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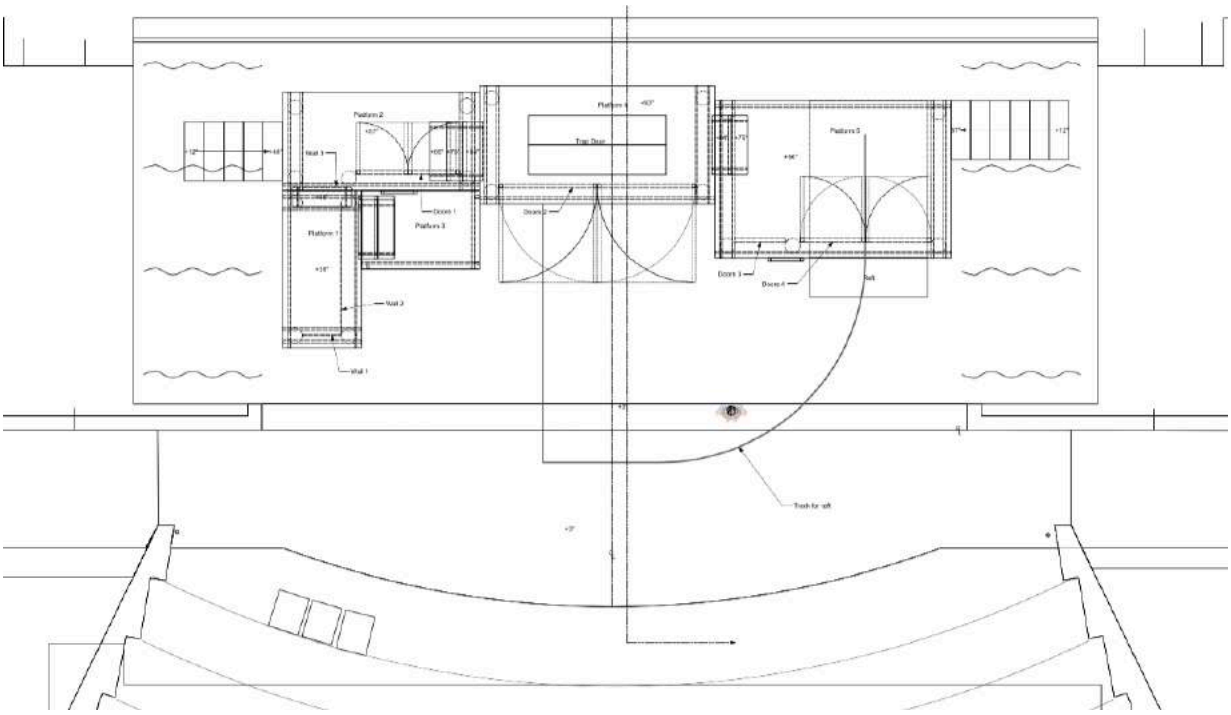
Curved-Track Automation and the Ten Thousand Dollar Budget

Design drawings for *Big River* landed on my desk in late winter of 2016. The first thing I noticed was the track, and it's apparent curve.



Our scenic budget for *Big River* was $10,250.00, and before looking at any drawings I knew this meant a few things: It is *Big River*- there will need to be a show deck, I will need to reallocate 30% of this budget for possible over-hire labor as I have no regular

staff, and whatever the aesthetic I will more than likely have to use Luan or milli-ply to mask the quality of the cheap materials I would be able to afford-

I knew my first step would be to get a quote from Creative Conners to check the cost of the winch and knife setup, the raft in *Big River* is essential.

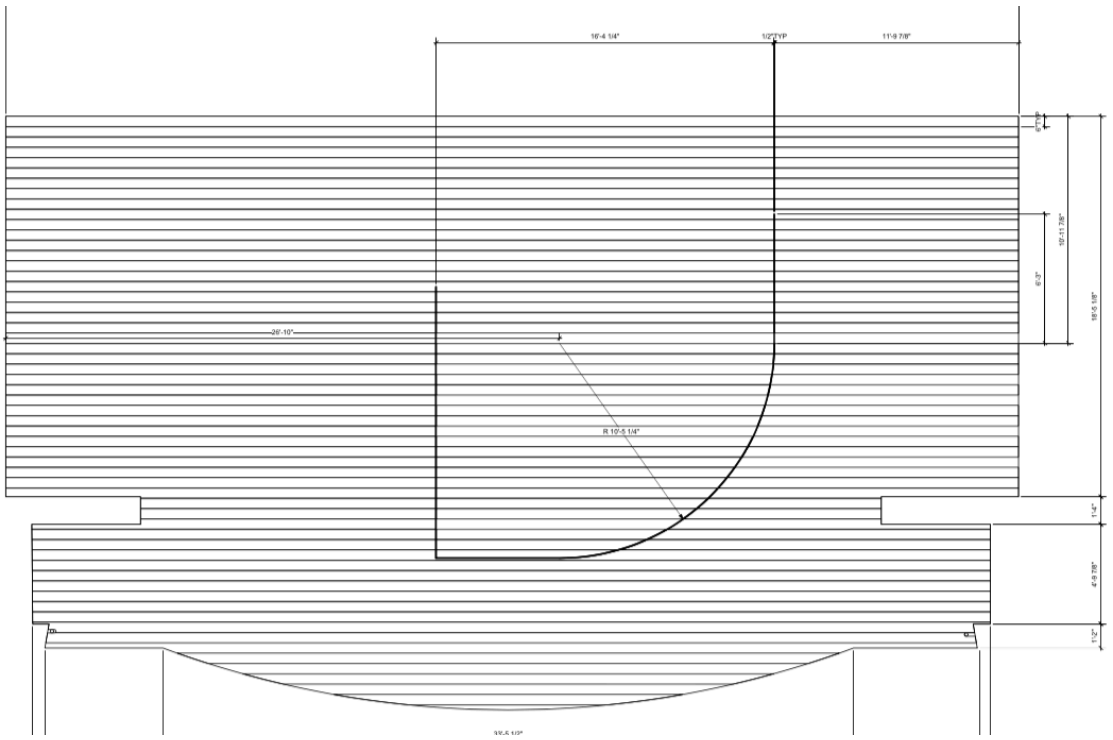
Rental charges	$3,685.00	Charge total	$4,750.00
Sale charges	$0.00	Tax total	$0.00
Service charges	$1,065.00	Charge and tax total	$4,750.00

Fifty percent of my budget going to an automation setup was clearly not an ideal approach.

I began to research rope driven wagon automation dating back to the 1880s and moving forward. There is a ton of information on rope driven wagons out there! My problem was this curve. The rope driven curve, I felt certain it had been done before, but the more I google'd the subject the more the internet gods would seem to laugh at me. I had more problems than the curve itself. The wagon needed to be able to pivot.

The University of Houston lent me nineteen 4'x8' platforms framed out of 2"x4" stick. After seeing the drawing of the show deck, we would indeed be planking over these with luan ripped to 5 1/2", setting the height of the show deck at roughly 4 1/2". This is the first parameter for how I created the knife.

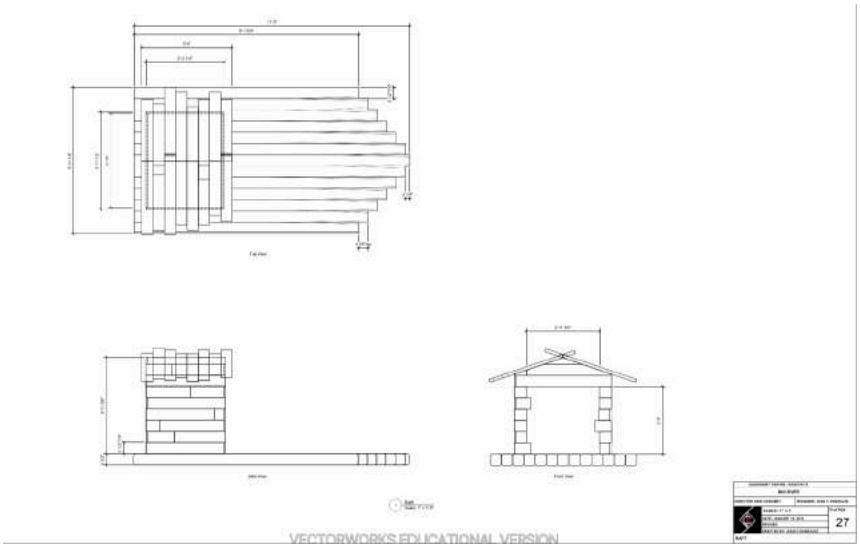
Had I had a couple of weeks time for research, I probably could have found alternative solutions, but creating something seemed like a more appropriate use of my time. Between rental shows, Comedy Sportz, and the education department; time at the Queensbury Theatre is a luxury I just don't have.



I stared at this drawing for hours. "Look at that lovely 90 degree cut in the curved track," I thought. I eventually made changes to the track design, but the challenge inherent in its original drafting is a huge source of inspiration to my ultimate solution for what seemed like a very expensive problem.

I started from scratch. Every piece of the unit was purchased from McMaster-Carr online. Fundamentally I knew what needed to happen. I needed something to use the

curved track as a guide for movement, so I needed something round, long enough to span the top of the raft platform and sit comfortably in the track, and something strong enough withstand being pulled after adding the weight of four people and sustain a 6 week period of use. I went directly to the hardened shafts with threaded ends. I saw many options of thread size and count, and knowing I needed an eye-nut at the end for a rope connection I based my ultimate decision on what was available to complete the necessary assembly.

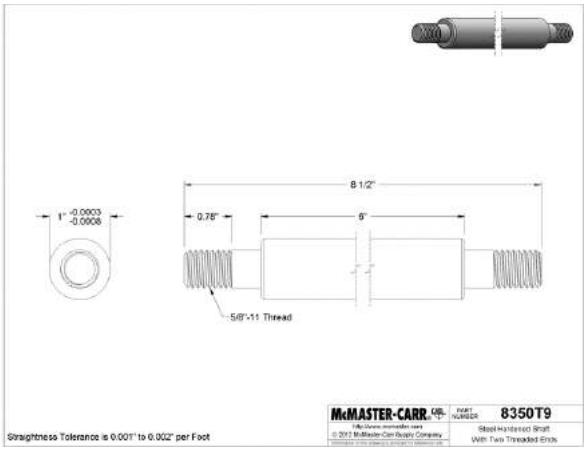


The original drawing had the raft sitting at 5 1/2” tall, and I plan for an added half inch lift to rolling platforms accounting for caster trim. The raft shelter was cut because of sight lines.

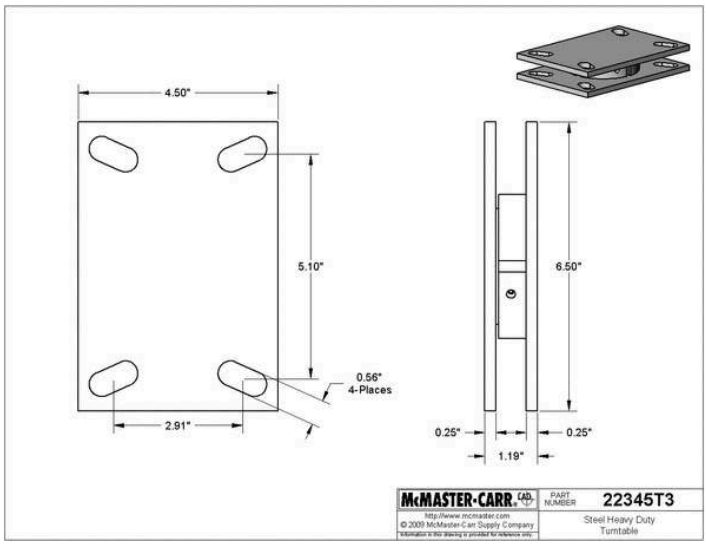
After spending several days looking at the combinations of materials on McMaster-Carr, I came up with the assembly pictured below.

Overall height: 11 1/8”

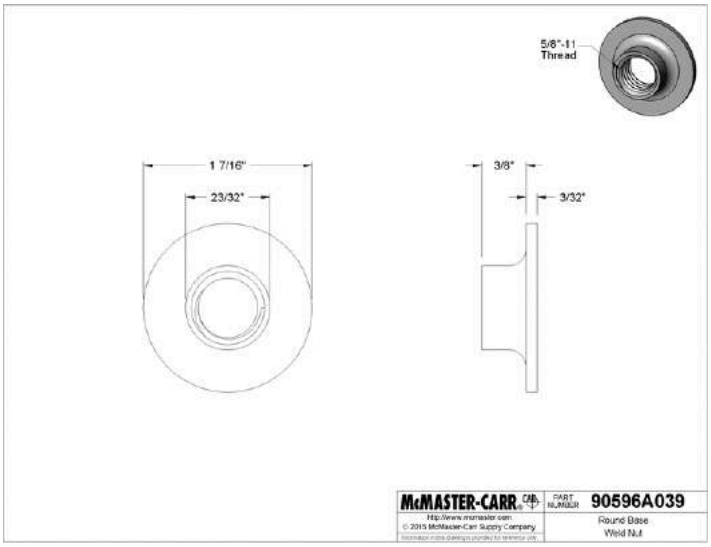
Before installation the shaft was braced with 2 2”x6” blocks screwed and glued together, with a 1” hole down the center for the shaft to slide through. Those blocks were then fastened to the to the bottom plate of the turntable with lag screws and washers.



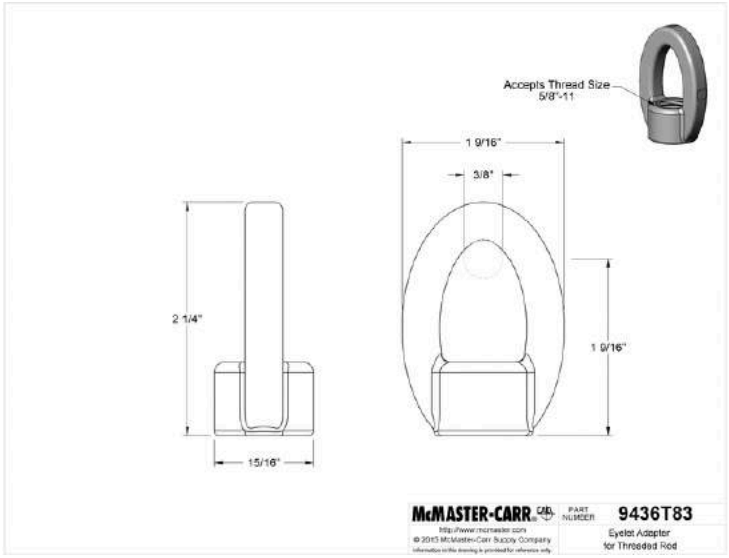
Hardened steel shaft; threading on both ends.



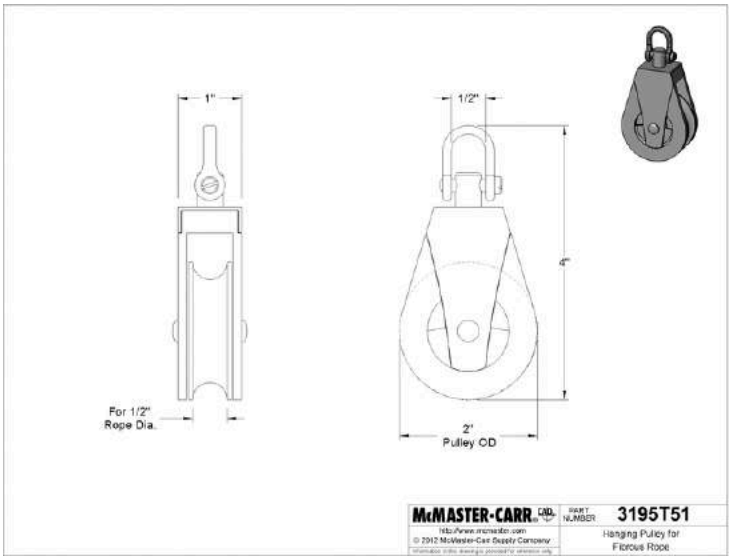
Non-locking turntable with bolt holes on top and bottom plates.



Weld nut, welded to center of non-locking turntable.



Eye-nut.

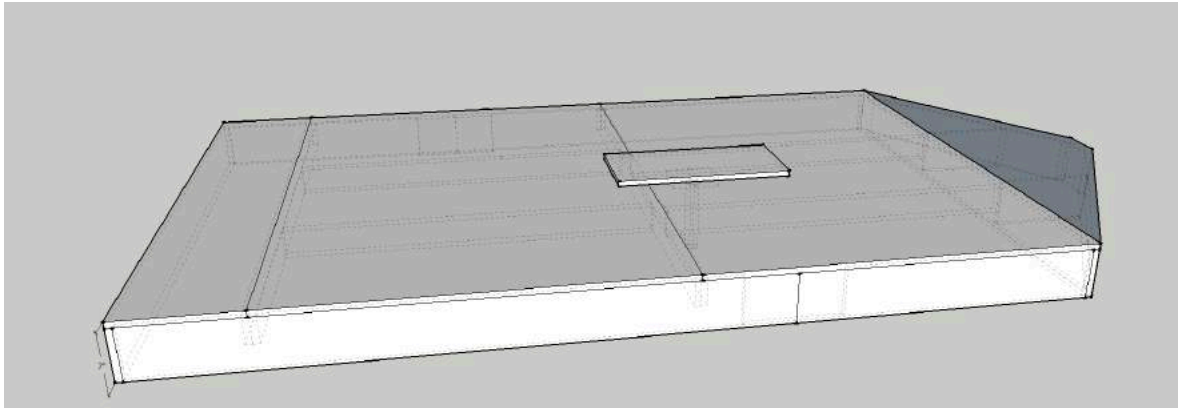


Purchased 2:

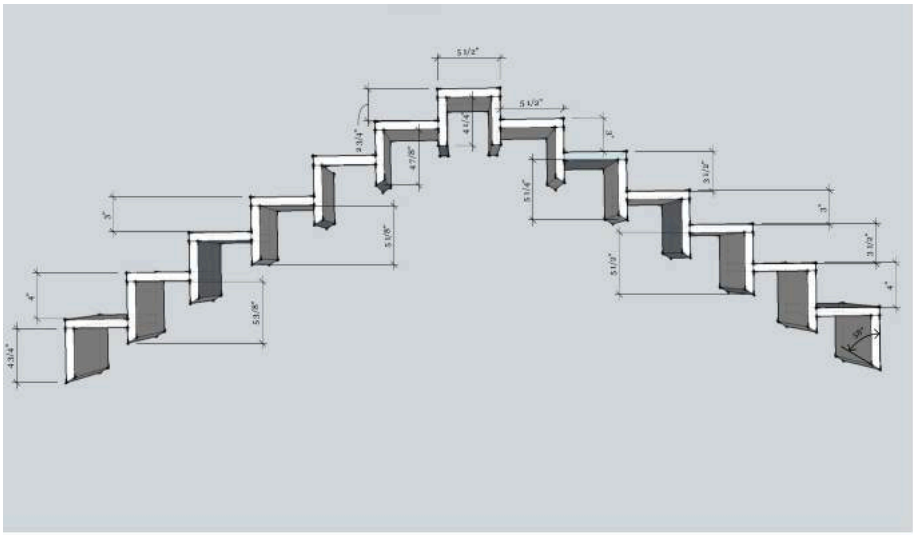
Workload limit 1,650 lbs. Shackled to eye nut with 1/4” shackles.

The raft would now have to be nearly two inches taller than its original design, because this assembly was the perfect combination of compact size, versatility, and strength. The track got wider as well. The track went from 1/2” wide to 1 1/4”, which is not ideal in the grand scheme of aesthetics, but it was a decision made with confidence along with the support and approval of the designer.

I began drafting the raft around this new parameter. If the depth of my track was limited to 4 1/2” and my knife is 11 1/8” tall, I could successfully give 7/8” headroom between the bottom of the knife and the stage floor under the show deck if I built the carriage platform to 7” tall and added a 1/2” lift for casters.

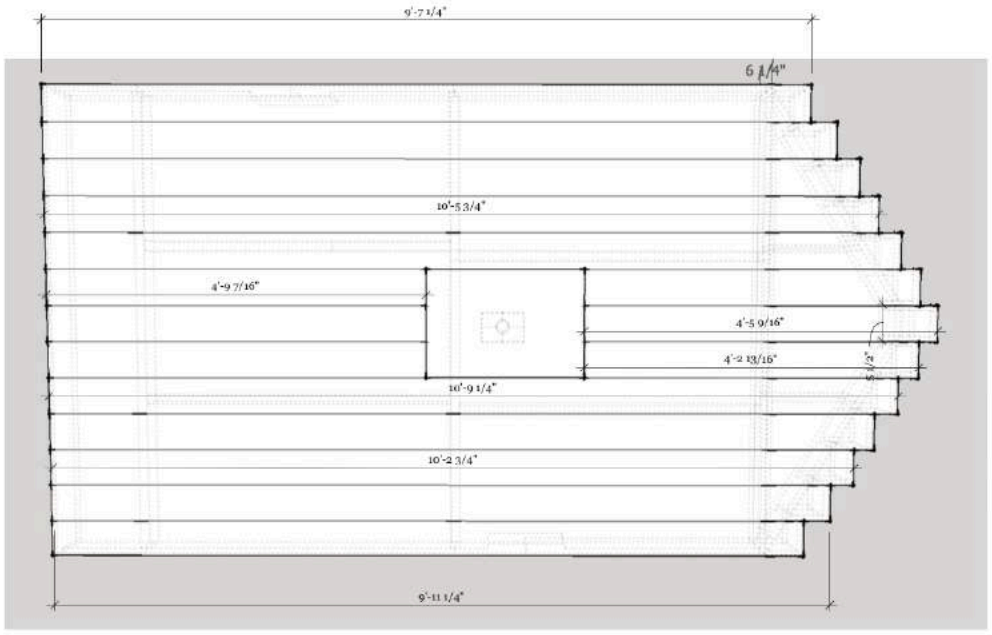


Knowing I would need to build up around the carriage frame, I decided to place a piece of 3/4” ply in the center of the unit that the 1”x6” log planking could go around and look relatively seamless once the final aesthetic touches were made, this idea also prevented me having to build the raft even taller. This plywood acts as the plate which the turntable is secured to for extra strength.

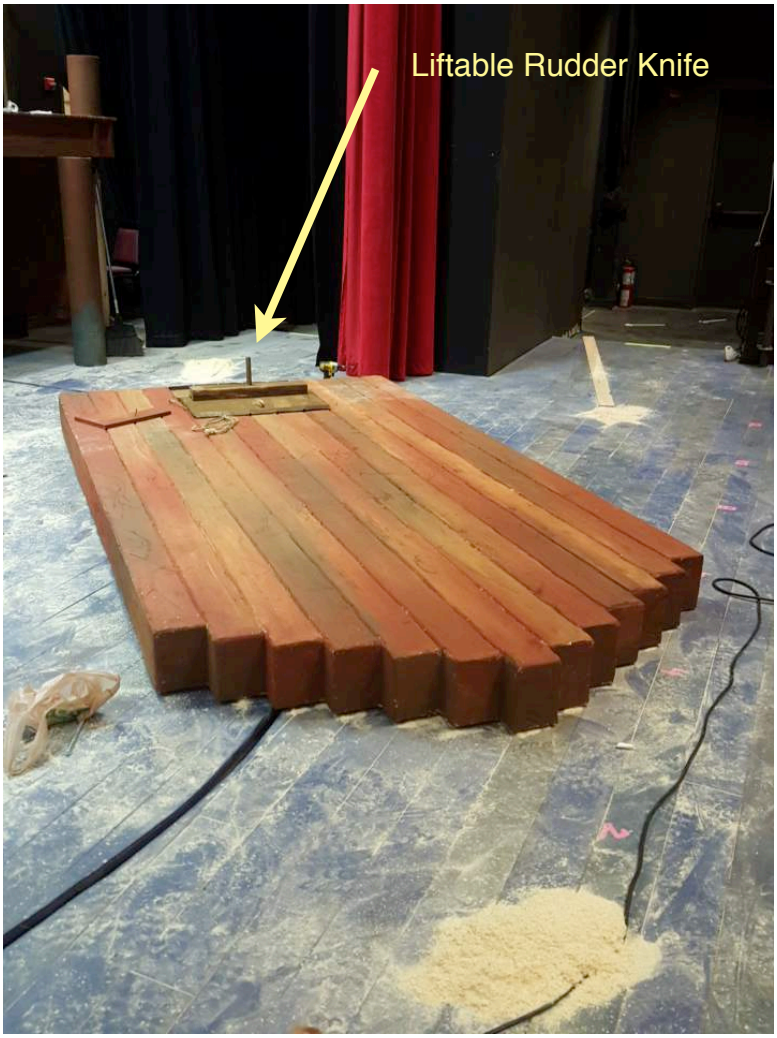


Raft log face framing.

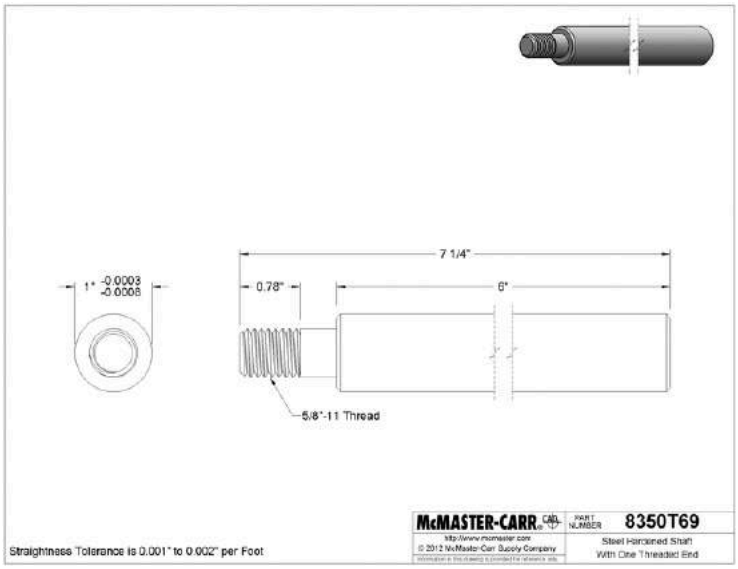
The track design and raft’s ability to pivot were problems being solved simultaneously along with the function and application of the swivel knife. I grew up around catamaran sailboats, and I would argue I use parts of my sailing knowledge daily in the theatre. While the wind is obviously the source of power in the drive of a sailing vessel, the ancient sailing device known as the rudder has been a fundamental aquatic tool for multiple centuries. I needed something able to be lifted from the track so the raft could rotate upstage one degrees, something to help change course. During “Muddy Water” the raft needed to face downstage.



Top Planks are cross cut from 1x6x12', bevel top corners with router and belt sander before installation.



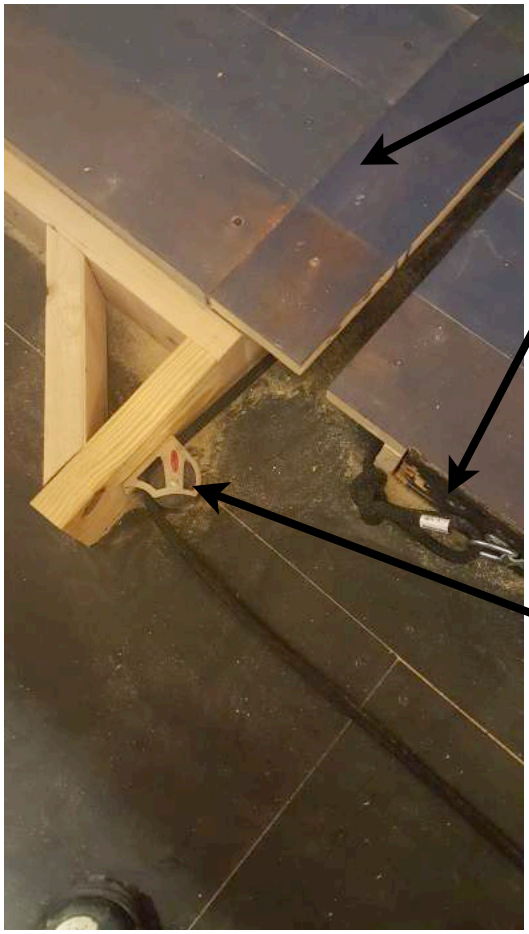
The rudder knife was made out of a similar hardened shaft from McMaster-Carr, only it was threaded on one end. I used a drill press to have a through-hole through a 2”x4” for the shaft, and then secured it to a weld nut with locktite adhesive and then sandwiched that connection by securing a strip of 3/4” ply over the 2”x4” and hinged that to the raft after the final log planking was laid over the wagon’s body.



Hardened Steel Shaft with threading on one end, to make rudder knife. I used locktite to secure this to a weld nut which was sandwiched between to piece of lumber.

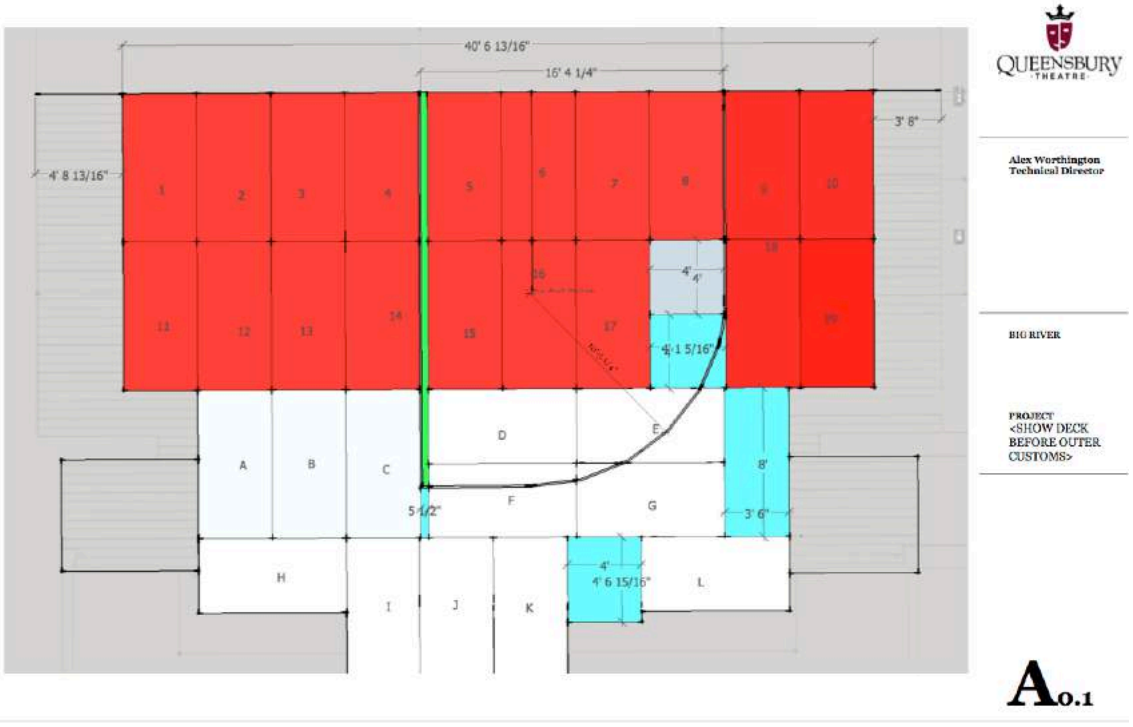
All pivoting was performed by actors and their gondola sticks. There was not any powered mechanical automation advancing the pivot motion.

The turntable was rated for 900 lbs of load. I was not worried about the direct load, because the structure of the raft would take on all of the mass on top. The primary concern was the impact of tangential force created by the combination of forward momentum and the directional change mandated by the curve in the track, which is why I ultimately braced the knife with two pieces of 2”x6” sleeved down the knife. Another choice made to alleviate the strain of four actors being pulled by rope was the decision to make the rope-track pulley system a 2:1 pulley system. This way the the technicians backstage only have to worry about approximately 400 lbs above raft-weight instead of 800 lbs. Pulley blocks are pictured below.

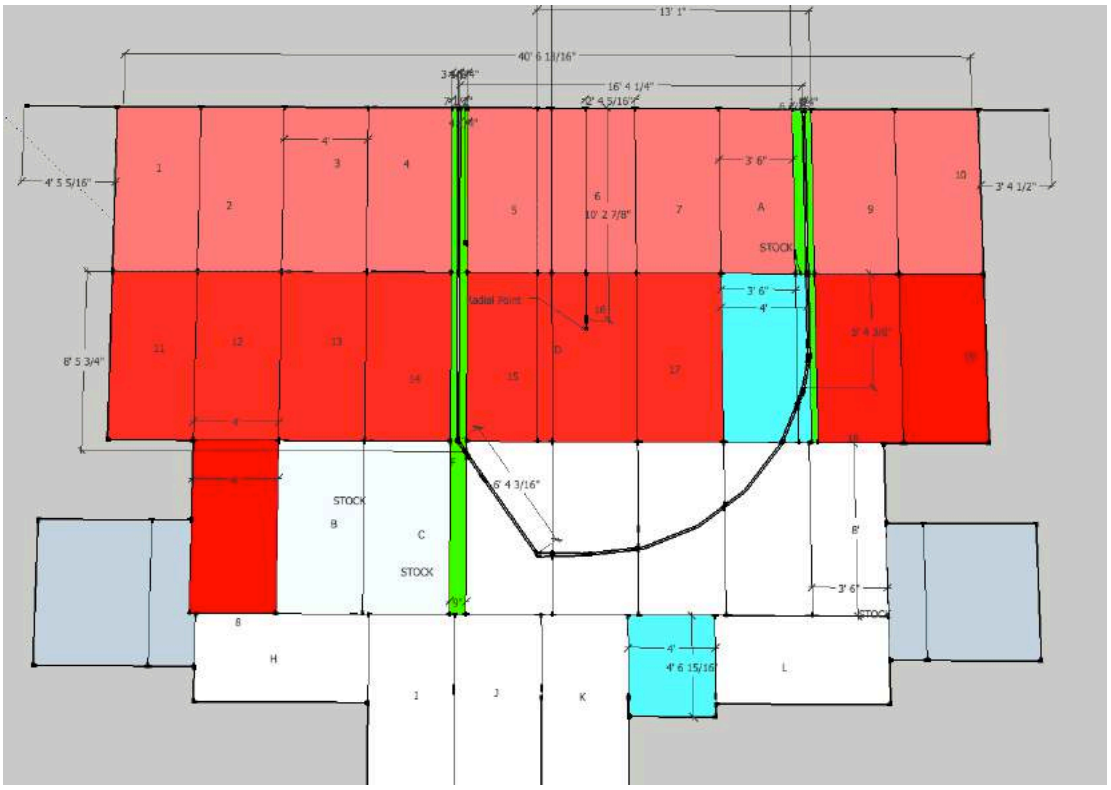


The photo above is the stage-right rope pull area. The rope must be kept close to the height of the pulley to remain effective. The two ropes used are 96kN black static assault lines. There is one rope for stage-left and one stage-right, both setups mirror each other. Both pull areas have footing blocks on the ground so the lead rope techs on either side can have a good source of resistance. The rope is knotted off at the D-ring plate, runs through the track, goes through the knife pulley, runs back through the track the way it came, and finally through the static pulley block before reaching the hands of the technician.

Not one aspect of this project would have been successful without an alteration of the track's design.



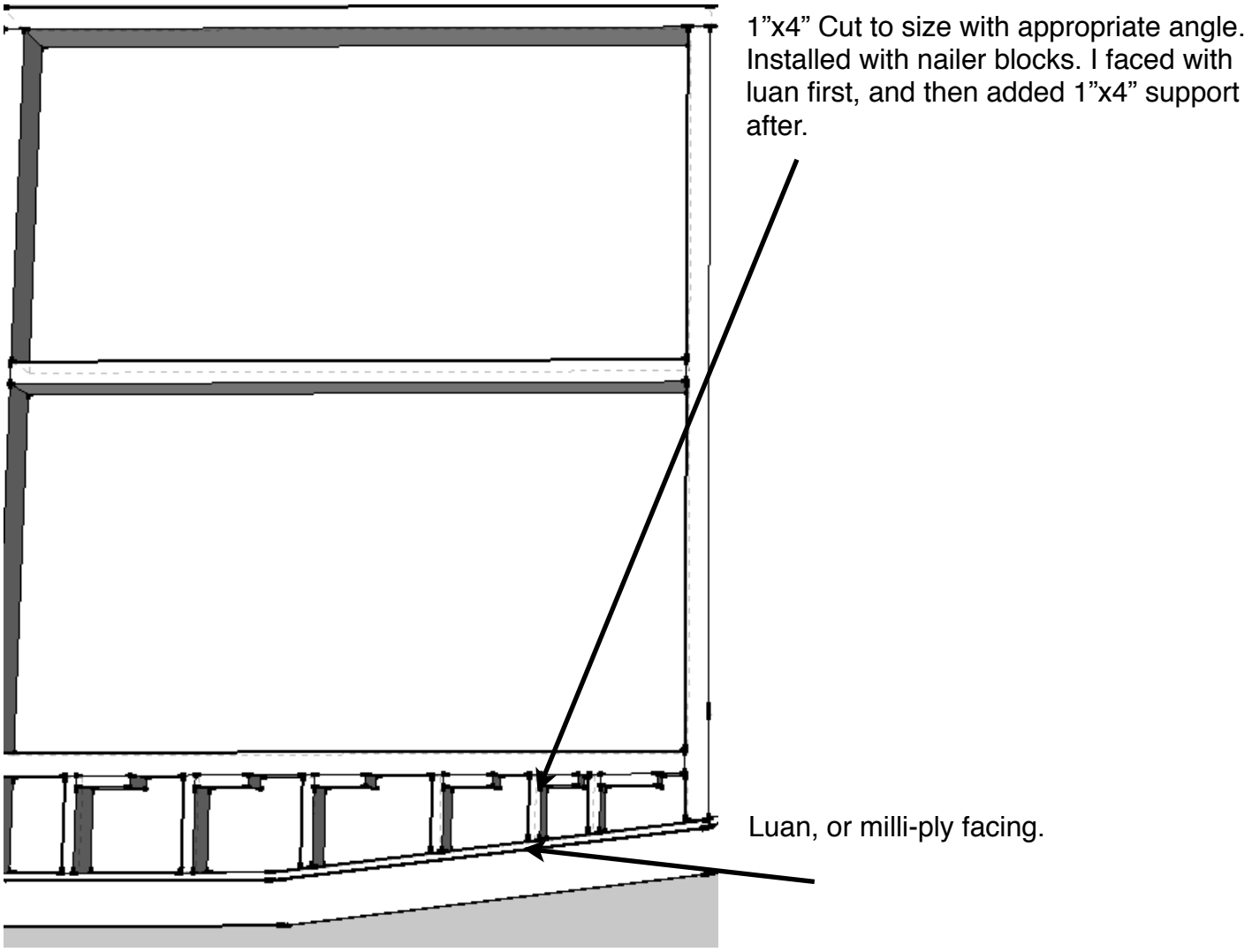
First Draft: I wanted access hatches on both stage-left and stage-right, and I was still not confident with the 90 degree angle. If this swivel and rudder concept was going to work, the swivel needed to be installed on the raft to where the raft could still be profile and be centered at center-stage, and I would need a diagonal cut in the track from center-stage to the stage-right up and down track longer than the distance between each knife, this way the turn could be made without extreme effort by multiple deck-hands. If the rope drive was going to be successful everything about this assembly needed to be as efficient as possible. Pictured below was my solution.



Once I had the track drawn out, I needed to make sure I allowed enough space underneath for the knife and two pulleys' clearance while balancing the minimum amount of platform cantilever for floor support yet keeping actor safety a priority. Near the access hatches, I allowed for six inches of space on the hatch side and three inches on

the opposite side. The rest of the track was designed with three and a half inches of hollow area on either side of the track.

The most fundamental piece of the rope-drive puzzle was recognizing the absolute necessity of ensuring the the framing of the inside and upstage part of the track was also curved. This project does not work without a curved faced framing. Example pictured below.



I believe this was the most crucial step. This curved facing not only increases the rope's advantage navigating the curve, but cuts down on the friction that would have existed had the framing underneath had been of a harsher geometry. Removing a great amount of rope-on-wood friction naturally increases the longevity of the assault lines, which are extremely valuable and integral to the functionality of this assembly.

The problems associated with this approach were few. We made it part of our pre-show process to check the ropes for twisting and frays, and have raft work in our fight-call to limit the possibility of actor operating error. An important note pertaining to the rudder knife; be sure whatever your wagon is for whichever production you use this method, have a latching mechanism for the rudder. If the rudder is not latched down, you will see many issues come along with this mistake: compromising the hardware that makes the rudder liftable, compromising actor safety, and more than likely damaging your track and show deck. There was a bit of noticeable wear to the masonite stage floor below after we struck the show deck. This was easily repaired, and considering the cost to fill some divots in an already easily replaceable masonite was less than twenty dollars, it was not an issue that leads me to shy away from this approach again in the future.

The overall cost of this assembly was $659.97, which includes the cost of the two ropes. Out of a scenic budget of $10,250.00, this cost is only 6.44%, and it is for the most iconic scenic element of the musical. This gave me the other 14/15th's of the budget to fulfill the remainder of the design. In conclusion, this technical design was a risk, but a well calculated one, and an ultimately cost-effective and successful approach

to curved track automation on a tight budget with consideration of today's theatre standards of quality and the modern day musical.