembly:

Arrange the first layer of filled bottles in the desired shape. Secure the string around the neck of the bottles and fill in the gaps with cement. Stager the next layer of bottles on top of the existing layer where the bottles are resting in the gaps of those below. Secure with string around the bottle necks and cover with mud. Repeat this step until desired height is reached. Check the structure periodically with a level. Lastly, take a wet sponge and smooth the mud surface.

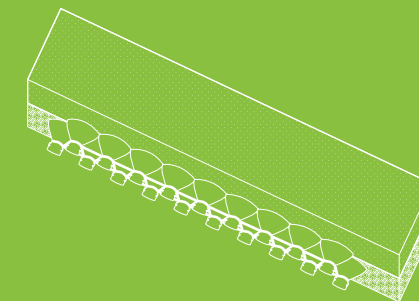
## Assembly:



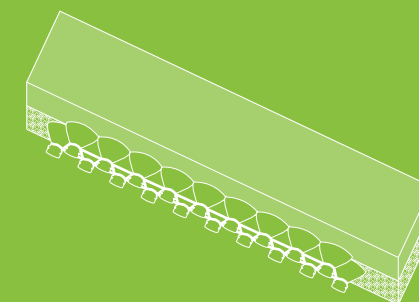
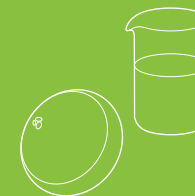
Arrange the filled bottles and bind with string around the neck



Surround the first layer in cement

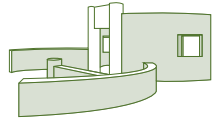


Stager the next layer of bottles on top of the existing layer, bind with string, surround in mud



Smooth the mud layers with a wet sponge





# Post Production

## **Waste:**

Potential waste includes scraps of string and dowels.

## **Maintenance:**

The bottle bricks are incredibly strong, and most likely will not need to be replaced.

The mud mortar will need to be maintained occasionally as it is subjected to wind and water. If the string that secures the bottles begins to fray, it can be reinforced or replaced by new string.





# Acknowledgments

I want to acknowledge several people who have helped me in my pursuit of design and say thank you.

Firstly, I would like to thank the **University of Arkansas**, the **Honors College**, and the **Fay Jones School of Architecture and Design** for challenging me to be the best student I could be over the last five years. Thank you for providing the environment on campus where I worked/lived as I dedicated my life to this degree in architecture.

I would also like to thank all the **Fay Jones faculty** that I have encountered in my education. Without your tireless efforts for us students, I would not be the designer I have become.

Specific faculty I would like to thank includes those who had a major hand in the production of this senior capstone. Thank you to **Brian Holland** and **Ken McCown** for the late nights of MODI that resulted in my research topic. Thank you to my Capstone Committee including **Frank Jacobus** (committee head), **Noah Billig**, and **Emily Baker** for their guidance and enthusiasm for this project. I would particularly like to thank **Emily** for the last four years of guidance in the classroom, academic counseling, and personal endeavors. She never failed to tackle any issue I threw at her head on with kindness and wisdom.

To my mother **Twila**, father **Lance**, and brother **Nicky** for being my best supporters. Thank you for your unwavering belief, pride, love, and humor for me. Because of you, I have never gone without.

For my fiancé, **George Black**, I thank you for your commitment, support, love, and care which I have especially appreciated in my last year.

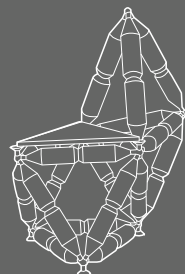
**Ada Thomas**, my best friend for 8 years now, thank you for standing by my side through the struggles and triumphs from high school through both of our graduations from the UofA. You have always been a much needed source of affection and laughs.

I want to thank **Walter Jennings** and **Lori Santa-Rita** for the best internship experience. You both provided wonderful opportunities for learning and mentorship. I am very excited to continue this relationship as I officially begin my career at **Jennings + Santa-Rita Architects, pllc**.

Lastly, I want to acknowledge my **classmates from Fay Jones**. For the last five years, I have had such a close community of peers to lean on and grow with. I never questioned that if need be, I had around 60 people I could count on. It saddens me knowing that this has come to an end, but I am excited to witness all the accomplishments we will have in the coming years. Specifically, I want to thank **Isai Castaneda**, **Kayla Ho**, **Ryan Harris**, **Taylor Conover**, **Ramsey Yarbrough**, and **Ben Ebbesmeyer** for becoming some of the best friends I have ever made.

**Thank you all.**





## TrussFab (pages 16 - 25)

2017

Robert Kovacs and team

28. (HCIHPI), "Connect PET Bottles, Make TRUSSFAB Structures."

29. Schires, "This Sketchup Plugin Designs Structures Made from Plastic Bottles and 3D-Printed Joints."

30. Kovacs, "Fabricating Sturdy Large-Scale Structures on Desktop 3D Printers."



## Head in the Clouds (pages 48 - 57)

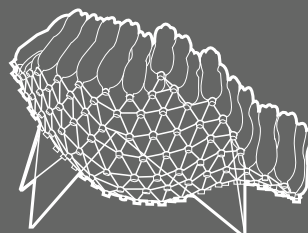
Governor's Island NYC, New York, USA – 2013

Studio Klimoski Chang Architects (STUDIOKCA)

36. Rackard, "New York Firm Designs 'Cloud' of Recycled Plastic Bottles."

37. Klayko, "Figment 2013 Brings a Cloud of 50,000 Plastic Bottles to Governors Island."

38. Griffiths, "Head in the Clouds Pavilion by Studiokca Wins AIA Small Projects Prize."



## SIE43 Chair (pages 26 - 35)

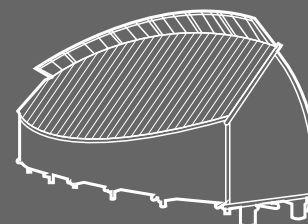
2009

Pawel Grunert

31. Yoneda, "Pawel Grunert's sie43 Chair Is Made from a Cascade of Clear Blue Plastic Bottles."

32. Tworze.com, Siedziska seats Meblarium Pawel Grunert.

33. Toby, "Pawel Grunert Still Finds Time to Design with a 'Re Purpose'."



## Bottle Sail (pages 60 - 69)

Hai Phong, Vietnam – 2014

1+1>2 International Architecture JSC collaborated & COHED

39. "Bottle Sail / 1+1>2 International Architecture JSC."



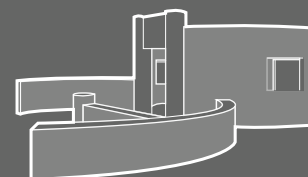
## Cola-Bow (pages 38 - 47)

Beijing, China – 2013

Penda

34. Furuto, "The Cola-Bow' Installation / Penda."

35. Lisa, "Beijing's Cola-Bow Turns 17,000 Plastic Coke Bottles into a Curvaceous Shelter."



## Bottle House (pages 70 - 79)

Kaduna, Nigeria – 2011

Development Association for Renewable Energies (DARE) & Africa Community Trust

8. Rosenfield, "This Plastic Bottle House Turns Trash into Affordable ..."

21. Opeyemi, "Here's What the United States Can Learn from Nigeria's Plastic Bottle Homes."

22. Laylin, "Africa's First Plastic Bottle House Rises in Nigeria."

23. BBC, "Plastic Bottle House in Kaduna Nigeria: Yahaya Ahmed Tok How and Why E Use Plastic Bottles Take Build."

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- The Holy Bible, New International Version, 2.
- Sexton, A Theology of Land: Terra Australis from Christian-Aboriginal Perspectives," 164.
- Golo, "Reclaiming Stewardship in Ghana: Religion and Climate Change," 283.
- Schroeder, "Place experience, gestalt, and the human-nature relationship," 295.
- Donnelley, "Frog Pond Philosophy," 33-35
- IISD, "Sustainable Development."
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