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Making Large Girandola Frames

Figure 1: Bundles of 5/8" half-round reed shipped in 24 foot lengths.

Figure 2: Using a 24" diameter disk to measure out a length of reed for making hoops.

Introduction:
One of the first barriers to entry people come across when moving up to bigger girandolas is the construction of a suitable frame. Small girandolas have a wide variety of simple frames to choose from, such as plastic bucket bottoms, tuna cans, knitting frames etc. As the diameter increases, some materials such as plastic, fiberglass and paper become too flimsy to work well. A typical 24" diameter girandola can weigh from seven to twelve pounds, depending on the payload and number of drivers used. Thus a strong frame must be built in order to support all that weight while sitting on the launch stick, yet still be light enough to enable the girandola to lift a respectable payload without using an unreasonable number of drivers.

Bamboo is the traditional material of choice when building larger girandola frames, or even smaller ones for that matter. The nice thing about bamboo frames is that they are virtually indestructible, thus they usually survive the fall back to Earth so that you can reuse them. The down side to bamboo is that it is a little more difficult to find, and can be extra work to prepare if you can't find it pre-cut into strips of the desired width. Recently it has become popular to cut apart the bamboo poles sold as Tiki torches in many stores. These poles are already split into several strips near the top, so all you need to do is remove the torch basket and split the poles the rest of the way down. However, these poles do not come in seven foot lengths, so you would not be able to construct a 24" hoop without splicing multiple pieces together.

I have tried several different kinds of materials for making larger frames, including laminated poplar strips, fiberglass, flat reed, half round reed, basket hoops and ash splints. Cutting your own wood strips and laminating them together around a form is a bit tedious and the strips often break if bent too far. Fiberglass is messy to work with and results in an overly flexible hoop that is far too flimsy unless you really use a lot of layers without getting air gaps between them. Basket hoops are strong and cheap, but only come in smaller sizes up to about 15" diameter. Ash and even oak wood splints can be laminated together to produce nice looking hoops that are quite strong, but finding them in the 76 inch lengths required to make a 24 inch diameter frame is difficult.

The material I have recently switched to for making the outer hoop rings is known as half-round reed, which is quite cheap, strong, very light, comes in long lengths and is very easy to work with. What I like

Figure 3: Cutting the reed with a thin pull saw.

Figure 4: Clamping and planning the rounded side where the ends will be spliced together.

Figure 5: Close-up of gradual 6" long taper.

about the reed as compared to bamboo is that you don't have to split it, the size and shape is very uniform, it takes wood glue well, is easy to splice into a hoop, it has a nice flat surface on one side for attaching drivers, it is cheap, easy to find and very light weight. The reed is flat on one side and round on the other, making it very strong yet still flexible and virtually impossible to break while bending it. The reed comes in rolled up bundles as seen in Figure 1, which is nice because the sticks will already have a curve to them in the direction that you want, removing the need to use forms, water or other methods of bending them into shape. The hoops can actually be spliced and glued without using any type of central holding fixture, allowing you to make many of them at once without having to have a form for each one. The half-round reed used here is the 5/8" size ordered from www.basketpatterns.com for $4.75 per 24 foot bundle. Unfortunately the bundles aren't usually one continuous 24 foot piece, rather two or three separate pieces that add up to 24 feet in length. You can always get two hoops and sometimes three made from each bundle depending on how they are cut.

Because my frames typically land in inaccessible places or get blown apart by the header effect, I don't really know how well they survive impact on landing. It is likely that some of the internal supports will break and need repairs, while the outer hoops will not suffer any damage. The internal framing is made from slats of poplar, which are easy to glue together and quick to assemble. The design of the cross members are quite strong and thus only four spokes are required, making for a very light frame. The finished frame will weigh just under one pound.

Construction

While it is not necessary, it is very useful to have a 24" diameter wooden disk cut from plywood or particle board for the purposes of measuring and marking positions on your frame during construction. Figure 2 shows this disk being used to measure out a length of reed for one of the hoops. The reed is tightly wrapped around the disk and then overlapped by about six inches where the pieces will be spliced together. Use a pencil to mark where the ends will be located on the spliced joint. Without the disk, you will need to measure out a two lengths of reed 81-3/8" long, then make a mark six inches from each end. The reed is very tightly coiled, but it can be bent and formed into shape without risk of breaking it. Still, trying to measure a long piece of it accurately will be difficult due to the curve, which is why the wood disk makes this task much easier. Once the length is marked, the reed can be cut using a fine toothed saw such as a pull saw, as seen in Figure 3.

The ends of the reed will be joined together using an overlapping joint that is planed at gradual angles so that the resulting joint fits together flush in one continuous piece. This type of joint is known as a scarf joint, and can be easily made using a block plane as seen in Figure 5. First plane the rounded face by clamping the reed to a work table as seen in Figure 4. Start the slope six inches back from the end, and keep planning until the reed tapers down to less than 1/16" thick at the end. The reed planes very easily, and a sander could probably also be used to create the angled slope.

The opposite end of the reed must be sloped on the flat side, which is a bit more of a pain due to the curvature. Figure 6 shows how the

Figure 6: Block planning the flat side of the opposite end.

reed will stubbornly cure upwards while you try to plane it. You just have to force the reed down flat on the table at the same time you are planning it.

Once you have planned both ends of the reed, they should overlap to form a nice joint. Wood glue is applied between this joint and clamped together for drying as seen in Figure 7. The process is repeated for the second hoop, then set aside to dry as seen in Figure 8. The hoops will likely be quite irregular and oblong at this point, but they will straighten out into perfect rings once the internal frame work is completed. You can also shape them by bending in order to work out some of the more drastic irregularities. Reed tends to be somewhat moldable rather than rigidly snapping back into its original shape the way wood or bamboo does.

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Figure 7: Clamping the ends together to form the overlapping scarf joint.

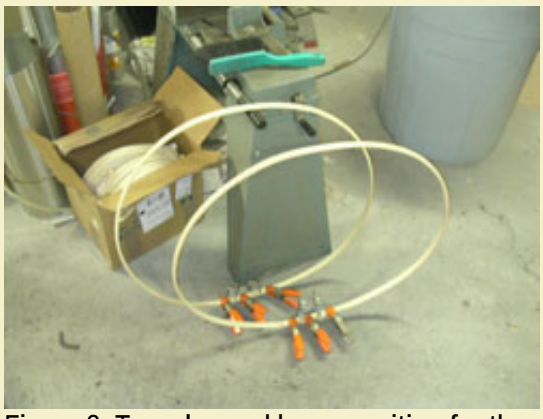

Figure 8: Two clamped hoops waiting for the glue to dry.

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Figure 9: Using the disk template to mark cross member connection points.

Figure 10: Aligning and gluing the vertical supports that connect the two rings together.

Figure 11: Using spring clamps to hold both ends of all four connectors until glue dries.

Once the hoop joints are dried, two hoops need to be connected together to form a double set of rings. This effectively produces one thick hoop with a double set of rails for tying the vertical drivers onto. While smaller girandolas can get by using just one ring, the larger drivers used in bigger girandolas need two tie-off points in order to securely fix them at the desired angles. The vertical drivers also become part of the frame integrity themselves, adding considerable support between the two rings to help minimize flexing.

The hoops are connected together using 5" tall strips of poplar cut to a thickness of about 3/16" thick. All of the internal frame members will be constructed from this same material, so it helps to rip a bunch of long 3/16" thick strips from a four foot long board to have them on hand when building more frames in the future.

In order to mark the four positions where the vertical supports will be glued, the wooden disk is again used as seen in Figure 9. The disk not only serves to hold the hoop into an even circle when marking the connection points, it serves as a template for marking both frame connection points and driver connection points. It is necessary that the exact center point of the wood disk be known so you can measure out the proper angles using a protractor. A set of lines crossing at right angles are first marked on the disk, which indicates where the frame spokes will be. A second set of tick marks are placed every 22.5 degrees, resulting in 16 evenly spaced points where the drivers will be located. Note that the frame markers are located at the midpoint between two driver points, insuring that the frame does not obstruct driver placement. If more than 16 drivers are required, it is easy to visually align more drivers between the first sixteen drivers. Sixteen is about the minimum number of drivers you would need for a girandola this big, while 28 is about the maximum number the frame will hold.

Once your hoop is slipped onto the marker guide, use a pen to transfer alignment marks onto the frame where the four vertical supports will be located. It is a good idea to align the hoop so that one support will fall directly at the midpoint of the scarf joint, even though the joint is very unlikely to ever come apart unless the frame gets wet. When marking the bottom ring, I like to take a different colored marker and mark all the points where the drivers will be located as well. For the top ring this is not necessary, as the top points will be in a slightly different spot due to the angle of the drivers when they are attached.

Once the hoops are marked, wood glue and spring clamps are used to quickly attach the hoops together using the vertical supports.

Figure 12: Drilling holes through the vertical cross members where the frame pins will connect into.

Figure 13: A pair of 2" square hubs made from poplar.

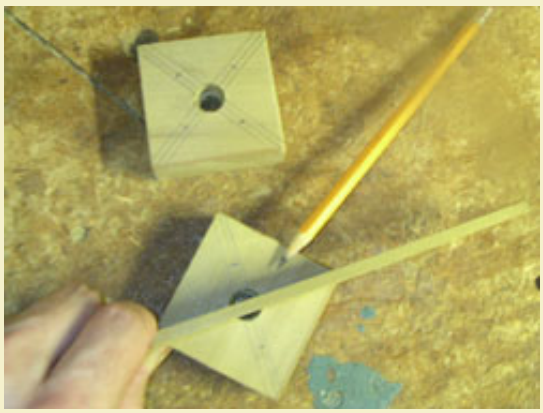

Figure 14: Using a piece of the frame members to mark the slot cutout widths on the hubs.

Figure 10 shows how a right-angle gauge is used to make sure the vertical supports are properly aligned before attaching them to the upper hoop. Figure 11 shows all supports in place with spring clamps at both ends of each support. For the purpose of creating a more balanced frame, it is a good idea to locate the scarf joint of the top hoop on the exact opposite side as the scarf joint on the lower hoop.

After the glue has dried, a small hole must be drilled through each end of the vertical supports at the midpoint of the frame, as seen in Figure 12. The diameter of this hole should be just a hair larger than the thickness of your frame members. So if you are using 3/16" thick wood slats, then the holes should be 7/32" diameter. These holes are used by the pins that will be formed on the end of the frame members, which will create a strong mortise and tenon type joint that will still hold even if the glue cracks during use.

The central hub for the frame spokes is made from two blocks of 2" square poplar. Poplar is used throughout the frame for its tight grain, absence of knots, light weight and resistance to splitting. Pine is lighter, but splits too easily to be used reliably for the hub blocks.

There is an upper hub block and a lower block, with a hollow aluminum rod sandwiched between them. The aluminum axle tube is 1/2" O.D. and 3/8" I.D. with a length of 4-1/2" , which is cut from a 36" long tube stock sold in many hardware stores. The center hole in the wood hubs should be drilled half way using a 1/2" diameter bit, then finished the remainder of the way using a 7/16" bit. This way the axle tube can be locked into position between the blocks without sliding up or down.

The corners of the hub blocks need to be slotted so that the frame spokes can be glued solidly into them. Use a piece of frame scrap to mark the width of the slots that are to be cut, as seen in Figure 14. The slots should be cut 3/4" long into the blocks using a band saw as seen in Figure 15. After cutting the left and right edges of the strip to be removed, the final back cut can be done by making many tiny angled cuts or using the side cutting action of some blades when pressed sideways.

Once the four slots are cut, the final step is to drill a small hole equal in diameter to the holes you drilled through the side of the frame hoops in Figure 12. The hole is drilled at the center point from the bottom of the slot all the way through to the axle hole. Figure 16 shows how a wood clamp can be used to hold the hubs on their corners when drilling this hole on a drill press. The frame spokes that fit into these slots will have a tenon pin that fits into this hole, reinforcing the joint so that it will not break even if the glue cracks under stress.

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Figure 15: Cutting out the frame junction slots using a band saw.

Figure 16: Drilling mortise holes for the frame pins to connect into.

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Figure 17: Notching the edge of a solid board before cutting the frame spoke strips from it.

Figure 18: Using a utility knife to round out the square pegs so that they will fit in the mortise holes.

Figure 19: Using a test hole in a scrap of wood to make sure each tenon will fit before installing into the frame.

Next you will need to produce two sets of four spokes that connect from the center hub to the outer rings, for a total of eight spokes. These spokes are made from the 3/16" thick poplar strips that are ripped from the edge of a standard 3/4" thick board. The ends of each spoke will reduce down to a round pin that fits into the holes you drilled in the outer rings and in the hubs. The diameter of this pin will equal the thickness of the slats, while the length will be 1/4" on the side that plugs into the hub and 7/16" on the side that plugs into the outer rings. The outer pin is longer because it runs through both the vertical ring supports and all the way flush with the outside of the rings.

The pins are created by first notching out square pins and then rounding them off by carving the corners off with a utility knife as seen in Figure 18. While you could use a band saw to notch out the spokes on each end, a faster way is to notch a much wider board and then rip the spokes from it one by one, as seen in Figure 17. Start with a 1x6 that is 12-1/16" long, then use a router or dado blade to rabbit the top and bottom of each edge to a depth of just a hair over 1/4". This way you only have to notch one large board to get many smaller notched strips.

Once you carve off the corners of the square pegs so that they look roughly circular, it is a good idea to test fit them into a 7/32" hole drilled in a piece of scrap wood as seen in Figure 19. This way you find any binding pins that need further carving before they are covered with glue!

Now you are ready to glue all the pieces together. I usually test fit all the parts before actually gluing them, just in case something needs more trimming. Start by gluing three spokes into the hub, applying glue to the sides of the slats as well as all around the pin. It is easiest to just pour a small pool of glue on a scrap of cardboard and just use your fingers to brush the glue onto the ends of the spokes when doing this.

When installing the lower frame, make sure the hub is orientated with the larger hole facing upwards, as seen in Figure 20. Glue the three spokes into the frame, then glue the fourth spoke into the frame first before trying to insert it into the last hub slot. You will have to bend the frame out until the spoke is able to drop down into the hub slot, then seat the pin into the hole to complete the lower portion of the frame.

The upper section of frame is completed in the same way, only with

Figure 20: After installing three spokes, the final one is inserted into the hoop and then pulled back and dropped into the slot.

Figure 21: After the top and bottom spokes have been assembled, the axle pin is seated into the hubs.

Figure 22: Diagonal braces are glued in place and held with spring clamps until dry.

the larger hub hole facing downwards. With the two frames assembled, the rings will be forced into a nice round shape as seen in Figure 21. At this point you will need to insert the aluminum tube between the two hubs. The frames will easily flex outwards to allow the tube to be pushed in place. There is no need to glue the axle tube in place, it will not be able to fall out once the upper and lower frames are tied together with the diagonal bracing.

If the frame were used without further bracing, there may be some sagging of the cross members when the completed girandola is resting on the launch stand. This is because the majority of the weight on a girandola resides on the outer perimeter rather than at the center. This weight will stress the cross members when supported at the center point, as is the case when it is resting on the launch stick. A fully loaded girandola could possibly crack the glue joints and compromise the frame in this scenario.

The addition of diagonal bracing as seen in Figure 22 will drastically increase the strength of the frame without adding much additional weight. Simply take some pieces of extra frame slats and trim the corners so that they don't stick up above or below the spokes when glued in place. One spring clamp on each end is all it takes to quickly glue these supports in place. The angle is not arbitrary, the braces must run from the bottom hub up to the upper ring in order to provide the strongest support when resting on the launch stick.

With the diagonal supports glued and clamped, rest the frame on a flat surface and make sure all edges come in contact with the table. If the frame is warped a little, placing weights on the frame can help flatten out the frame and insure that it stays that way when the glue dries.

The finished frame should weigh about 450 grams and take less than 4 hours to construct. This gives you a light weight frame that can be made on short notice without the need for tarred string, split bamboo or special forms.

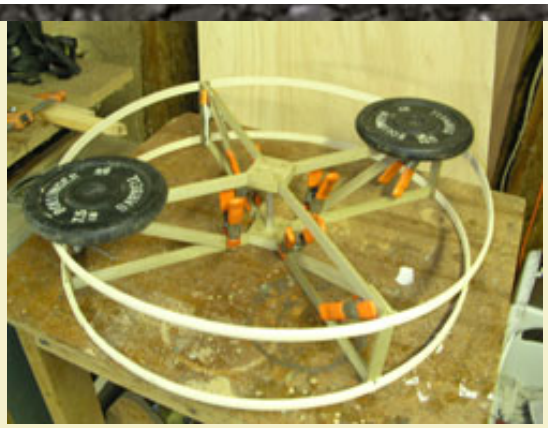

Figure 23: Using weights to make sure the frame lies flat on the table while the diagonal braces are allowed to dry.