Moocow Unicycles – Bambooni

Manufacturability and Assembly Statement

1 Introduction

The intention of the Moocow Unicycles design was to create a bamboo frame capable of urban styles of riding. It was designed for performance, with manufacturability in mind. After significant testing the frame has proven itself to be just as capable for flatland, street and trials as more conventional aluminum and steel frames.

2 Manufacturability

The Moocow Unicycles bamboo frame was designed with performance and manufacturability in mind. The optimized design (discussed below in section 4) requires only 4 custom bamboo pieces to be cut, with simple operations required to create the necessary part geometry. The only other piece required are the bearing holders.

Total materials cost of this project: $41

Estimated cost on a production scale: $12.50

For this project, a quantity of one set of bearing holders was required. This meant the purchasing cost was $22 Canadian, whereas an order directly from a manufacturer would easily drop the cost below $5 Canadian if the volume is high enough. The bamboo cost was only $3 for the entirety of the frame, when adjusting for material used. On a larger volume production run, the price could be driven down even further by purchasing in bulk. The cost of epoxy and composites further raises the cost of the frame. Roughly 175 grams of epoxy were used in the development of the frame, which costs about $10.00 when purchasing t quart of epoxy and 0.44 quarts of hardener (the smallest quantities available). Again, this cost can go down significantly when purchasing in volume. Lastly, the composites used to join the bamboo. Carbon fiber string (known as tow) was sourced for $15 for 50 yards. 20 yards of tow were used, bringing the cost of composites to $6. Again, the cost could be driven down by purchasing in volume, however the composites cost can be driven down further by using fiberglass tow in place of carbon fiber, or more common for bamboo, hemp string.

The total unit cost for this project comes to $41. However, when adjusting for purchasing in bulk, for an optimized frame the materials cost comes to an estimated $12.50 (estimates based on a production run of 250 units).

3 Design Considerations & Constraints

The Moocow Unicycles bamboo frame uses the same standard dimensions as other unicycle frame designs. The frame could be swapped out with a frame on any 19” unicycle with a 27.2mm seatpost and still work with the same parts. The frame accepts a standard 31.8mm seatpost clamp with a 27.2mm post.

For a neck design to be able to resist the compressive forces of the seat post clamp, the bamboo was impregnated with epoxy for reinforcement. Low viscosity epoxy ensured sufficient impregnation. However, regular epoxy should achieve acceptable results.

The strength of the frame was a tremendous concern from the very beginning of design. With this in mind, the composite used to bond the joints was carbon fiber, as it is both extremely strong and light. It is common to see bamboo frames for bicycling with joints bonded with shredded composites. While this does decrease manufacturing costs and increase assembly time, it does not provide the strength of a joint wrapped in composite string. Wrapping with string better maintains the directional strength of the composite materials, and wrapping in the direction that is subject to the greatest forces creates an extremely strong design.

The Moocow Unicycles bamboo frame was designed and constructed with the supplies and materials available to Moocow Unicycles. Certain construction techniques outlined in the assembly procedure are examples of this; the crossbar could be manufactured rapidly with a milling machine fitted with a 1” endmill, but this wasn’t available during construction. The lean and accelerated design schedule unfortunately meant that a slightly suboptimal design was fabricated. Examples are shown below.

A. Two piece neck
    I. The material sourced for this project was simply not straight enough to fabricate the neck as one piece. To accommodate this, a 75mm piece was fabricated separately, as it was sufficiently concentric to turn the 31.8mm Outside Diameter for the seat post clamp.

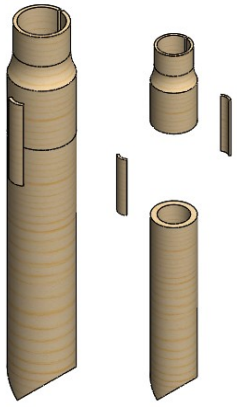

Figure 1: Neck Components

B. Exposed bearing housings
    I. The design used bearing housings from a 2007 Sun Unicycle. The tubing the housings were welded too had an oval profile. Carving out an oval centered on a round tube proved too difficult to manufacture. Cutting a relief on the sides allowed the bearing housings to be composite wrapped in place securely.

Figure 2: Leg-Bearing Housing Interface

C. Bearing housing material
    I. Steel bearing housings were used as they were readily available, but aluminum would be preferable as it is significantly lighter.

4 Design Optimization

With the design constraints in mind, an optimized design has been included in the Bambooni submission package. This design has a one piece neck, which could be manufactured with straighter bamboo. Straight bamboo could be sourced cheaply with the volume manufacturing would demand. The bearing housings in the optimized design could be aluminum, which would further cut down on the weight of the currently 710 gram frame. Additionally, with circular tubing welded onto the bearing cap, a simple centered hole could be drilled in the end of the bamboo leg, allowing a much simpler assembly procedure, requiring only adhesive to attach the bearing housings, as opposed to the current design which requires composite wrap for the bearing housing.

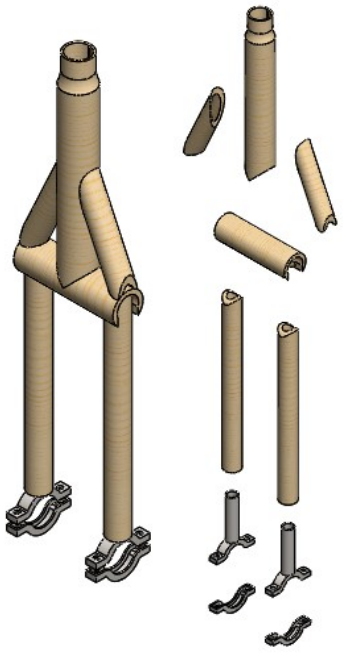

Figure 3: Optimized Design

5 ASSEMBLY PROCEDURE

Assembly is fairly straightforward for the frame design. Once the individual pieces are all cut to size, it is simply a matter of composites wrapping the parts and heat treating to prevent warpage.

To keep the components properly oriented during composites wrapping, an assembly jig was designed, and is included in the submission as a STEP file.

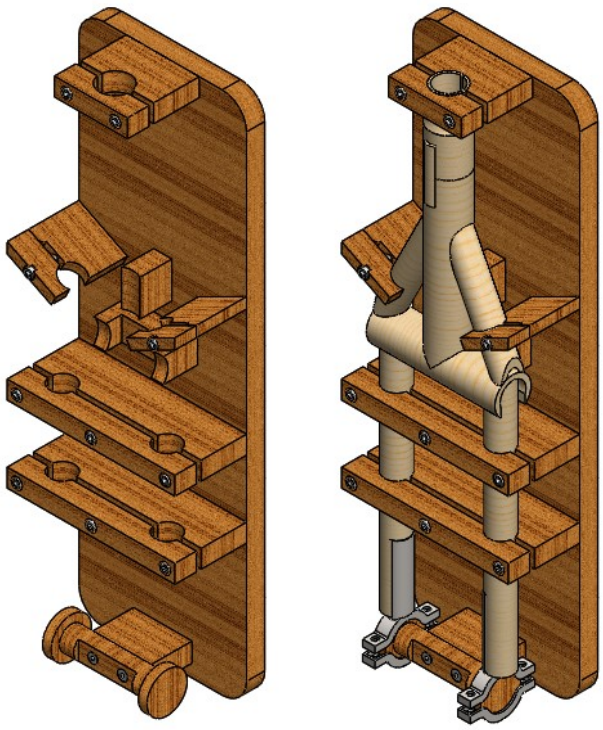

Figure 4: Assembly Jig