



Blade Runner Construction Suggestions

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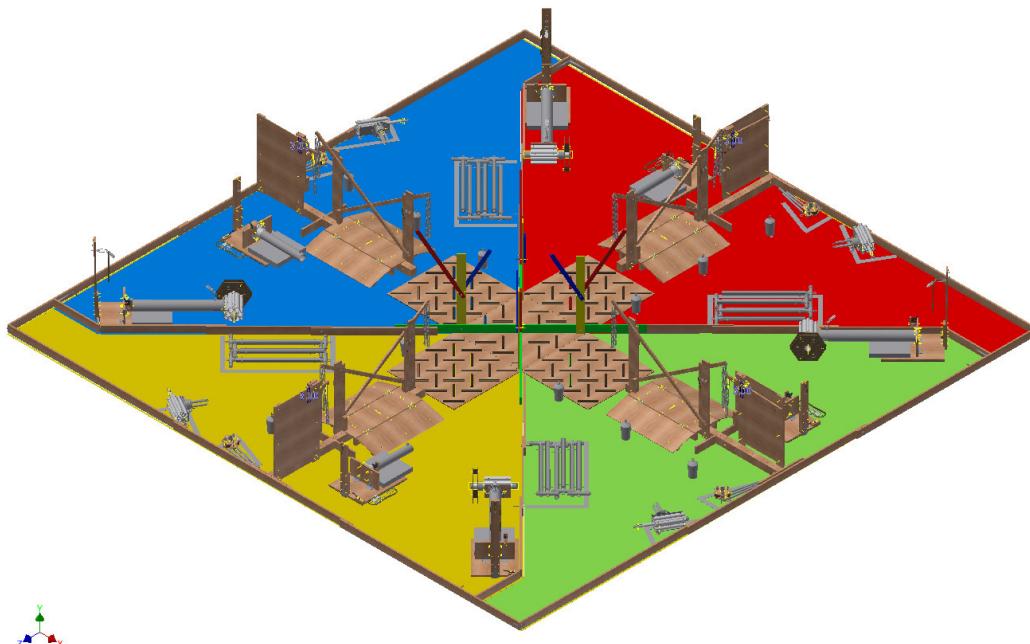
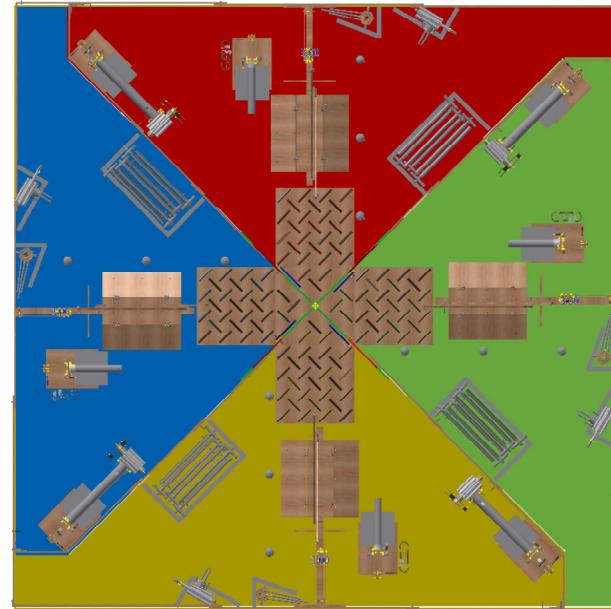


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FLOOR PLAN FOR BLADE RUNNER

Field Assembly

1. Lay down rug
2. Lay out the perimeter 1x4's
3. Place bad road in the center of the playing field.
4. Place the center barrier with cactus.
5. Put the cooperative play barriers in place and connect to the perimeter boards.
6. Place the bridges on the field.
7. Place the Over Weigh/Over Length-Tie breaker, on the field.
8. Place the small tower on the field
9. Place the large tower on the field
10. Place the large turbine blades on the field
11. Place the small nacelle on the field
12. Place the small hub on the field
13. Place the Prairie Chickens on the field





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FASTENING HARDWARE

All the large screws used for wood and PVC are shown below.

For construction, several sizes of attachment screws were used. Shown above are $\frac{3}{4}$ " wood screws, 1 $\frac{1}{4}$ ", 1 $\frac{5}{8}$ ", 2" and 2 $\frac{1}{2}$ " coarse thread drywall screws. If the need for a flat washer and a drywall screw came up, a #12 flat washer worked nicely.



Hinges and other ware usually come with their attachment screws.

Silicon Rubber is needed for covering the screw tips, for safety and protection, when they protrude through wood.



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All threaded bolts and nuts are 5/16" x 4" carriage bolts or 5/16" x 3 1/4" eye bolts or 5/16" all thread (cut to fit) with 5/16" nuts, and flat washers. Flat washers are 1/4" or 5/16" depending on location. All thru holes drilled for the 5/16" bolts are 3/8" holes. The 1/4" flat washers are used, in special cases, where the diameter of the 5/16" flat washers was excessive. The length of eye bolts used was measured from the end of the bolt to the top of the eye, not the length of the thread. Diameter of the eye is about 1"



For counter weights, a piece of 3/8" steel log chain was used.



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MODIFY THE HOLE SAWS SLIGHTLY

The inexpensive hole saws cut a small kerf making the biscuits in the hole saw difficult to remove. A simple fix. With a pair of vice grips pinch the hole saw at the teeth in two places 180° apart. This will displace and flatten the hole saw slightly making the kerf slightly wider and the biscuit easier to remove. Save the 2" Biscuits for $\frac{1}{4}$ " spacers.

PVC fittings are compression fit and held in place with drywall screws, where screws are indicated on drawings.

A third hand. Vice and Vice grips.



The vice grips are shown holding a turbine blade of a small hub in place during assembly using drywall screws. The blades hold the hub pieces in alignment while the screws are installed.

The vice grips on the right are shown holding a hole saw. To change the set of the teeth on the hole saw the vice grips are placed directly on the teeth of the hole saw and compressed as much as possible by hand. This procedure resets the teeth under the vice grips and slightly deforms the hole saw making a wider kerf.

Nonslip material

Nonslip material for the tower bases.

The tower bases are the same dimensions.



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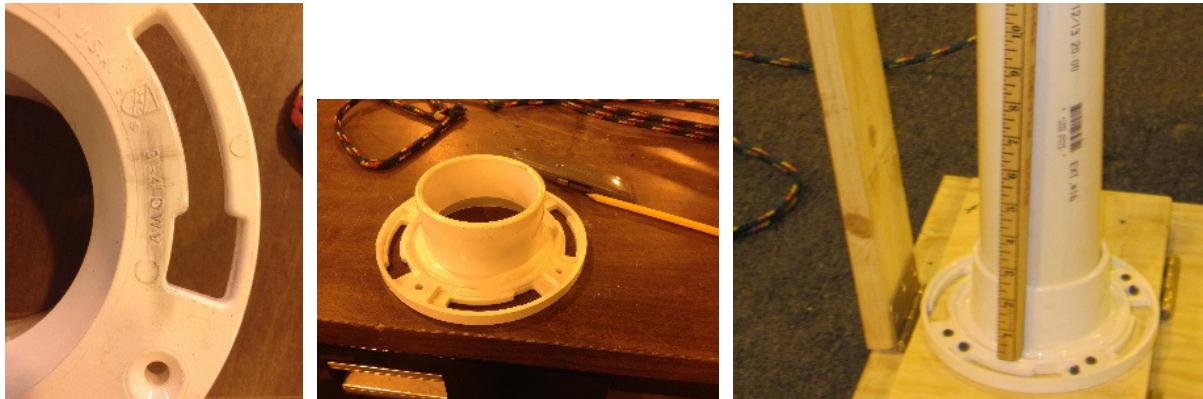
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Attach the material with 9-ea. ¾" wood screws

Tower Flanges

The tower flanges are the same size for both 3" and 4" PVC.



The towers flanges fit both 3" and 4" PVC pipe. The pipe connection is approximately 2 ½" long.

CENTER FIELD CACTUS AND FIELD CROSS QUADRANT BARRIER



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The center field cross is made of two 1x4 by 8' pieces notched in the center to mesh.
The cactus are two 1x2's and a 1x4 in each quadrant

Cross quadrant barrier

The 90° angle bracket is screwed to the 2', 1x4 using 1 ¼" drywall screws and bolted to the field perimeter with 5/16" carriage bolts. The carriage bolt length on the first 4' section from the perimeter barrier is cut to fit. The carriage bolt in the middle section is left 4' long as a handle for folding the barrier

Silicone rubber handling protection is added to the penetrating ends of the 1 ¼" drywall screws.

BAD ROAD



The bad road is made of four pieces of 3'x3' sheet of 1/4" plywood, each with 50 pieces of 1/2 " quarter round, cut in 8" lengths and glued to the plywood in the "Leon Shturman" array. A fifth piece of 3"x3" plywood makes the center piece of the field. It is same as the first four floor pieces, except the diagonal half round pieces are left off so that the center "cross piece with cactus" feature will sit on the plywood rather than on the quarter round.

Cut five, 3' x 3' pieces of 1/4" plywood. Cut the 1/2" x 1/2" quarter round piece, 50 pieces for outer bad roads and 26 pieces for the center bad road. Mark the positions for the quarter round piece on the 3' x 3'



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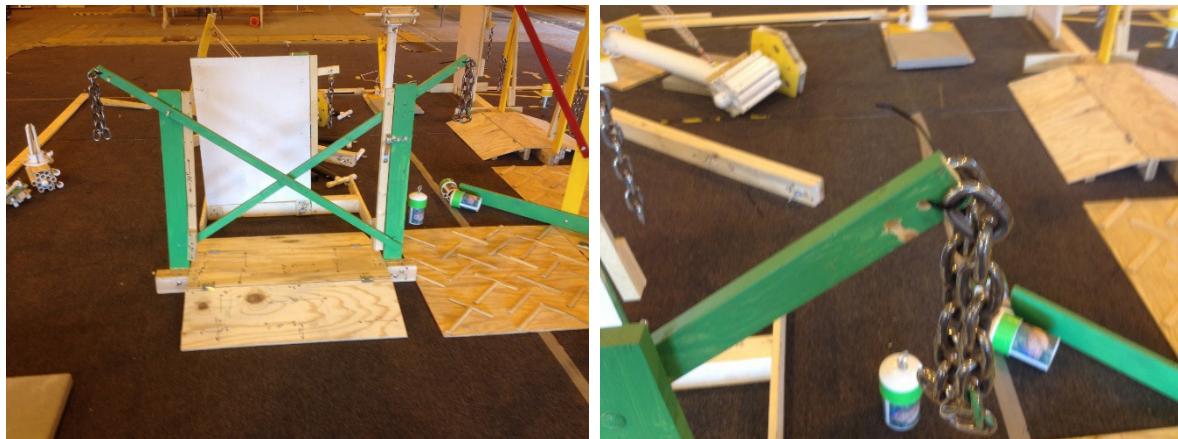
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piece of $\frac{1}{4}$ " plywood. Set the quarter round in place using **LIBERAL** amounts of wood glue. Stack the plywood in a flat place with some weight on top to compress the pieces of plywood, glue, and quarter round together.

Some 15" x 15" x 2" paving blocks make good compression weights for glue curing cycle.

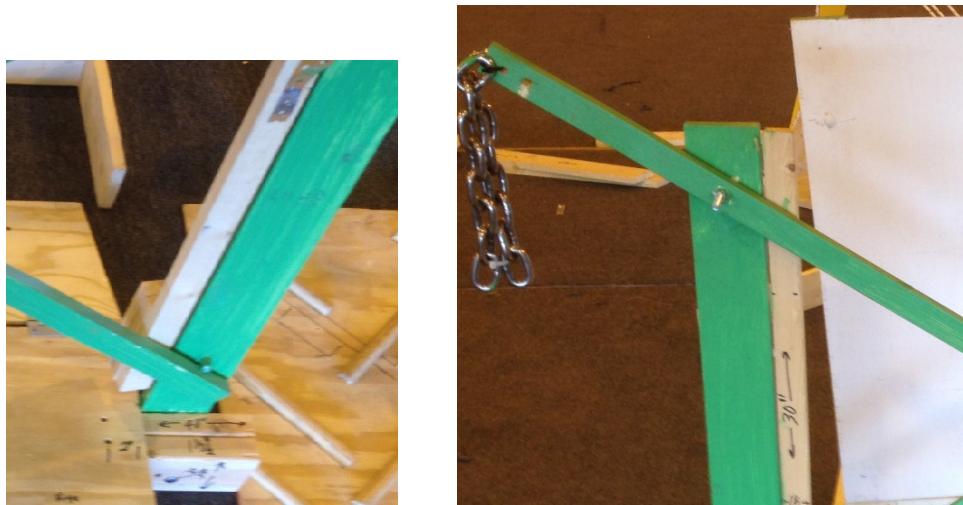
Put some paper between each stacked piece to prevent accidentally gluing the stack together. (News paper is good.) Let is set overnight.

BRIDGE



Bridge is constructed with:

2x4's, 1x4's, 1x2's, 3 pieces of $\frac{1}{4}$ " plywood cut to 1'x3', four 2" hinges and assorted hardware. The counter weights for the gate are 3/8" log chain.



The gate counter weight is made of a 3/8" chain, approximately 16 links on each side. A length of chain is attached to the end of the bridge gate. The bottom gate latch is made of a 5/16" x4" carriage bolt, cut to fit with a set of double nuts tightened on the end of the bolt. The double nuts are a resting place for the gate when the gate is closed.



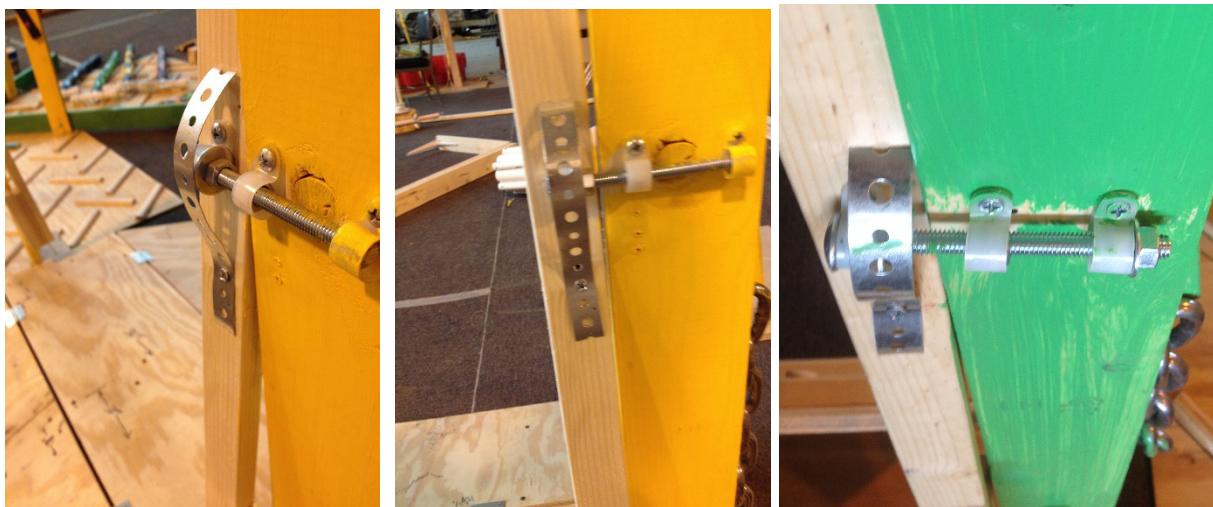
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The gate axle pivot bolt is a 5/16" x 4" carriage bolt through a 3/8" hole in the 1x4 support structure and the 1x2 gate. The carriage bolt is tightened onto the 1x4 support structure. The gate is loosely bolted on the carriage bolt so it can be displaced horizontally to trigger the gate. The horizontal travel of the gate on the 5/16" carriage bolt travel needs to be tuned for travel and over travel. When activated by the gate trigger lever the gate should slide on the carriage bolt and pivot slightly to disengage the gate from the bottom latch rest. After the gate is tuned with an end tuning nut put a locking nut on the end of the bolt against the tuning nut..



The hinge deflector is made of 3/4" wide pipe hanger material attached over the end of the carriage bolt, to deflect the gate around the hinge.

PIVOT ATTACHMENT BOLT

The "gate trigger hinge" is a 5/16x4" carriage bolt with four nuts, 5/16" flat washers, 3/4" wood screws, and three wire cable straps. Tighten the carriage bolt to a cable strap using a nut and flat washer. Attach the cable strap to the "gate trigger" 1x2 with a 3/4" wood screw, align the carriage bolt perpendicular to the "gate trigger". Compress the carriage head and the flat washer into the 1x2 "gate trigger" (using a vice or some other device). Use three nuts and a flat washer to attach the carriage bolt to the 1x4 gate support. Two nuts inside, two cable straps to attach the carriage bolt to the 1x4 gate support and a washer and one nut on the end of the carriage bolt. The nuts inside the cable straps are pivot nuts and the washer and nut on the end is a keeper nut. Place pivot nuts on the carriage bolts as far apart as possible, cover the nuts with cable straps and attach the cable straps to the 1x4 gate support. Rotate the "gate trigger" clockwise or counter clockwise to adjust the spacing between "gate trigger" and 1x4 gate support.

The end nut and washer. This end nut and flat washer will prevent the carriage bolt from pulling out of the cable strap.

Adjust the spacing between 1x2 and 1x4 by rotating the 1x2 clockwise or counter clockwise, decreasing or increasing the spacing between the 1x2 and 1x4.

OVER WEIGHT/OVER LENGTH TIE BREAKER (OW/OL TB)



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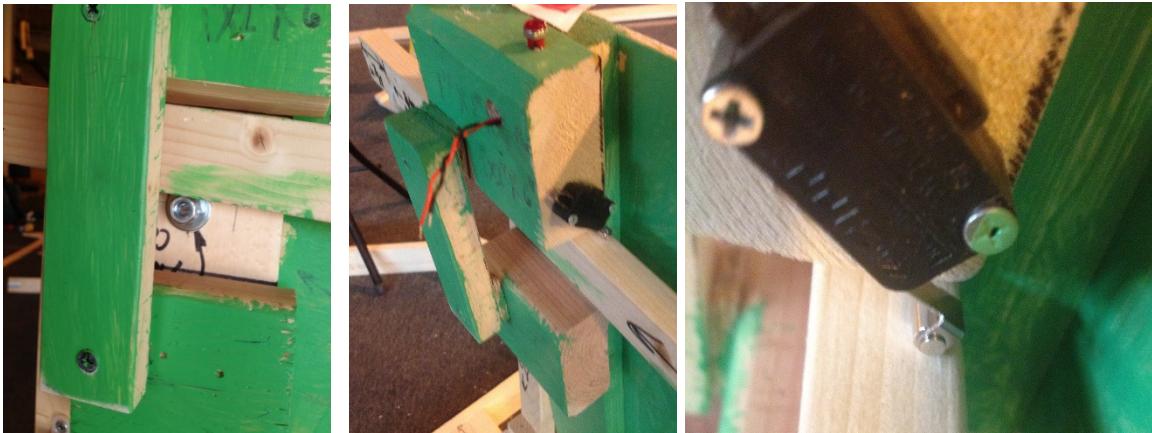


Cut a carriage bolt to 1 ½" for the resting place for OW/OL "TB activator rod". Using a flat washer and two nuts, Double nut the bolt in place, to provide a resting place for the OW/OL "TB activator rod".

PIVOT ATTACHMENT CARRIAGE BOLT

Install the pivot attachment carriage bolt exactly as the pivot bolts on the bridge were installed. Adjust the spacing between 1x2 and 1x4 by rotating the 1x2 clockwise or counter clockwise, decreasing or increasing the spacing between the 1x2 and 1x4.

Tie breaker rod, LED, and limit switch



Install the limit switch onto the upper 2x4 x 4" block and adjust the switch to engage when the rod is in the up position resting on the nuts of the carriage bolt. Drill holes in the 2x4 x 4" upper block to install the LED. The top hole is a ¼" hole drilled 2" deep. The side hole is a 7/16" hole drilled 1 ½" deep and intersecting the ¼" hole. The 7/16" hole is approximately 1" below the top of the 2x4. Insert a pull wire loop into the 7/16" hole and insert the pig tails of the LED into the ¼" hole through the wire pull wire.



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Pull the LED power wires through the block and, with a small amount of force, press the LED into place.



Tie breaker indicator light and limit switch. The indicator light is an LED. The limit switch is in the Normally Open position. Upon triggering the “TB activator rod” with the “Tie breaker rod activation leaver” the LED will turn on and a signal will be sent to the field Data Acquisition System to note the activation time.

To restrict over travel of the “TB activator rod” (the horizontal 30” 1x2) when it is triggered by the “Tie breaker rod activation leaver” (the vertical 24” 1x2) a 6”, 1x2 with 1/4” plywood spacers, is attached between the top 2x4 x 4”s and the bottom 2x4 x 4” blocks.

SMALL TOWER

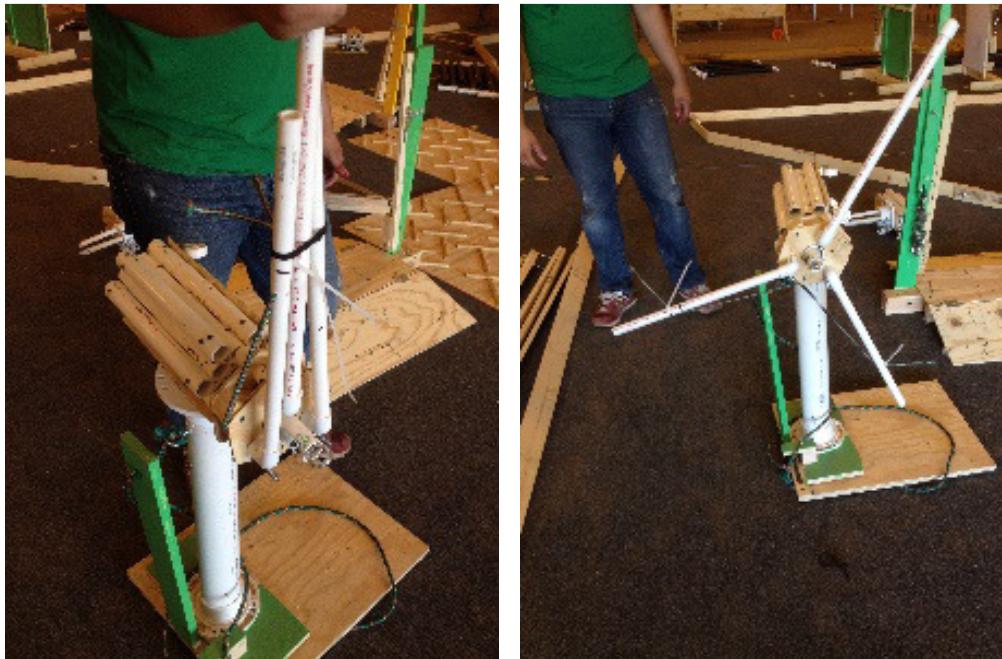


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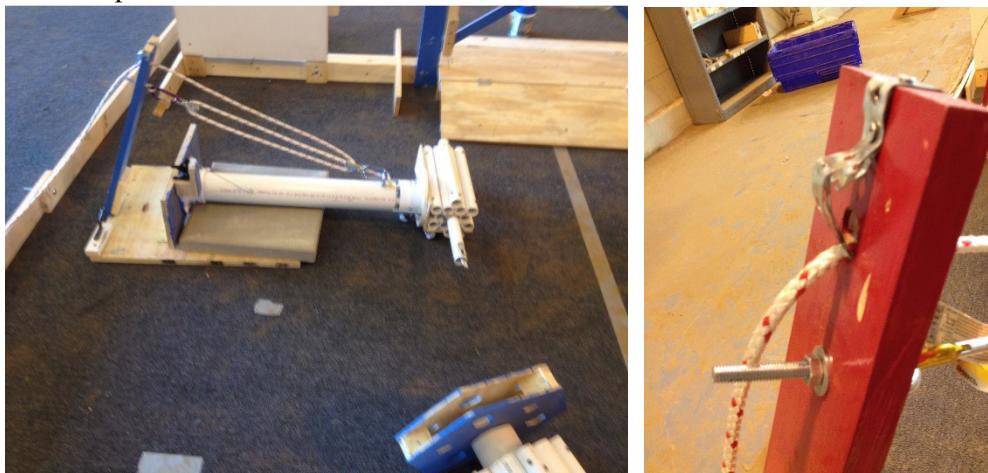
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Shown above is a small tower erect and latched in place at the base of the tower, with a nacelle attached, a hub assembly attached to the nacelle, and with the turbine blades contracted in transport position. Then the small tower erect and latched in place, with nacelle attached, hub assembly attached, and the turbine blades expanded.



Shown above is a small tower with a nacelle attached, with a rope and pulley system to lift the tower into place and a counter weight. A counter weight (15"x15"x2" cement block) is placed on the base of all of the towers, Small and large,

A tower falling break is in place to catch the tower when the lifting rope is released in an unstable position to prevent the tower and nacelles to crash to the floor.

Tower falling breaks are on all the towers, large and small.

Small Tower Latch & Large Tower Latch



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SMALL HUB AND SMALL TURBINE BLADES

The small hub is a 7" hexagon



Two 5/16" x 4" carriage bolts are installed and bolted in place with 1/4" flat washers (due to clearance considerations). These bolts are used for turbine blade stops upon expansion for the turbine blades.



The through holes for the bungee strap are staggered about 1". Small flexible steel wire was used to pull the bungee strap through the holes in the small turbine blades. Wire ties are used to set the turbine blade tension. The turbine blades should be tested for operation, **then stored in the open position to prevent stretching of the bungee straps**. If a bungee strap loses strength due to stretching replace it with a new strap. A 1/2" or 5/8" hole was drilled in the 2x2 x2" spacer for the bungee strap placement. Two turns through the hole for stabilization under load, then attached to the small turbine blades.

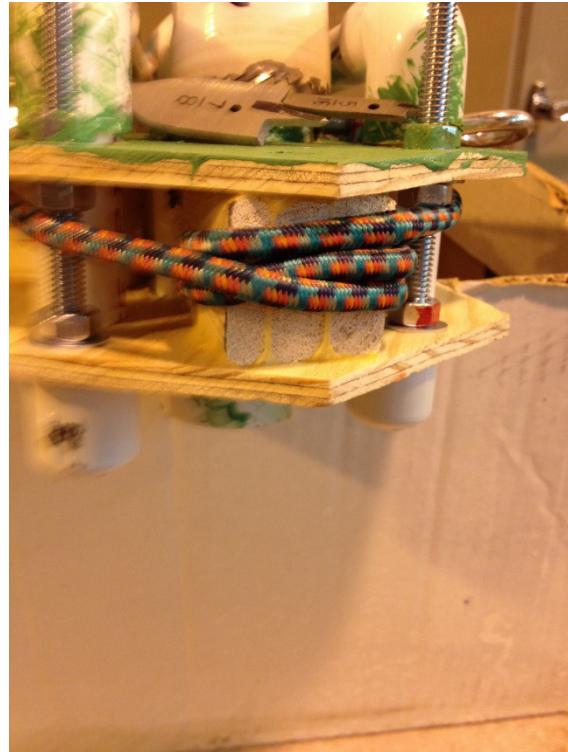


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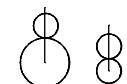
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The center turbine blade is fixed in place. The outer two are free to rotate using the bungee strap. The hole saw and drill bits used for the small nacelle are shown here. The 2" hole saw is used for the center hub shaft pipe hole. The 7/8" wood drill bit was used for making holes for the 1/2" PVC pipe. The 7/8" drill bit is large enough for the PVC pipe but too small for the elbows and end caps to slip through and fall out. The end caps and elbows are compression fit.

NACELLE Jigs

Build a jig for constructing the large nacelles and the small nacelles. 2x4's and 3/4" plywood worked for us. The jig for the large nacelle is about 2" wide for the 2" PVC pipe and the jig for the small nacelle is approximately 1" wide for the 1" PVC pipe. Mark the approximate location for the PVC assembly screws. The attachment pilot holes are drilled into the PVC approximately 1" from each end of the PVC. The pilot holes should be **drilled as close as possible through the center lines of the two pieces of PVC**.



Use vice grips to hold the pieces of PVC together for drill pilot holes in the PVC and inserting the 2" drywall screws in place for the **PVC sub-assemblies**. The small nacelle is made of two pieces of 1" PVC each 12" long and the large nacelle is made of a 1" and a 2" piece of PVC each 10" long.



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A large Nacelle sub-assembly jig. Using vice grips to clamp the PVC pieces together in the jig, drill pilot holes in the PVC pipe and install 2" drywall screws.



Drill pilot holes in the top PVC pipe approximately 1" from each end of the PVC pipe.



Install the 2" drywall screws into the nacelle sub-assembly.





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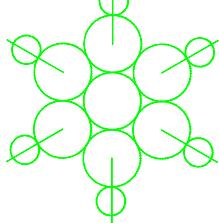
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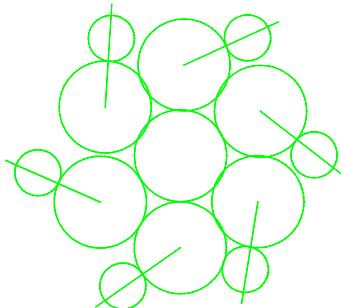
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For a Large nacelle, sub-assembly and a small sub-assembly.

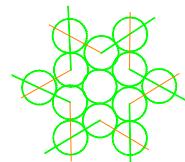
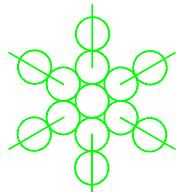
sub-assembles mounted radially around center shaft



sub-assembles mounted radially around center shaft



sub-assembles rotated clockwise around center shaft and screwed in place



A profile of a Large nacelle sub-assembly array and a small sub-assembly array are shown above.



After Constructing a Small Nacelle sub-assembly jig. Using vice grips to clamp the PVC pieces together in the jig, drill pilot holes in the PVC pipe and install 2" drywall screws, for Small Nacelle sub-assemblies.

SMALL NACELLE





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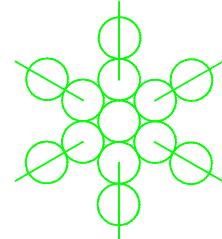
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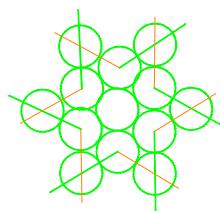
sub-assembles mounted
radially around center
shaft



Construct the small nacelle sub-assemblies and bundle them around a nacelle hub shaft pipe. Here we used pieces of all thread through the sub-assemblies and wired them around shaft pipe to stabilize the sub-assemblies around a center shaft. Then arrange the sub-assemblies symmetrically around the center shaft pipe. Each center sub-assembly pipe will be touching the center shaft pipe, the two adjacent sub-assembly pipes.



sub-assembles
rotated clockwise
around center shaft
and screwed in place



Rotate the sub-assemblies around the nacelle center shaft, either clockwise or counter clockwise. Each center sub-assembly pipe will be touching the center shaft pipe, two adjacent sub-assembly pipes, and the outside perimeter pipes will rotate to be tangent to two of the central sub-assembly pipes. Two adjacent center sub-assembly pipes will be touching one outer perimeter pipe.

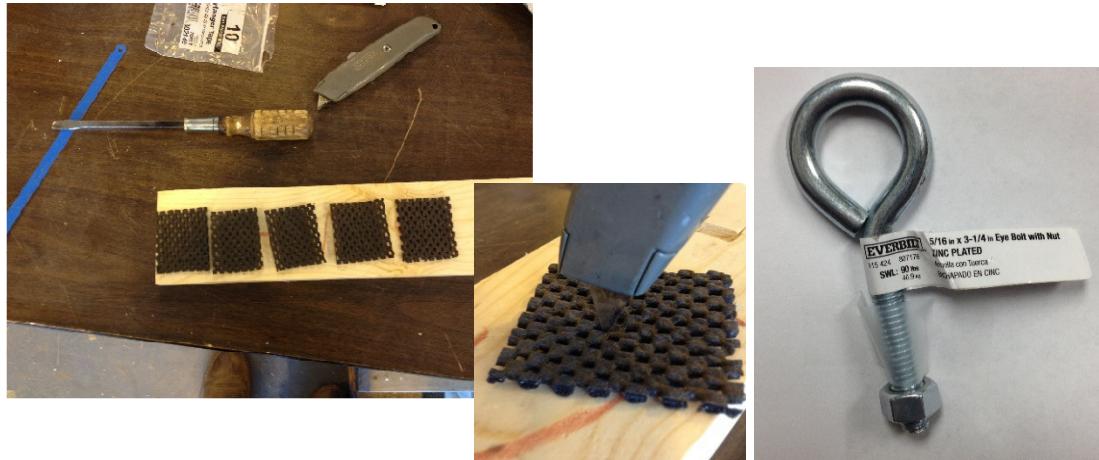


Using the vice grips to hold the loose sub-assembly pipes in place, Drill pilot holes from the outside perimeter pipes to a center sub-assembly pipes, and, screw the sub-assembly together.



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Making and installing the pulling hitch for the small nacelle. The eye bolt used in this illustration (5/16"x 6") is not the eye bolt used for the hitch, an eye bolt (5/16"x 3 1/4") is the proper length. The 5/16"x6" eye bolt photographed nicely and was easier to manipulate for the illustration.



Cut five or six square pads, cut a short slot in the center of each pad, and thread them on an eye bolt.



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Place a back-up nut and washer on the eye bolt behind the pads, and a washer and Double nut on the end of the eye bolt. Then trim the pads in roughly a circle, slightly larger than the inside diameter of the 1" center shaft pipe.



With the back-up nut loosely holding the trimmed pads, tuck the trimmed pads into the center shaft pipe. With the pads tucked into the shaft pipe, the back-up nut may be tightened to compress the pads inside the shaft. The eye bolt may then be tapped into the pipe shaft.

Making and installing the nacelle latch, after the hitch is in place. The latch screws prevent the hitch from being pulled out under any heavy load, due to the 5/16" flat washers on the eye bolt interfering with the latch screws. The latch prevents the small hub from falling off of the small nacelle when the small tower is erected into final scoring position. The latch is a piece of hanger tape approximately 3 1/2" long, cut, folded, and trimmed to fit.



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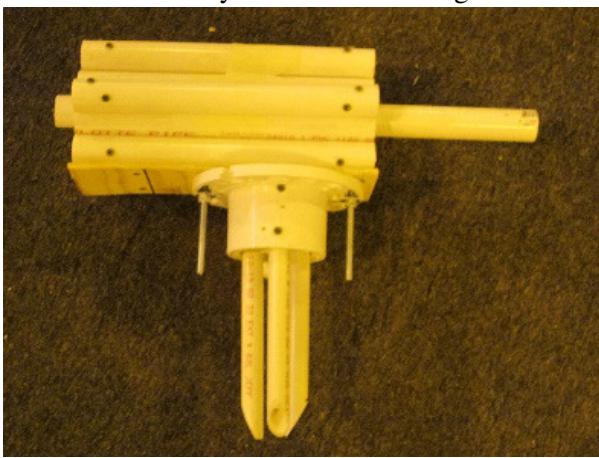
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Small nacelle ready for caster and flange attachments.



The small nacelle is constructed with twelve 1"x12" pieces of PVC with a 1"PVC center shaft pipe.



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The attachment flange for nacelle is a 3"- 4" flange. Inside the flange are 7 pieces, 1 piece of 3" PVC for an exterior spacer, extending about half way down the flange, 3 pieces of $\frac{1}{2}$ " PVC pipe, extending to the bottom of the flange touching the $\frac{1}{4}$ " plywood flange attachment plate, beveled 30° at their ends, and 3 pieces of $\frac{3}{4}$ " PVC pipe for center spacers, extending to the bottom of the flange touching the $\frac{1}{4}$ " plywood flange attachment plate..

The $\frac{1}{2}$ " PVC is indexed to engagement with the tower to prevent rotation under load when the tower is lifted during game play. The indexing may be accomplished using a combination of, installing the $\frac{1}{2}$ " PVC in a good location and by rotating the slotted flange into a good location.

With the 3" PVC horizontal, in beginning field position. The 5/16" eye bolt is located at 12:00 in the PVC, 16-26-3 of 9 field drawing. With the small nacelle's wheels on the floor, looking at the 3"-4" flange the $\frac{1}{2}$ " x 10" pieces are oriented at about 11:00, 3:00, and 7:00 as shown in the 20-1 of 10 field drawing, far left side.

A small kerf may be cut in the 3" PVC spacer for easy insertion.



Five casters are installed on the small nacelle, two on each of the two $\frac{1}{4}$ " plywood floor plates (four casters on the nacelle), and one on the neck of the 3"-4" flange



The eye bolt "towing hitch" and the small hub installation "latch" are shown above. The center line of the eye bolt is approximately 4" above the playing surface. The eye should be rotated parallel to the playing



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surface during game play. The latch should be rotated to the top of the center shaft. (Latch is shown on the bottom of the shaft and eye bolt is oriented vertically in these two images. Bottom and top are with respect to the casters being on the floor and the small nacelle in playing position.)

LARGE TURBINE BLADE CONSTRUCTION AND MATERIALS

A large turbine blades is constructed using: one 6" piece of, 1-inch, sch-40, PVC pipe, and two, 3 1/2" pieces of 1-inch, sch-40, PVC pipe, one 1" PVC Tee, two 1" PVC end caps, one 4" piece of 5/16" all thread (cut to fit), one 1 1/4" coarse thread drywall screw, one piece of 1" pipe insulation cut to 32" long, and one 5/16" x 3 1/4" eye bolt. From the inside of the Tee drill a 3/8" hole through the top of the Tee. Install the 5/16" x 3 1/4" eye bolt.



Make two 3" large turbine (L.T.B) spacers to locate the depth of the 6" stub in the 1" Tee.



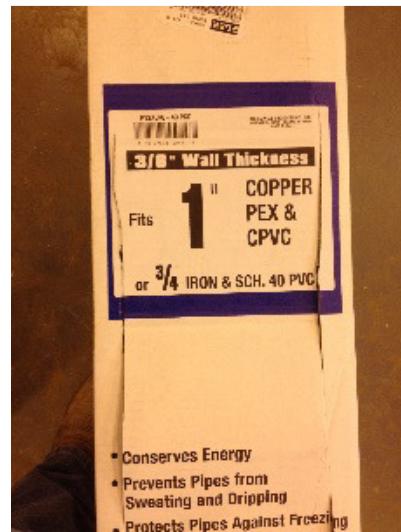


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Drill a pilot hole in the shaft and Tee for a drywall screw, to attach the pipe to the Tee with a screw.

DRILL THE 3/8" HOLE FOR THE EYE BOLT FROM THE INSIDE OF THE TEE, IF USING A HAND DRILL. Drill from inside or outside if using a drill press.



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The 6" PVC pipe has a single 3/8" hole drilled through the PVC centered at 3" from its end. The 3/8" hole is for a 5/16" x 4" cross bolt (all thread cut to 4") as shown. Slide the pipe insulation over the 1" PVC and an awl locates the 3/8" hole for the bolt. Insert the cross bolt install the nuts and 5/16" washers.

Large turbine blades assembled and are color coded for field use with Duct tape.

LARGE TOWER AND LARGE HUB IN FIXED INDEXED POSITION

The large hub is a 14" hexagon



The large tower, the large nacelle, and the large hub are a single unit. The large hub is six sided and 120° symmetric. The large hub indexed with a flat side on the floor and the hub is fixed in place on the nacelle axle with a drywall screw. The large nacelle is fixed in place with a drywall screw from the nacelle axle shaft to the nacelle assembly. It is indexed as shown with two turbine blade insertion locations closest to the tower bottom and one turbine blade insertion location away from the tower bottom.

Large tower & small tower falling break

This is a passive break. When the rope is released, the break should engage to stop or slow the decent of the tower.



A 4 1/2" to 5" piece of hanger tape is used for the large and small tower falling break. The small holes are 1" apart, the large holes are 1" apart and the large to small hole is 1/2". 1 1/2" of the tape is folded back under the tape, for a double layer of hanger tape over the rope pull hole, this stiffen the tape, and mitigates sharp edges from cutting the tape with shears. The break is double strength from bottom to 1 1/2" up then



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single strength for $\frac{1}{2}$ " to the screw hole. The tape is then screwed over the 3/8" rope pull hole, mostly covering the pull hole.

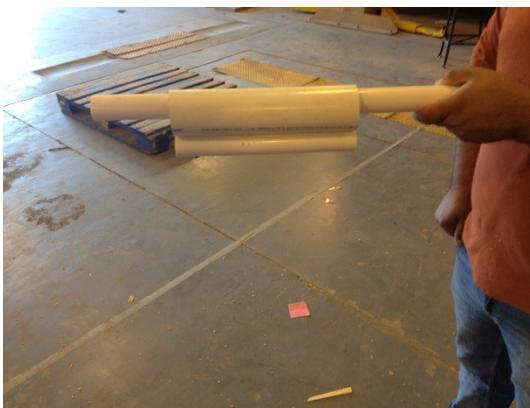


The 5/16" pull rope is threaded through the 3/8" pull hole. The break latch is adjusted to catch the pull rope upon release. Periodic adjustments may be necessary during game play, depending on tower usage.

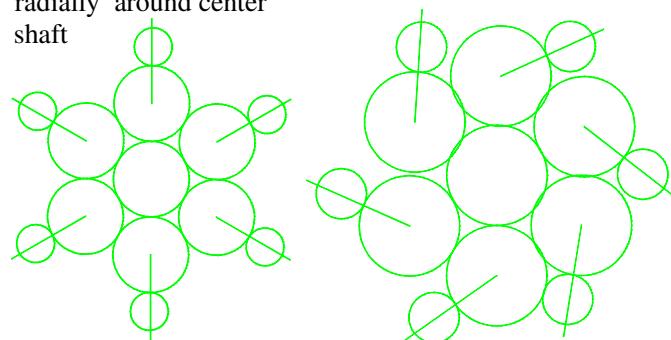


Falling break: tower suspended, break engaged

LARGE NACELLE



sub-assembles mounted radially around center shaft



Make the sub-assemblies for a large nacelle from six, 2" and six, 1" pieces of PVC cut 10" long.
 $\frac{3}{4}$ " or $\frac{1}{2}$ " PVC may be used for sub-assembly alignment around the center 2" shaft.

Using the same procedure to distribute the small sub assemblies around a central shaft. Distribute the large nacelle sub-assemblies around a 2" center shaft. Use 2" drywall screws to attach the 1" outer PVC



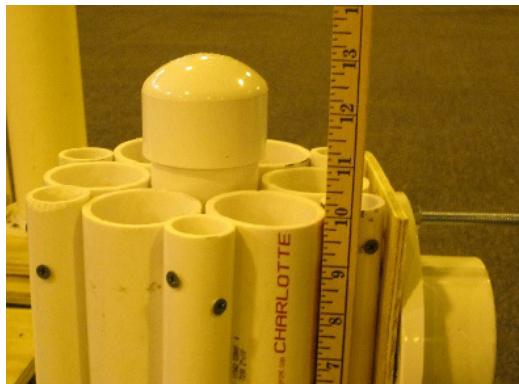
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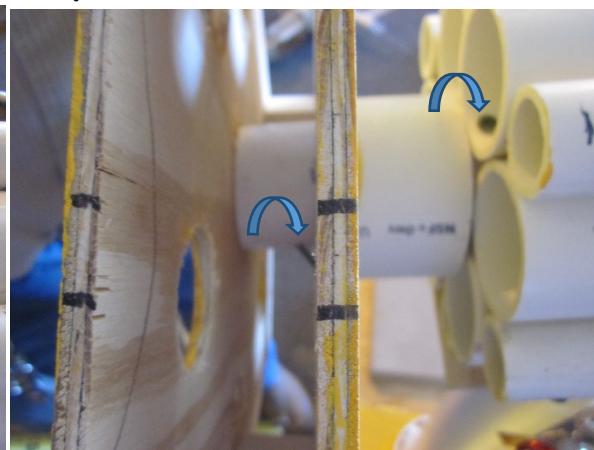


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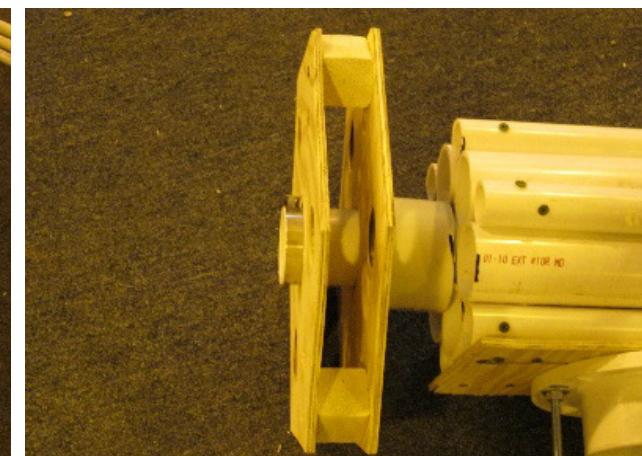
to an inner perimeter sub-assembly 2" PVC. Use the vice grips to the 1" PVC to the 2" PVC when drilling pilot holes and inserting the 2" drywall screws.



The large nacelle is made of six 1" x 10" PVC pieces, six 2"x10" PVC pieces, and one 2" PVC central shaft pipe, and a spacer, a 3" PVC pipe about 2" long. The spacer provides room behind the hub for the large turbine blade end caps when the blade is completely inserted into the hub. A single drywall screw is used to fix the axle to the nacelle assembly. A second drywall screw is used to fix the hub to the axle.



LARGE HUB



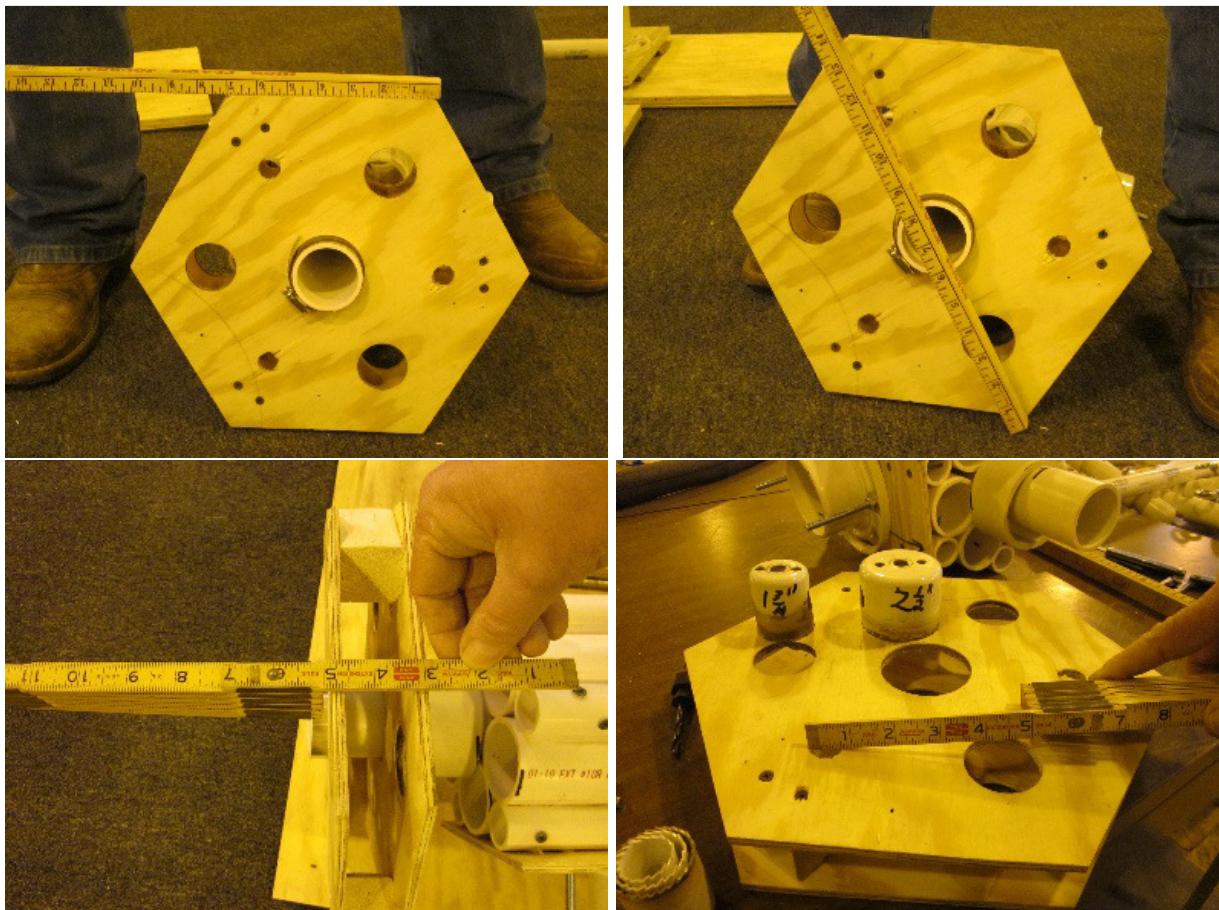


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The large hub is made of 2 pieces of $\frac{1}{4}$ " plywood cut in 14" diameter hexagon.

There are 3 spacers between the plywood made of 1x2 pine lumber cut 2" long and screwed in place, spaced at the outer edge of the large hub at a 120° separation.

The central hole is cut with a $2\frac{1}{2}$ " hole saw, the turbine blade insertion holes are cut with a $1\frac{3}{4}$ " hole saw, and the blade indexing holes are cut with a $7/8$ " drill bit. The indexing holes and insertion holes are centered on a 4" radius from the center of the hexagon, and the holes are cut 60° apart.

The latching holes for the large turbine blades are $7/8$ " diameter.

Tower Safety Latches (gate latch and strike)

A completely erect tower is locked in place by a base safety latch and strike. The safety latches are common gate latches arranged to latch the erect tower in place. The latches are attach to the tower, $\frac{3}{4}$ " plywood base plate, and the strikes to the tower, $\frac{3}{4}$ " plywood floor plate

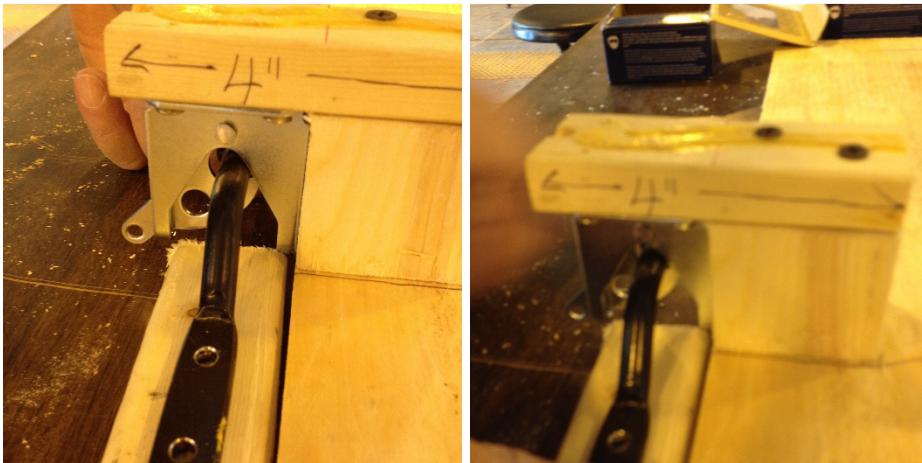


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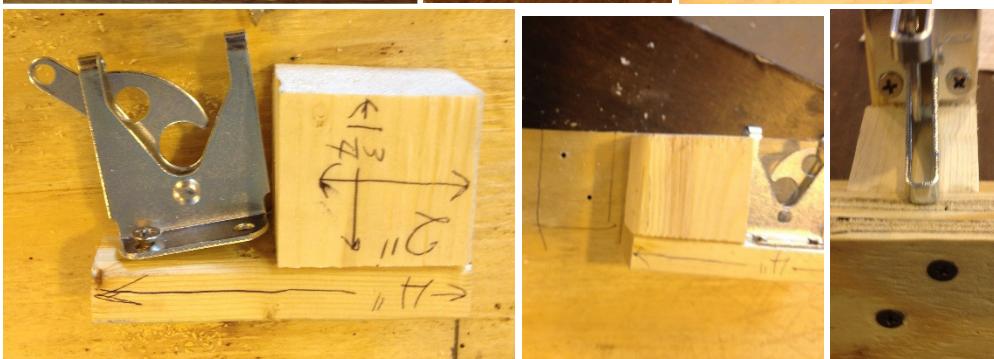
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Using 1 5/8" drywall screws, two 4" 1x2's, and a custom cut piece of 2x4, construct the latch support assembly



The latch bracket is made of a custom cut piece of 2x4. It is cut 1 3/4 high and 2" wide. Attach one 4" 1x2 on top of the custom cut 2x4. Use the custom cut 2x4 to mark the 1x2. Flip the 1x2 over so that the mark is clearly shown (here in red ink). Drill two pilot holes, evenly spaced, across on a diagonal of the 1x2 and into the 2x4. The inserted screws are shown in the pictures above. Attach the latch to the 1x2 extension as shown.



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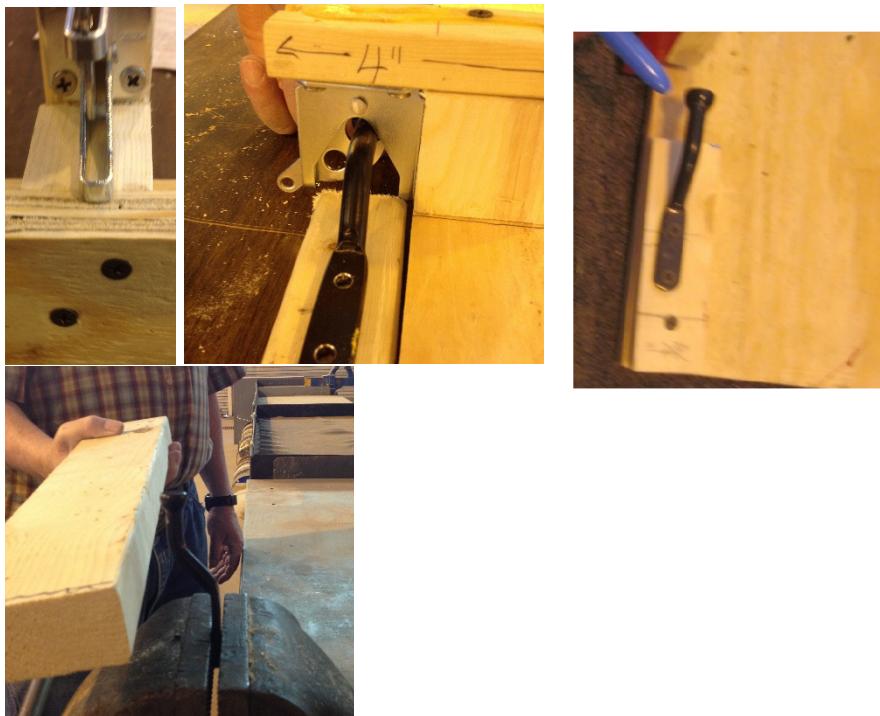
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Mark the perimeter of the latch base on the tower, $\frac{3}{4}$ " plywood base plate. Drill pilot holes across on a diagonal in the tower, $\frac{3}{4}$ " plywood base plate. The diagonal of the tower base plate should be opposite that of the diagonal of the 1x2 latch support, as shown above (so the screws don't interfere when they are inserted top and bottom of the custom cut 2x4). Use the pilot holes in the $\frac{3}{4}$ " plywood base plate to drill matching pilot holes in the custom cut 2x4.



The protruding latch should index against the $\frac{3}{4}$ " plywood. Use the second 4" 1x2 as a spacer for the base strike. The 1x2 is screwed to the $\frac{3}{4}$ " floor plate and the strike is screwed to the 1x2 spacer. The strike and latch do not always latch properly and may need adjustment. The adjustment is made with a hammer, a vice, and the strike. I used a 2x4 for the hammer to prevent marring the paint on the strike.

PRAIRIE CHICKEN



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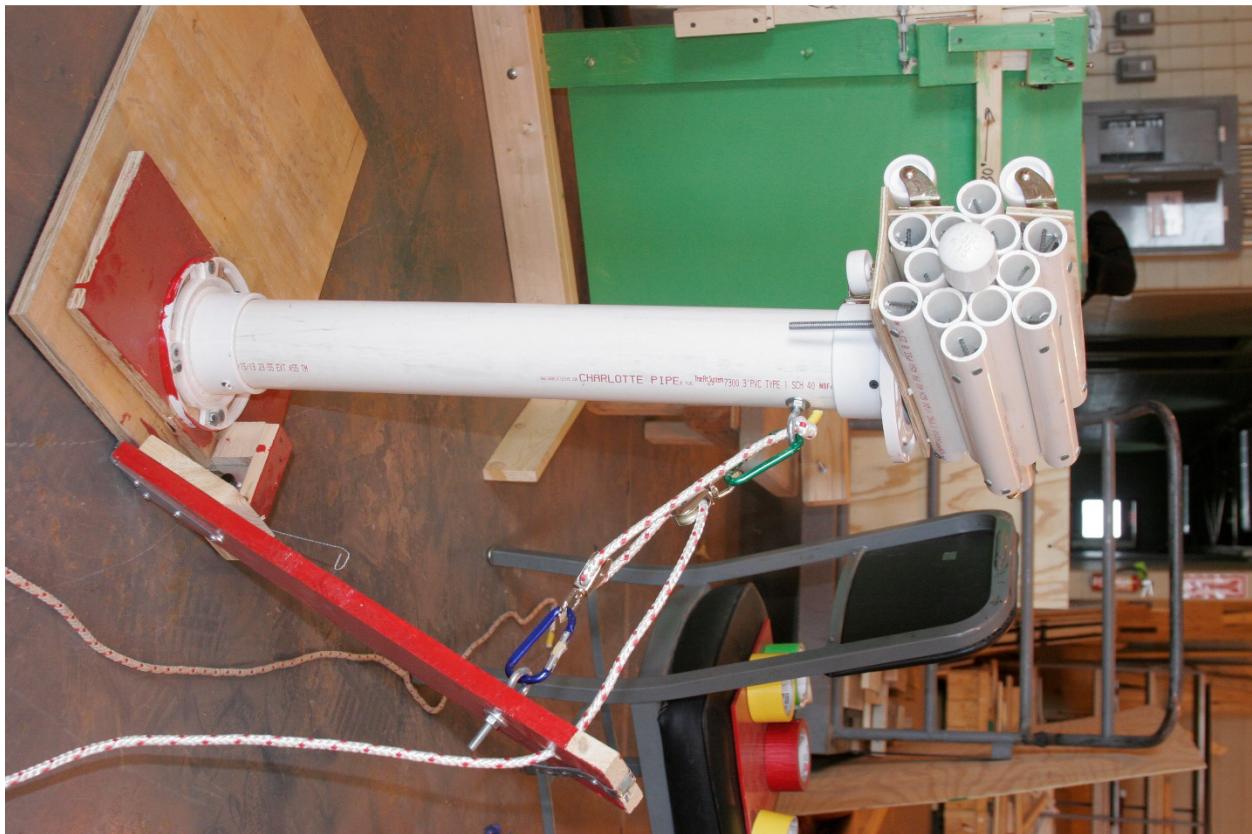


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One 6" piece of 3" PVC, one 3" end cap.

Drill the eye bolt hole (3/8th ") from the inside of the end cap to the outside of the end cap (if using a hand drill). Drill from either side if using a drill press. (We had to relearn this trick.)



The lifting rope is attached to the tower, runs from the tower to the 1st pulley (on the 1x4), from the 1st pulley to the 2nd pulley (on the tower) then back through hole in the 1x4.



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For Field construction, only 5/16"x4" carriage bolts were purchased. The carriage bolts are often longer than necessary for their specified locations. In those locations the carriage bolts should be cut to fit. If the carriage bolt does not extend outside the playing field and doesn't interfere with field play it is not necessary to trim the bolt. The bolts above extend outside the playing field and should be trimmed.



The Over Weight/Over Length-Tie Breaker latching carriage bolt is shown here with a double nut, for locking the nuts on the bolt. The carriage bolt should be cut flush with the end of the double nuts. The pivot carriage bolt for the OW/OL-Tie Breaker does not interfere with the playing field and does not extend outside the playing field and was not trimmed. There are washers on either side of the leaver arm as seen in the photo.



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The Bridge gate latching carriage bolt has a double nut and is trimmed flush with the ends of the nuts. The gate pivot bolt is not trimmed, as it does not interfere with game play. **The gate pivot also has (3) nuts.** An interior nut for locking the carriage bolt in place and double locking nuts on the outside to fix the horizontal adjustment for gate horizontal swing. **(The third nut is not necessary but it is convenient. The OW/OL-Tie Breaker bar does not have a third nut. It was convenient to leave the third nut off.)** There are washers on either side of the leaver arm on the pivot bolt.



The axle on the small nacelle should not slide inside the nacelle. The friction fit for the axle may not be enough to hold the axle in place during game play. A single drywall screw from the small nacelle to the nacelle axle will fix the axle in place.

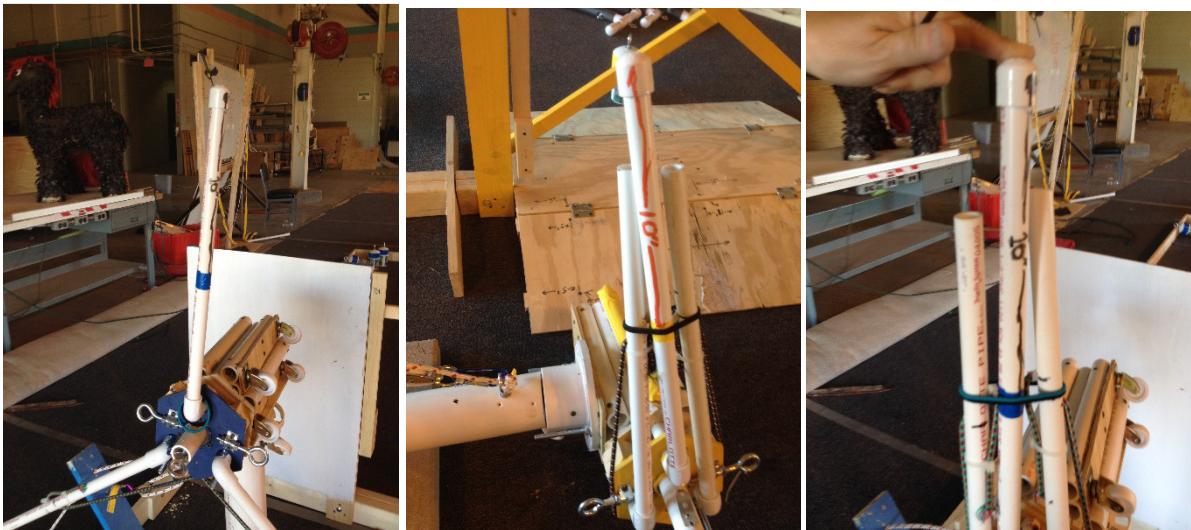


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Small Hub Scunci strap location. A piece of tape is used to mark the approximate location of the Scunci straps. The tape is 1" wide **centered** 10" from the end of the fixed turbine blade. The Scunci straps should be indexed (anywhere) inside the taped area for field play.