



Designing and Building the Altar
for Christ Church in Andover

2011-2012

By

Allen Townsend & Carol Reid

Acknowledgements

I would like to thank Reverend Jeffrey Shilling Gill and the vestry of Christ Church for giving me the opportunity to build this altar and for their support throughout the process. I would also like to thank the members of the parish of Christ Church for their comments and encouragement during the design and building of this new altar.

Mostly, I would like to thank my wife, Carol, for her help, encouragement, support, and patience throughout this project which has taken over 15 months. Her photography and editing made this book possible.

Early Design

The primary design concept work started in August 2011 at a meeting with Reverend Jeffrey Shilling Gill, Verger Catherine Rosen, and Allen Townsend in the sanctuary at Christ Church. The Sanctuary was being renovated at the time, The renovations included a new balcony and organ, new lighting and floor coverings, and changes in the chancel area to make it more spacious. At that time, the work in the chancel had started, mostly by removing items. The reredos had been removed; the windows on the back wall were being uncovered; the choir pews, organ console, communion rail, and pulpit had all been removed. The chancel floor had yet to be extended into the nave.



Sanctuary under renovation in August 2011

The objective for the altar was to replace the current box design altar with a new table style altar. The new altar would be centered under the arch and be usable facing the nave or facing the apse for small services. 39" was considered a good height. The new altar would also be movable to clear the chancel area for other events.

Early Design



3D computer models were made to develop ideas, presentations, and patterns

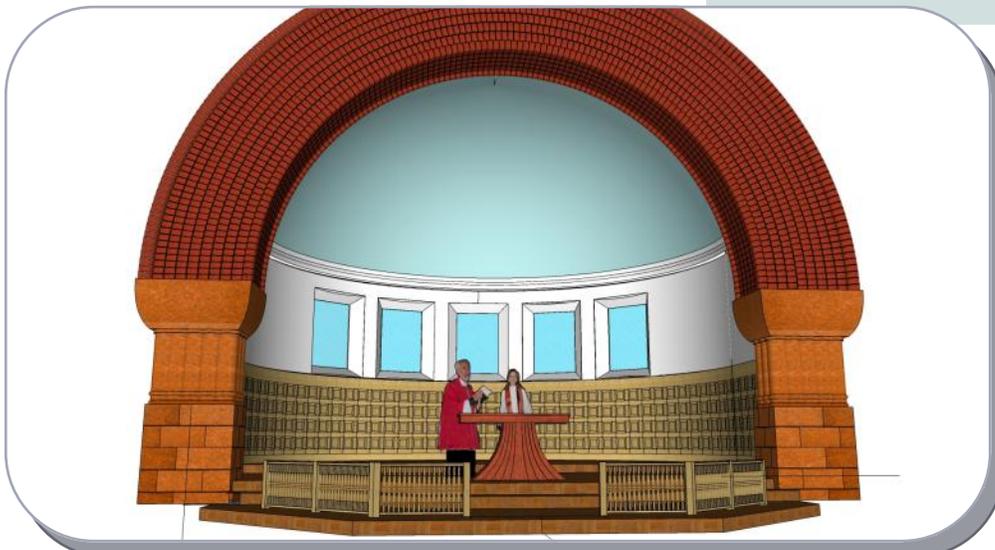
A number of hand sketches were made. The sketches were intended to explore different styles for discussions on esthetics and functionality. Some of these ideas were developed into 3D computer models.



A 3D computer model of the chancel area of the church was also developed to enable viewing the altar sketches in the context of the new space.

3D was used so one could rotate the model and look at it from various positions.

3D Sketches of various styles of altars considered



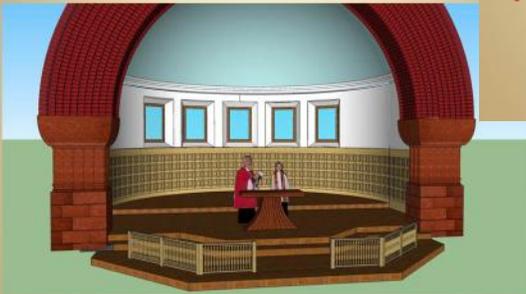
3D computer model of chancel

The computer models were then built into power point presentations which were discussed with the Church staff, the parish, and the vestry.

Altar Sketches

By
Allen Townsend
October 16, 2011

Altar 3 in Chancel



Design Process

- Requirements
 - Test size and function
- Sketches
- ¼ scale models
- Full scale mock up
 - Full scale drawing;
 - Build jigs and fixtures
 - Not final material or joinery
- Final Build

Requirements

- Table; not box design
- Two sided (to be used facing nave and apse)
- Movable by two people
 - Desirable to incorporate casters
- 39" high
 - Room for feet when standing at the altar
- "Fit" in surroundings
- Focal point in chancel
- High quality design and construction
- Design which will be functional and appreciated for many years.
- Other requirements ??? This is the time to bring them up

Proportions and Materials Recommendations

- Classical proportions
 - Golden Ratio; .61804
 - Found in nature, used in architecture since the Parthenon; art; furniture; music
 - 39" high implies 63" wide and 24" deep
 - Current Sanctuary Altar: 40"h x 84"w x 25"d
 - North Chapel Altar: 36 ½"h x 60"w x 22 ¼"d
- Mahogany as primary material
 - Stands out from white oak background
 - Reddish color works well with brick and brown sandstone

Part of Presentations to Parish and Vestry



A quarter scale model of the altar design which seemed to best meet the requirements both functionally and aesthetically was built using patterns produced from the computer model.

Quarter Scale Model built for presentation to the vestry

Design intent and features

This pedestal altar was designed to be a strong focal point for the sanctuary and to bring your eyes upward to the top of the table. When he saw the model, Brother Kevin Hackett said it made him think of a tree, sturdy and solid like the architecture of the sanctuary, and it directed his eyes up to the top of the table and to the heavens above. In another discussion on this design, Michael Marcinelli said it made him think of a medieval painting with light rays emanating from a holy object.

This design was based on classical proportions which are known to be pleasing to the eye and has sweeping arcs which are reflective of the arches in the structure of the sanctuary. The design also has visual mass to provide a focal point in the massive Richardsonian architecture of Christ Church. Functionally, the altar can be used from either side as well as by people standing around it as they would the Lord's Table. When necessary, it can be moved by two people.

Mahogany was chosen for the primary wood because it enhances the focal point of the altar by tying in with the red brick and brown sandstone in the front wall of the sanctuary and yet it stands out from the back wall of the chancel which is paneled with white oak. Mahogany was also the primary material of the first communion table used in Christ Church Andover.

Australian lacewood was used as an accent. Lacewood's characteristic lace pattern provides a contrast to the more linear grain of mahogany. The background color of lacewood is a reddish brown which goes well with the mahogany.

One side of the altar is marked with one of the oldest symbols for Christ, Chi-Rho. This Chi-Rho is carved in Gabon ebony and inset into the face of the mahogany. The letters are carved with flourishes that reflect the ornate ironwork in the ceiling beams of the sanctuary.

Final agreement to go ahead with the design concept came in mid-December 2011 at a meeting we had with Reverend Jeffrey Gill and Brother Kevin Hackett from Saint John's the Evangelist, the Episcopal monastery in Cambridge.



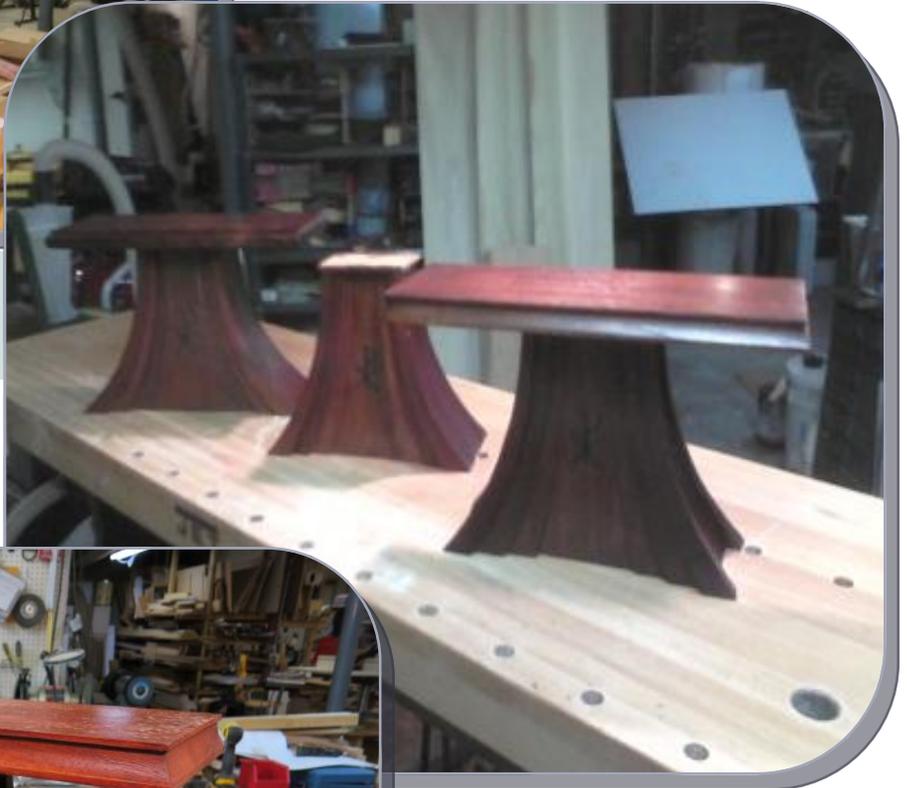
Lacewood grain pattern

Quarter Scale Models



Assembling a quarter scale model

During January 2012, two additional quarter scale models were built to explore variations in the basic design and structure to make the altar lighter both visually and physically.



*Progression of quarter scale models
(First in back, Last in front)*



3rd and final model

The third model was accepted as the final design.

Prototype

The next step was a full size “prototype” which was made primarily of poplar wood. This prototype was built to test the weight, structural integrity, and functionality of the design. It also served as a vehicle to develop patterns, fixtures, and techniques which would be used in building the actual altar.



Parts are clamped in place on the assembly table and measurements are made for cuts.

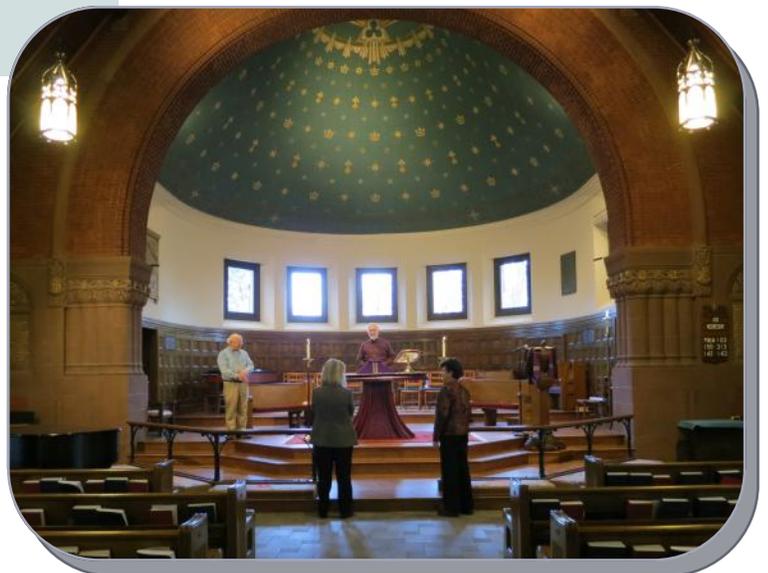
Setting up and using an assembly table to fit parts together was invaluable in the construction of the altar. The assembly table is level and flat, and allows for temporary supports to be added. This enabled parts to be accurately placed and held in three dimensions for fitting and taking measurements.



Rev. Jeffrey Gill with Carol and Allen and the prototype in the workshop

Reverend Jeffrey Gill came over to inspect the prototype and to test its functionality and ease of use.

In mid-February we brought the prototype to the sanctuary to see it in place. It was after this, that I was ready to begin building the altar using the mahogany, lacewood, and ebony.



Viewing the prototype in the sanctuary

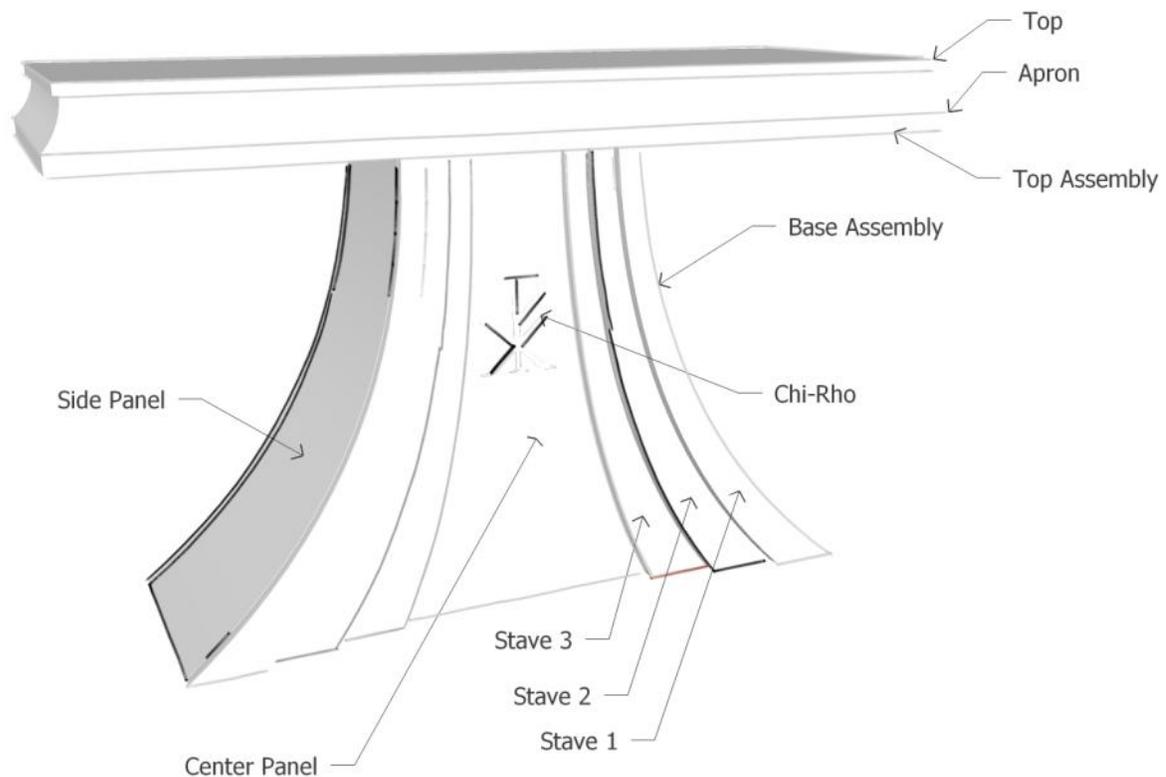
Building the altar overview

Building the actual altar required a large number of steps and over 130 pieces to complete. 94 different pieces went into the assembled base. The top assembly includes another 38 pieces. These numbers do not include the quarter scale models, the prototype, or the many patterns, jigs, and fixtures.

The base was built first. It is the most complex and required building four of each of the three staves, two center panels and two side panels, as well as an internal structure to make it rigid. Then the top was built with an apron sub assembly. Lastly, the base and the top were bolted together. Almost all the surfaces on the altar are curved. The only flat surfaces are on the top assembly and the bottom of the altar itself.

A wide variety of woodworking procedures were use including steam bending, bent laminations, vacuum forming, inlay, and re-sawing.

The sketch below identifies the names of the parts used in the altar.



Steam Bending

The first step in building the base was steam bending the wood for the staves. In a steam bent part, the grain of the wood follows the curve of the part. This improves both the appearance and the strength of the part.



Taking wood out of steam box.



Loading the hot steamed part for bending

To bend wood, you steam it for an hour for each inch of thickness of the part, and then quickly bend it against a form.

A steel strap was used to keep the outside fibers of the wood from stretching (wood splits when it is stretched) and forced the wood to compress as it bent to the form. The parts to be bent were very thick, approximately 1.8 x 4.5 inches in cross section. To make the curve, the inside edge of the stave needed to compress 2 inches.

Bending was a family affair. In the pictures, you see my father-in-law, Charles Reid, helping. Carol was also helping, and taking pictures as well.



Bending the mahogany part with a come along for added force



The bent stave clamped on the bending table. There are small compression failures making the part unusable.

We made six attempts with varying shapes, steaming time, and wood grain before deciding to use thinner pieces of wood. One inch thick mahogany is reasonably steam bendable. The pieces can then be glued together to make the part. This is similar to a “bent lamination” approach which slices the wood into bendable pieces and then glues them together to create the part. In the case of the altar, the laminations were too thick to bend without steaming them first.

The tapered slats were cut on the band saw with a taper jig.



The left piece is glued up with straight tapers; the right piece is glued up with tapers which have been shaped with the planer.

The piece on the right is more graceful.



The Slats are cut on the band saw with a tapering jig

Tapers were steam bent and glued to form the first stave.

By further shaping the tapers with a special jig in the planer, a graceful shape with a uniform grain was obtained.

Steam bending

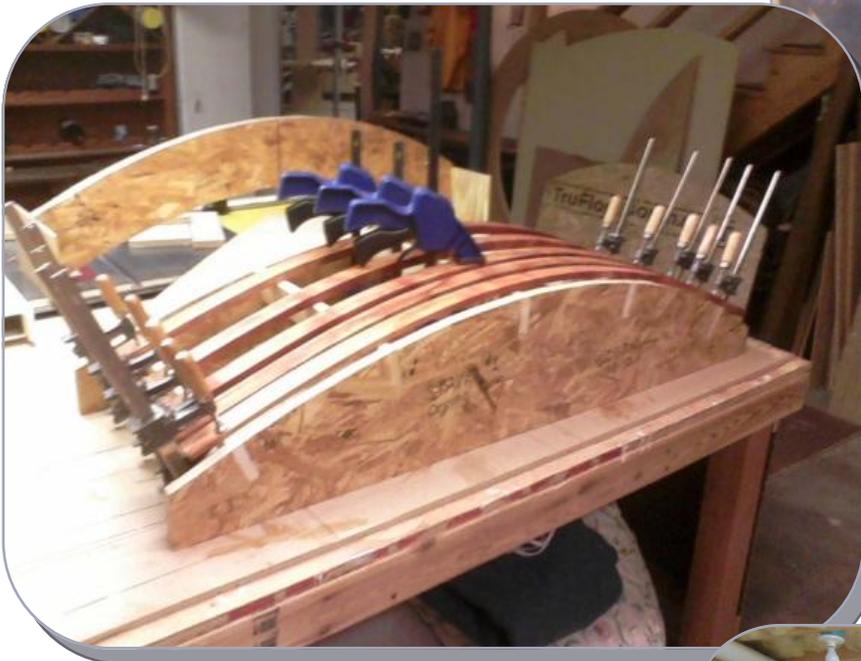
The tapered slats were steamed and individually bent on the form and left to cool.

The parts were then moved to a specially built drying rack to hold them in the right shape until the moisture content equalizes again, about two days.



Steam bent tapered slat on the bending table

Once dry, the slats were glued together using a form to hold them to the appropriate curve. The glue is a plastic resin glue which is very strong and does not creep over time. This was heated for at least 8 hours for the glue to set.



Steam bent slats were dried on a special rack until the moisture equalized.

This process of slicing the slats, shaping, steaming, bending, drying, and gluing was repeated for each of the four outside staves. A new gluing form was made to the curve for the second stave, and the process was repeated four more times with lacewood slats. A third gluing form was made for the third stave, and four more mahogany staves were made in the same way.



A form was made for clamping the glued and tapered slats. Lots of clamps were used to keep the pressure uniform.

We were able to have several groups come to our house to see the altar building in progress.



The Men's Ministry group inspects the prototype



A learning experience for the children also



Guess Who's Coming to Dinner Group

Shaping the staves



After cleaning, jointing, and thickening each staff; each face was cut to a shallow curve so that they are not flat. The maximum depth is small, but light will reflect differently off of the curved surface.

The face of each staff was further shaped with a pull shave, spoke shave, and scraper.

The face of each staff was cut to a shallow curve.

Staff 1, outside staves, are concave. Staff 2, lacewood staves, are convex; and staff 3, interior staves, are concave.



A pull shave does the primary concave shaping



The inclined edges of the corner staves are shaped with a hand plane.

the side. It is also wide at the bottom and tapers to the top. All of the surfaces are shaped in proportion to the changing width of the staves.

The shaping of the staves was done by hand because it is a very complex set of curves. The face of the staff is dished out and curves to



Carving the cove in one of the corner staves

Stave joinery



Cutting the bottom of the staves to the correct angle on the miter saw

Once completed, the staves were clamped in place on the assembly table, marked for length and then cut on the miter saw. Wood templates were used to hold the staves at the same angle they were on the assembly table, and the miter saw was tilted to give the required compound angled cut.

The parts were assembled on the assembly table so that the joinery for mounting the top could be marked.



Assembly table used to mark joinery for top



Cutting joinery in top of the staves

Hand cut joinery on the top of the staves will hold rails which are part of the top assembly.



Joinery in the outside staves. Note the slot for the side panels as well

The top assembly will fit into this joinery and be bolted to the structural center column in the base of the altar.

Front and Back Panels

The front and back center panels provide part of the central core structure. They were made by re-sawing thick mahogany veneers and laminating them on plywood for strength and stability. Straight vertical grain mahogany was used to provide a contrast to the sweeping curves of the surrounding staves.

The front and back panels were shaped to the same bow that was sawn into the front face of the staves. A form was made by taping strips of different thickness onto a reinforced platen. Layers of mahogany and plywood were then glued together over this form with a vacuum press.



Slats of different thickness are taped to a flat board to shape the form for the front and back panels.



Vacuum Press forming the curved mahogany front and back panels

pump. The vacuum pump removes the air in the bag so that about 14 pounds per square inch (over 5,000 pounds total) of pressure is applied to the stacked laminations. Plastic resin glue is again used to assure that the panel keeps its shape over time.

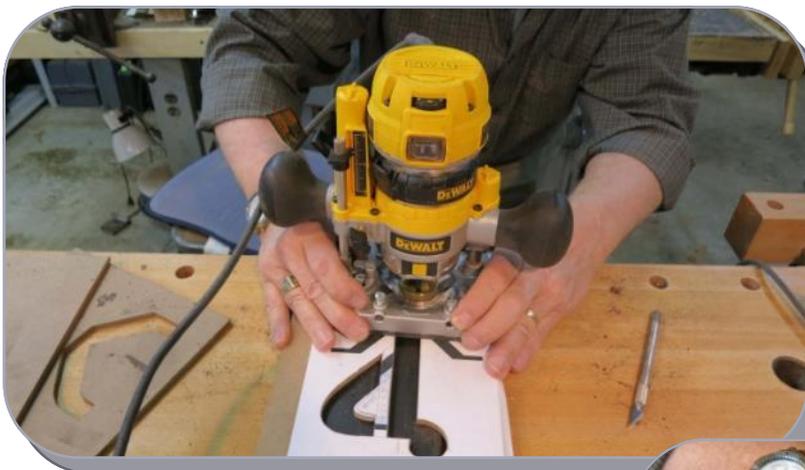
The result is a curved mahogany panel.

Stiffeners are glued to the back of the panels. These stiffeners provide part of the structural box core of the altar.

The vacuum press is a heavy (very stretchable) plastic bag which is attached to a vacuum



Stiffeners were cut to the curve of the panel and fastened to the rear of the front and back panels



The front of the altar has the Chi-Rho symbol for Christ made in ebony and inset in the mahogany. A practice piece was done, and then the final. The ebony is sliced in 1/4" thick boards and the Chi-Rho was cut from these with a router using templates made from the computer model as the pattern.

Routing the ebony parts with a template

To do the inset, the pieces of ebony were glued to the mahogany, and the outline was cut into the wood by hand. The ebony pieces were removed from the mahogany. The mahogany inside the scribed marks was then removed to a depth of approximately 1/8" inch. The edges were done by hand so that the pieces of ebony fit like puzzle pieces.

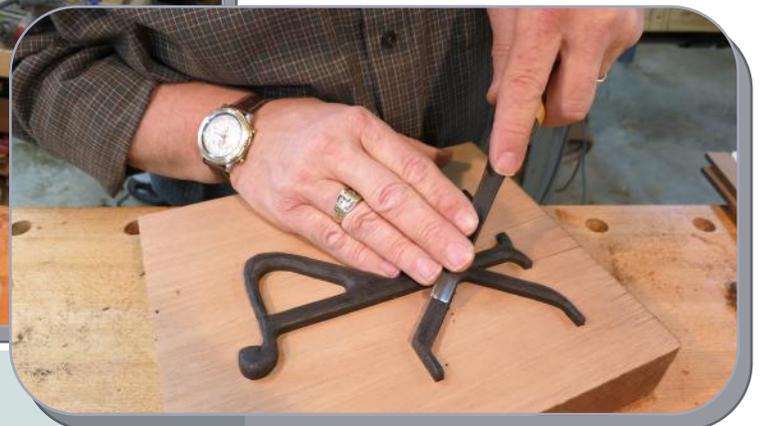


Marking the edge of the ebony pieces



The wood behind the ebony is removed first with a router, and then the edges are carefully cleaned with

The ebony Chi-Rho is then epoxied in place and chip carved to shape and texture the surface.



Side Panels

The sweeping side panels of the altar were created by laminating layers of mahogany and plywood, again using a vacuum press. The mahogany was chosen to be almost straight grain and is book matched to provide a linear and symmetrical grain pattern up the side of the altar.

To make the form, the curved shape of the sides was transferred from the assembly to a pattern which was then cut out, smoothed, and replicated via pattern routing.



Pattern routing the stiffeners for the form for the side panels

Pattern routing uses one piece as the pattern, and has a second piece clamped on top of it. The router bit has a bearing which follows the shape of the bottom piece, and cuts the top piece to match it. It makes exact copies of the pattern.



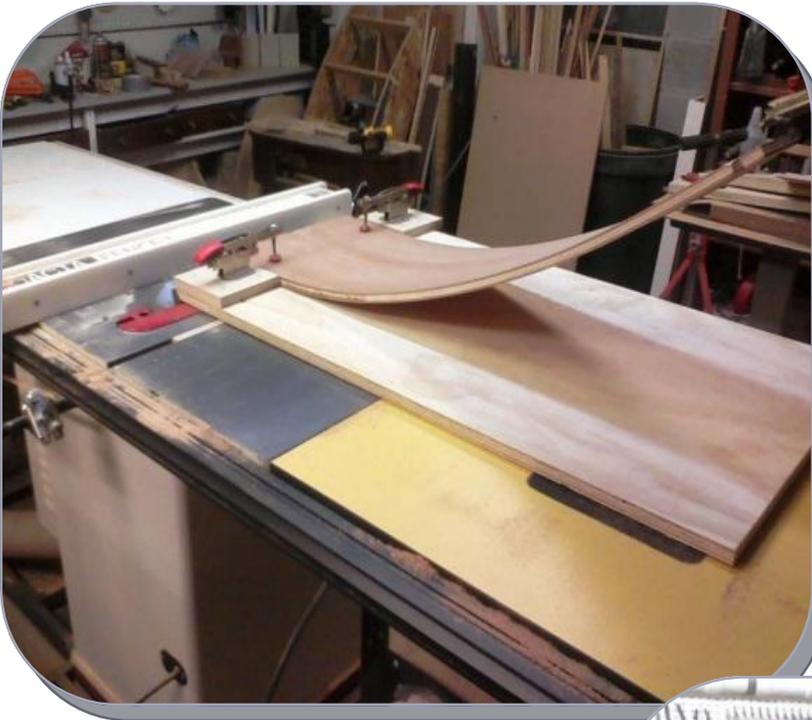
Vacuum press form for the side panels

The form for the sides was made by spacing and reinforcing these 9 ribs and covering the assembly with a caul (or flat sheet) which is not shown in the picture.



Vacuum forming the side panels: The vacuum pump is in the lower left

Side Panels and Staves

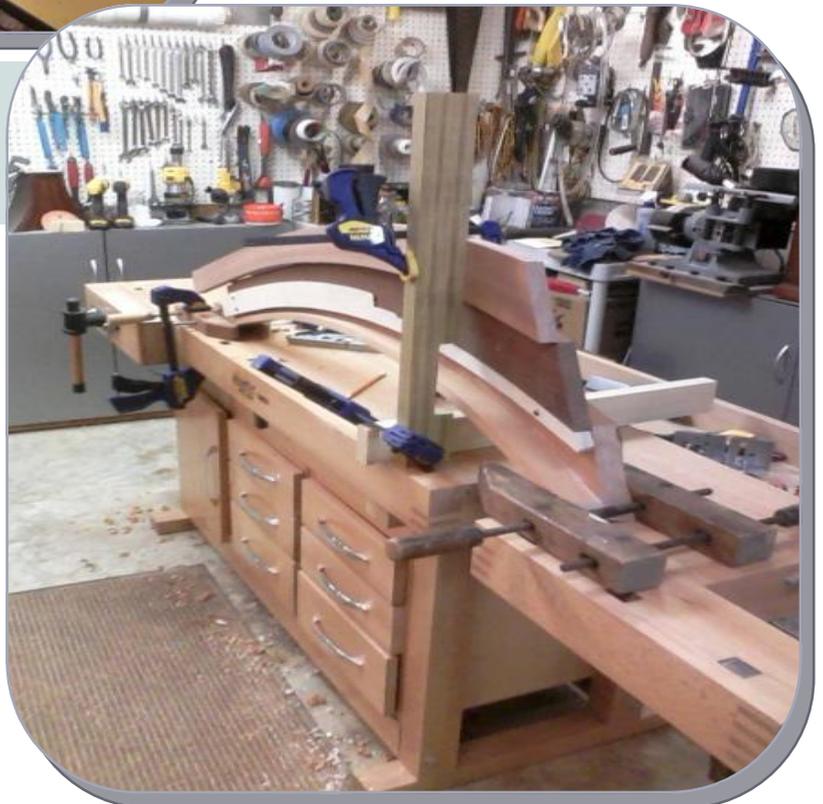


After the glue sets, the resulting side panels are stiff and shaped to fit into slots in the outer staves.

These side panels were clamped to a jig to cut them to length at the correct angle.

Cutting the bottom of the side panels to length at the correct angle

The staves were assembled on the bench with references to assure that they fit perfectly to one another while being held so the flat back surfaces are vertical. The back is the only flat or reference surface on the staves. The fit was fine tuned by rabbeting the back of one stave to fit with the curved face of the mating stave.



Fine tuning the fit of the staves.

Apron for the top

The top of the altar was made next. It includes an apron with rails to connect to the base, and the flat top that sits on the apron.



The cove on the apron is cut on the table saw

Angled cuts on the table saw made the cove in the apron for the top of the altar. The blade was tilted so the cut is elliptical. This was done so that it reflects the overall shape of the base of the altar. The bottom edge of the apron is thicker than the top piece to provide visual weight and grounding to the assembly.



The apron joints are reinforced to support lifting the altar

Slots on the inside of the apron were used to mount the top and also to add a finger grip for lifting and moving the altar.

This apron is designed to be prominent to give the top visual weight and mass to better fit with the massive beams in the sanctuary. It also provided the strength for two people to lift the altar by the apron.



The apron cove is elliptical to reflect the overall shape of the base of the altar



The apron was glued and squared

The top of the altar was made from one mahogany board which was 12" wide and 2" thick. It was selected from a board which had opposing cathedral grain patterns. The length is cut so that these cathedral patterns are balanced on opposite ends of the board, pointing towards the center.



The two pieces were "opened" like a book, planed, and joined to form the wide top. The grain pattern continues the theme of pointing to the center of the altar.

The board for the top is sliced in half on the band saw



The altar top (with finish) shows the book matched symmetrical grain

Getting ready to apply the finish

Some of the hand work on the altar pieces was done during the summer in Maine.

Sailing and swimming were important distractions.



Fine tuning the shaping of the staves



Getting a start on finish sanding



Making samples of dye and testing the oil and urethane varnish

The Finishing Process

The altar was fully assembled to ensure that everything fit perfectly before the stain and oil-urethane finish was applied.

The final finish process included sanding, applying a dye, and a thin oil-sealer designed to enhance the grain. An oil-urethane was the end finish. Most of the parts have 5 coats, the top has more. Each coat was allowed to dry for at least 12 hours and sanded between each coat of urethane.



The apron without the top was bolted to the base



Final assembly before applying the finish

Applying the Finish and Reassembling

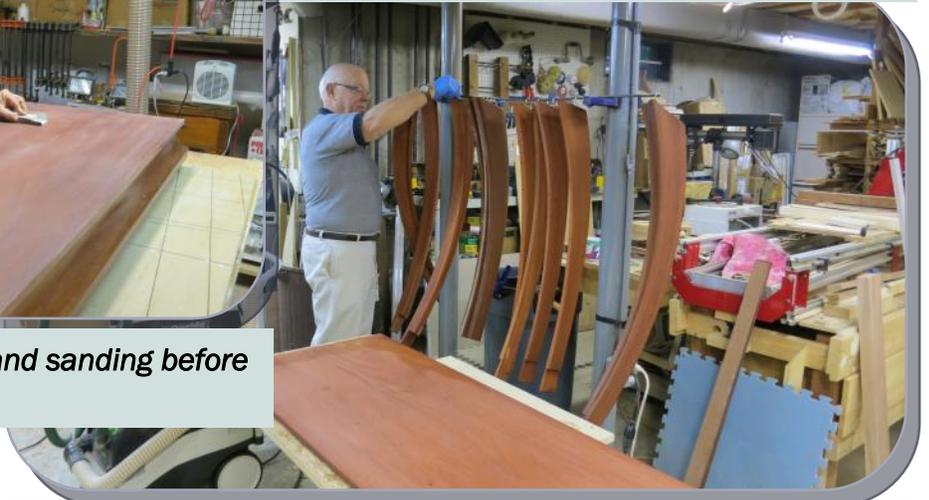
The altar was disassembled into approximately 30 pieces. Each part was finished separately so that all sides could be sealed. This also assured that the seams between pieces would be clean and sharp when it was reassembled.



Starting the hand rubbed finish



The top gets extra coats of varnish and sanding before it is polished



The staves are sealed on all sides and hung to dry



Altar base upside down showing internal structure

The last step was to assemble the altar for the final time using glue this time.



Test fitting the pieces after the finish is applied

Completed Altar

Reverend Jeffrey Gill came by to view the completed altar in the shop.



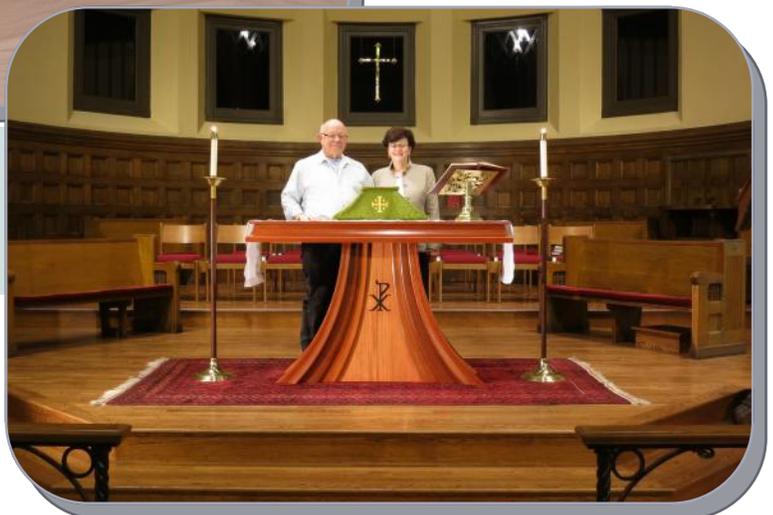
Rev. Jeffrey Gill viewing the completed altar



Our son, Stuart, came from Portland Maine to record the completion of the altar.

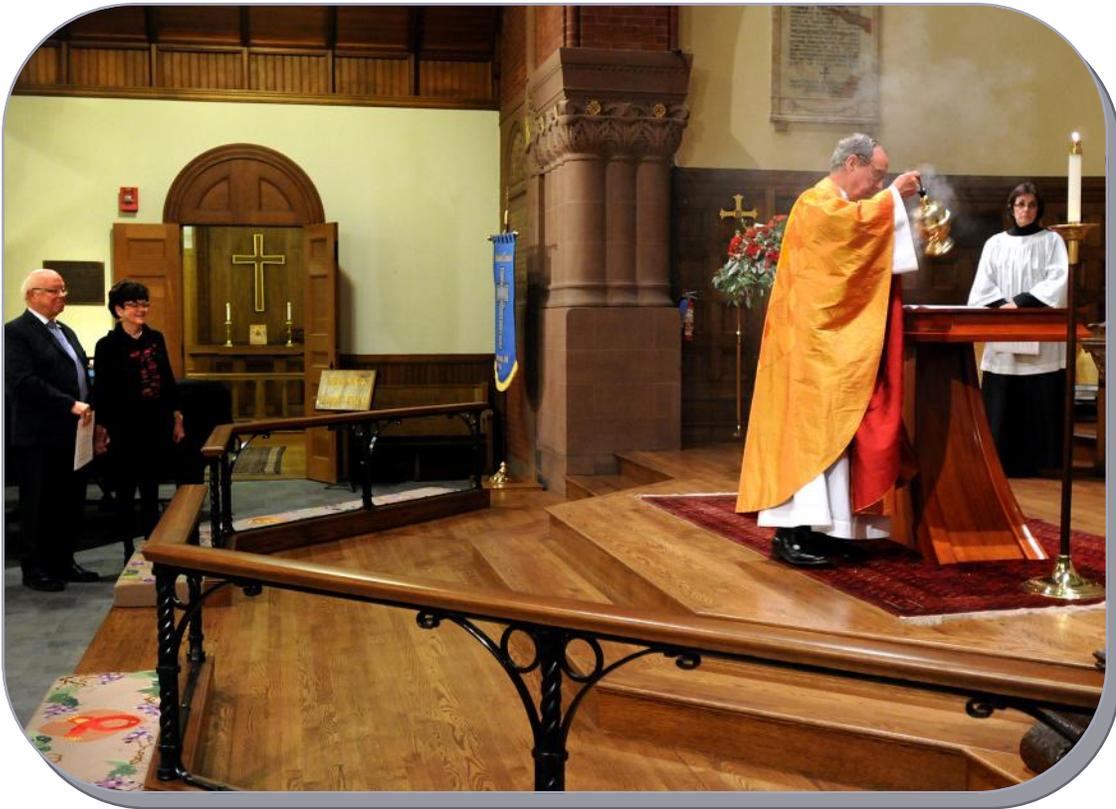
The altar photographed by Stuart Townsend in the garage studio

The altar was taken to the sanctuary for more pictures. The top came back to the shop for more work before the dedication service.



*Allen Townsend and Carol Reid with the altar
November 2012*

The Altar Dedication



The altar was dedicated by The Rt. Rev. M. Thomas Shaw, SSJE, Diocesan Bishop, at a special service on November 28th, 2012

Bishop Thomas Shaw incensed the altar

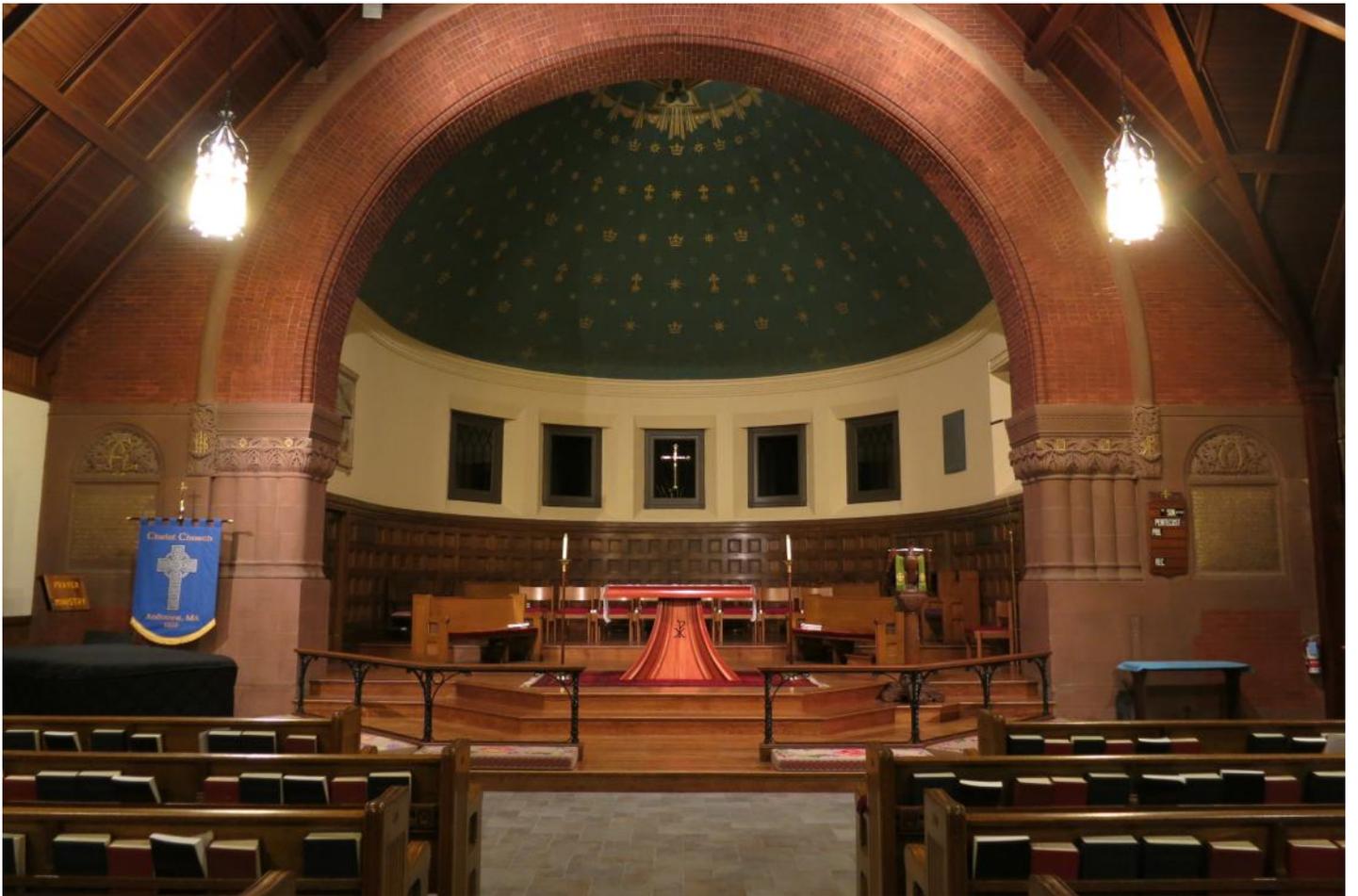
From the Iona Eucharist Liturgy

This is the table of company with Jesus, and all who love him. It is the table of sharing with the poor of the world, with whom Jesus identified himself. It is the table of communion with the earth, in which Christ became incarnate.....

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Reverend Jeffrey Shilling Gill, Bishop Thomas Shaw, and Reverend Kit Lonergan at the dedication service



About the Woodworker:

Allen Townsend has always had a passion for building and creating things. His interest started as a boy while helping his father build things. Allen has been working with wood for many years. His first project was a box he built while in high school to organize his drafting instruments. His first furniture piece was a mahogany English butler's table built in 1972. He learned casework construction by building 18th century reproductions of a Queen Anne high boy and a low boy dresser from the Bartley collection . He took his only woodworking class at the Center for Furniture Craftsmanship in Rockport Maine in 2010. That class provided inspiration and some of the techniques used in building this altar. His current work including this altar are influenced by the works of Michael Fortune and Jere Osgood.

Allen primarily does furniture pieces intended to be unique and enduring. He likes to use classical proportions and make variations of classical designs modified to include graceful curves. He has designed and built a number of pieces including some for commissions. His work includes dressers, chests, cabinets, desks, many styles of tables both large and small, bookshelves, display shelves, and a variety of smaller pieces like a jewelry box and wedding cake stands. All are individually designed pieces and built in some combination of hardwoods such as cherry, mahogany, birdseye maple, and lacewood. Recent pieces include a coffee table with a walnut base with three way miter joints and a cherry top with a wenge inlay; as well as a pair of entry tables with stylized cabriole legs in cherry and lacewood. An unusual piece was a six foot tall Queen Anne style birdcage.

This altar is his second "public" piece. Earlier he designed and built two semi-circular bookcases in oak and cherry for the South Branch of the Peabody Institute Library. These bookcases were donated in memory of Dorothy L Reid, Carol's mother.

Allen was born and raised in Overland, Mo, a suburb of St. Louis. He earned a BSME at the University of Missouri at Rolla, a Masters in Mechanical Engineering from Massachusetts Institute of Technology, and an MBA from Boston University. His professional career was with Bell Telephone Laboratories and later Lucent Technologies first as an engineer, and then as a technical manager.

He lives in Andover with his wife, Carol Reid. Carol is a financial executive and serves on the Board of Directors of Enterprise Bank and other non profit and educational boards. They have attended Christ Church in Andover for many years and have two sons, Justin and Stuart.