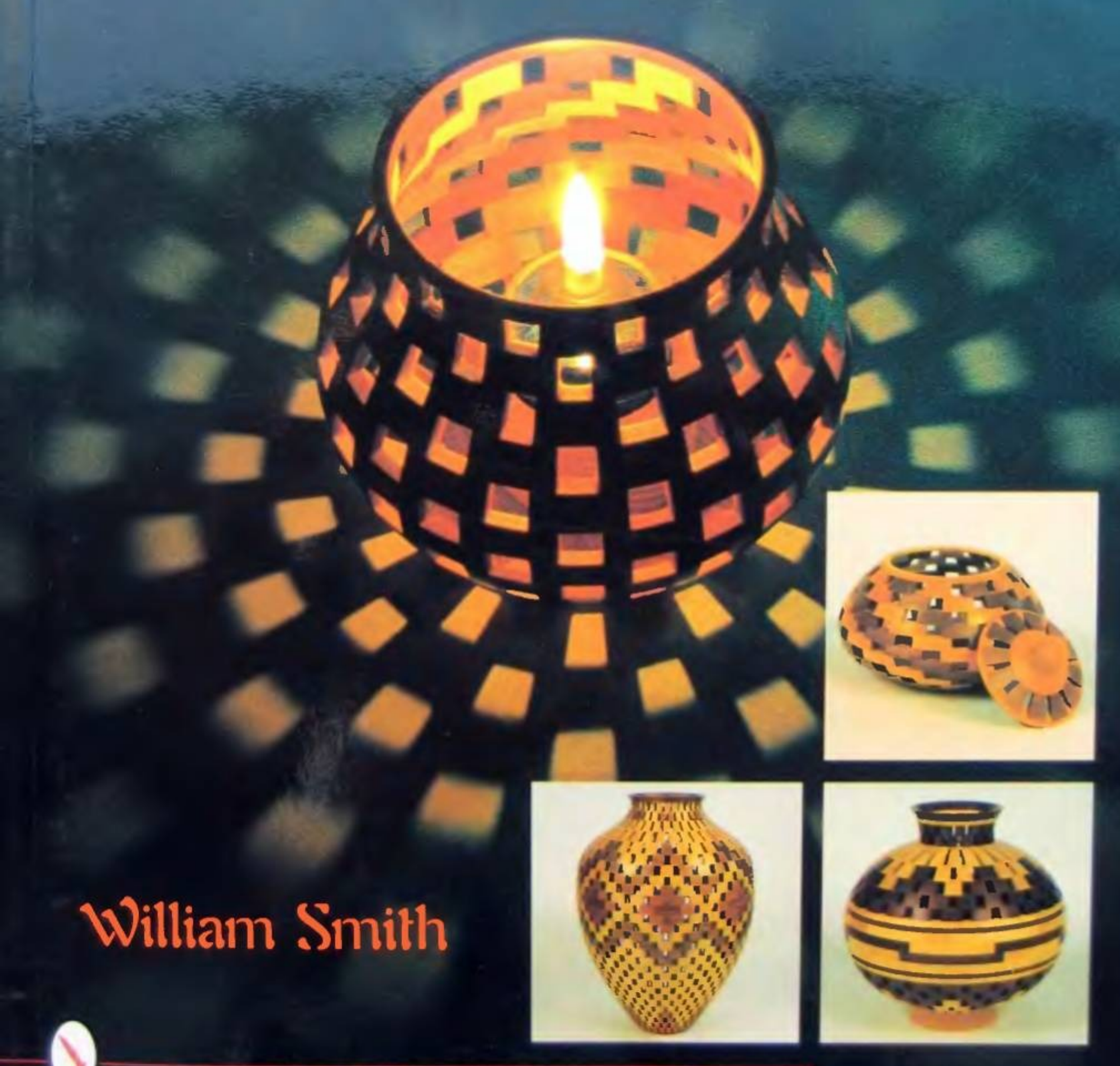
Segmented Wood Turning



William Smith

A Schiffer Book for Woodworkers

Segmented Wood Turning

William Smith

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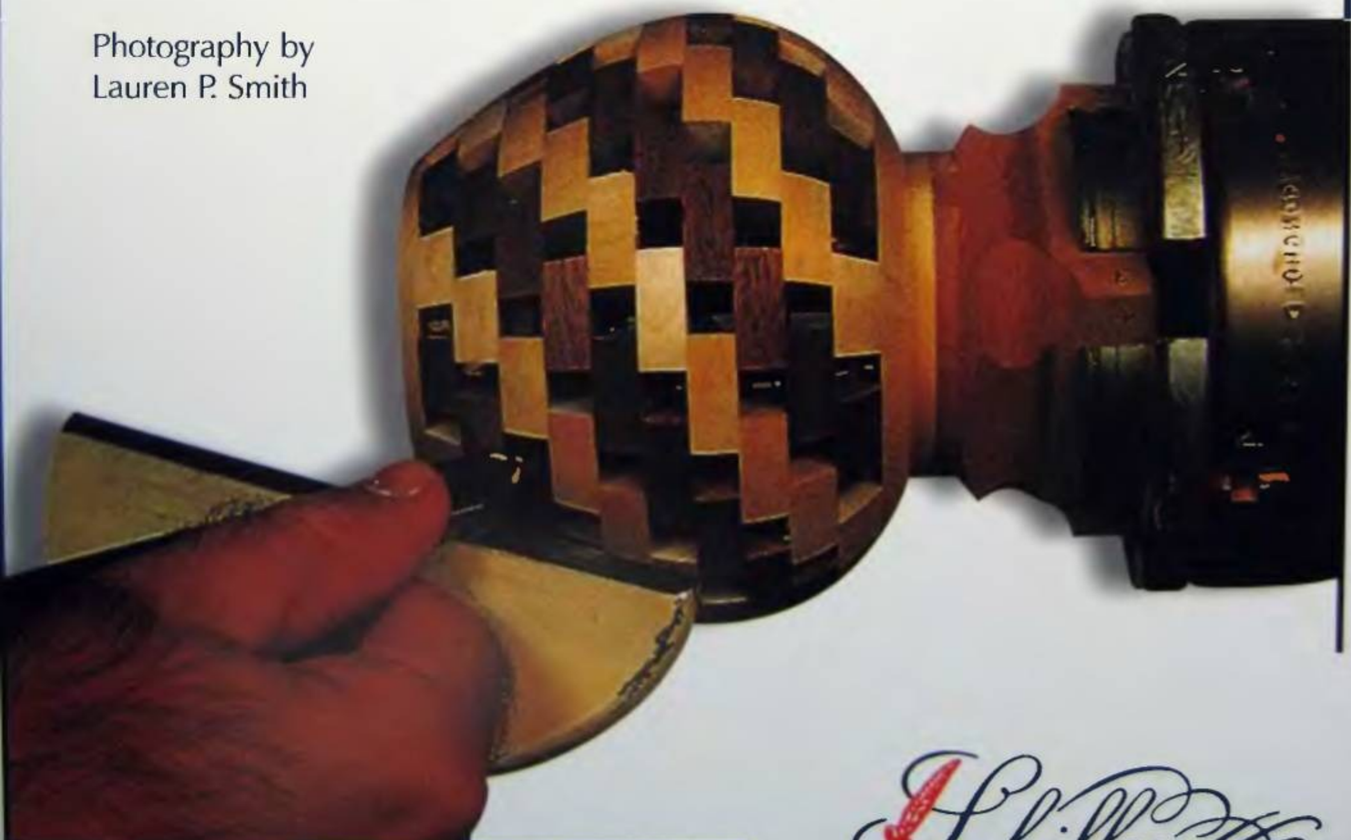
Lauren P. Smith



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Dedication

This book is dedicated to Margaret and Gene Smith for instilling in me the character and qualities needed to see this project through to completion, and to my family, Lynn, Scott and Lauren, for their unending encouragement and understanding.

Contents

Introduction 3
Chapter 1: Theory 4
Geometry For Open Segmented Turnings 4
Design Principles for Open Segmented Turnings 6
Chapter 2: Making The Jigs 8
Index Wheel 8
Positioning Jig 12
Chapter 3: Wood Selection, Preparation, and Cutting 16
Wood Selection 16
Wood Preparation 18
Cutting Segments 20
Chapter 4: Construction 24
Chapter 5: Turning 32
Safety 32
Tools and Turning 32
Wall Thickness 34
Finishing 34
Chapter 6: Advanced Techniques 37
Split Construction 37
Dish With Segmented Lid 45
Appendix I: Chart To Find Dimension C 52
Appendix II: Index Wheels 53
Gallery 59

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Introduction

Open segment construction is a relatively new and fascinating concept in the wood turning field. I first saw a piece in 1997 made by Yosh Sugiyama. It was a small turning in a friend's collection that stimulated my interest. Over several weeks of experimentation I developed the system described in this book. I continue to use this system and have found it to be flexible enough to handle all of the variations and ideas I can dream up. In 1999, I demonstrated the system at the American Association of Woodturners (AAW) symposium in Tacoma, Washington and since then many turners have used it successfully.

Open segmented turnings are similar to traditional segmented turnings except there are gaps between each segment. As a result, the techniques used for traditional segmented turnings do not work. An entirely new process is needed and is described in this book. Picture 1 shows a simple open segmented turning. Compare this to the normal segmented turning in Picture 2. Note the spaces between each wood segment in Picture 1.

1. A simple open segmented turning consisting of 122 pieces of maple and walnut. We will use this turning to demonstrate how to design and build an open segmented turning.

2. A traditional segmented turning. Note that each segment is glued to the segments on either side. Compare this to the spaces between segments in the turning shown in Picture 1.

Picture 1 also shows the project I have chosen for this book. It is a simple and relatively easy project made from walnut and maple and contains 122 pieces. The tolerances are not critical, the piece builds quickly, and it is easy to turn. It will teach you all of the principles and techniques needed to make a wide variety of styles. With each design you can make many variations simply by altering the thickness of the wood you use and by using your imagination during turning. Picture 3 shows four turnings all made with the same basic design. When you become comfortable with this basic design you can use more elaborate designs to produce some very creative work.

3. A variety of turnings may be made from the same design.

Our book project consists of ten layers made of twelve segments each and a solid piece for the base and the rim. You should be able to complete this project in a weekend. You do not need any special equipment or turning tools other than the easily constructed jig described in the chapter on jigs. I have made the book project on a wide variety of lathes ranging from Jet and Vicmarc minilathes up to OneWay's 2436.

I will start with a little theory and geometry. You can skip this section when making the book project. If you want to get more creative, however, you will need to understand the theory section. Don't be scared off by the theory. It is fairly simple and it lays the groundwork for endless variations of open segmented turnings.

There are two simple jigs that you will need. Construction details are given in the chapter on jigs.

Next I discuss wood selection, preparation, and cutting. This chapter gives you the information to quickly and efficiently prepare your materials for the glue-up process.

The next two chapters cover constructing the piece and then turning it. This includes using the jigs, glue, turning tools, turning techniques, and finishes.

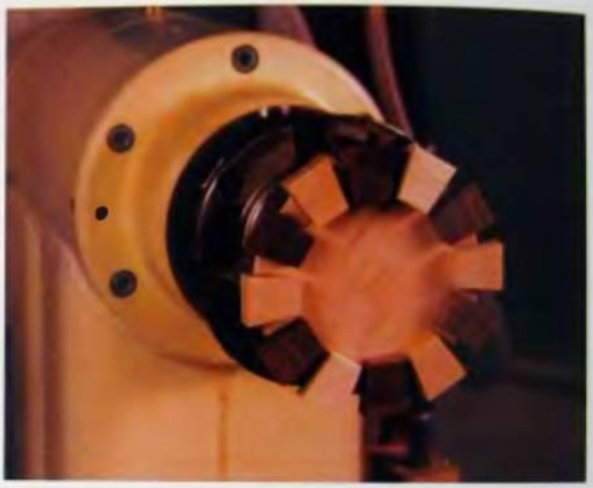
Finally there is an advanced techniques section and a gallery of some of my turnings. These last two have been included to get your mind into high gear so you can develop some really great work.

Theory

Geometry for Open Segmented Turnings

If you plan to make your own designs, you will need to know a little theory. Let's start with Picture 4, which shows a finished glue-up ready to turn. It is composed of ten layers of segments glued to a solid wood base and a solid wood top piece. In Picture 5 I have removed everything except the first layer of segments, which are glued to the solid base. The position and size of these segments is critical. This is a plan view of one layer; you are looking down on a single layer of the turning.

4. Finished glue-up ready to turn. Ten layers of segments are glued on a solid maple base with a solid maple rim.



5. The first layer glued to the base. The theory section explains how the segment sizes and positions are calculated.

Diagrams 1 through 3 show how I arrived at this layout. Start with a circle that matches the outside diameter of the layer upon which you are working. The circle is then divided into 12 equal sections of 30°. On a traditional closed segmented piece, this would be the end of the theory. On an open segmented turning, each of the 30° segments is further reduced in order to create the gaps or openings between segments. I have chosen a ratio of .67. In other words, about 1/3 of each segment has been removed and 2/3 remains. This gives segments spanning 20° for our 12 segment turning as shown by the dotted lines in Diagram 2. I have found that the ratio of .67 is a good compromise between strength and openness.

Diagram 3 shows the segments inserted into the circle. The dimension C is the length of each segment and can be found using the chart in Appendix I. As the diameter of the turning increases, the dimension C will naturally increase. It can be calculated with the formula C = Tangent (20° ÷ 2) x Diameter. Relax! You will not need a calculator for our project. I have included the chart in Appendix I so that you can look up the value for dimension C based on the diameter of the circle and the number of segments.

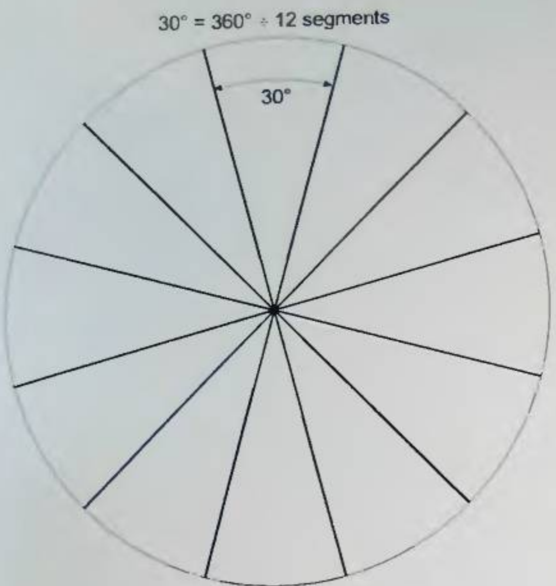


Diagram 1

The theory behind open segment construction can be visualized by starting with a circle representing the outside wall of the turning. Divide this into 12 equal sections of 30° each for a 12 segment turning.

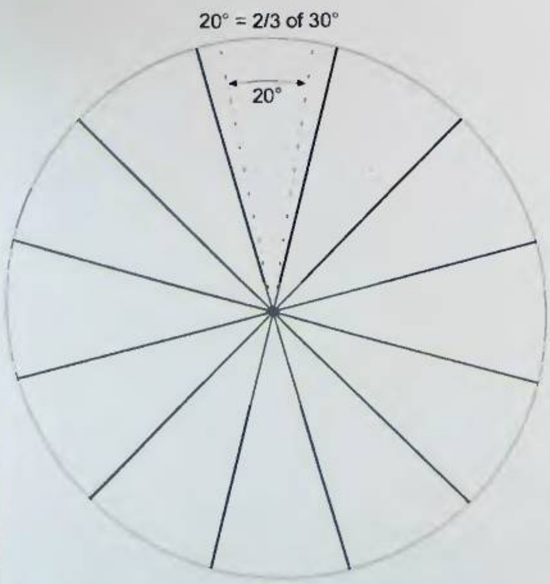
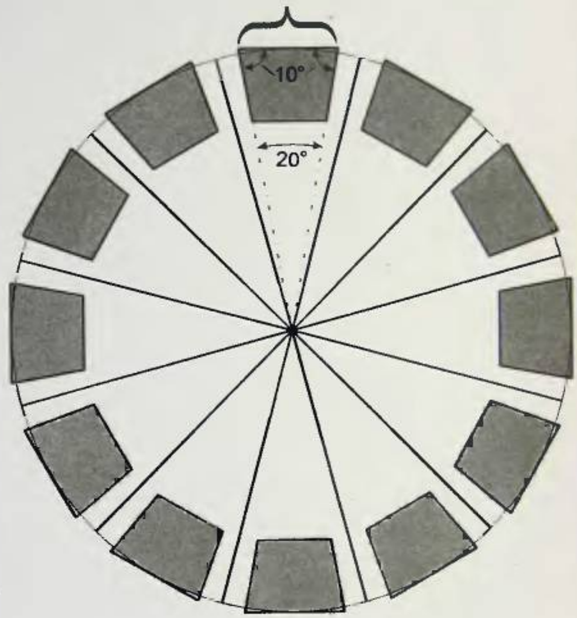


Diagram 2

To leave room for the gaps between segments, I have trimmed 5° from either side of each segment. Now each segment will subtend 20° of arc.



The outline of the segment has been added to the diagram. Compare this to Picture 5. Note the segments are cut at an angle of 10° for each side. Dimension C is the length of the segment and will vary depending on the diameter of the circle.

20° is the included angle for the segments you will need to cut out. To cut the pieces, you will need to set your miter gauge to 1/2 or 10° for a 12 segment turning.

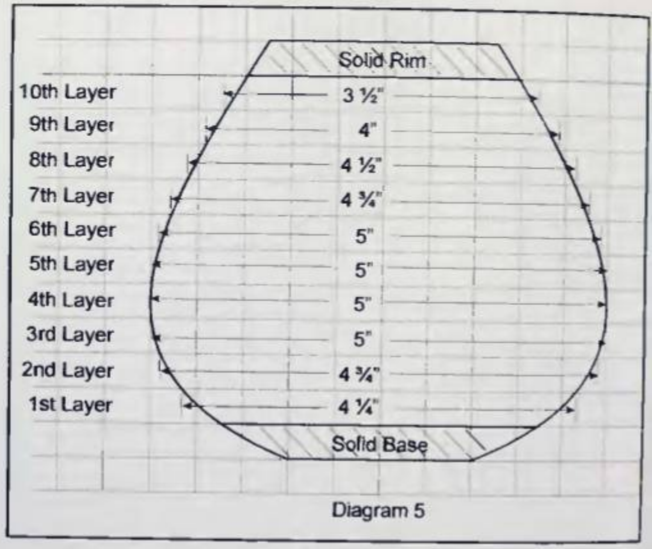
Design Principles for Open Segmented Turnings

To design an open segmented turning, think of it as a series of layers with varying diameters each stacked on top of the previous layer. Measure the diameter of each layer and then you will be able to calculate the size of the segments needed for each.

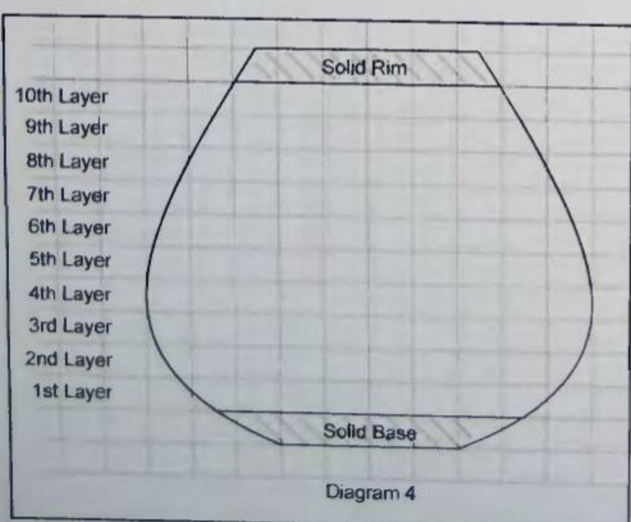
My approach to design is to lay out a side view of the turning on graph paper as shown in Diagram 4. This design is for our project turning with 12 segments per layer and 10 layers. A solid piece is used for the base and rim.

The vertical spacing on the graph paper is the height of each layer. I have chosen 3/8 inch for our project. The horizontal spacing is 1/2 inch and is chosen for convenience only. Down the center I have noted the maximum diameter of each layer. It is important to measure the largest diameter needed for the layer and always round up in order to have sufficient wood to get smooth sides when turning.

6. A profile view of the turning for our project. Note the shape of the outline.



Measure the diameter for each layer. Be sure to measure at the widest point for each layer and always round up to the next higher 1/4 inch.



I have drawn the shape of our project turning on graph paper. Compare this to Picture 6. The height of the graph paper squares should equal the height of each layer.

In Diagram 6 I have added the dimension C for each layer. This may be calculated using the formula or taken from the chart in Appendix I. You will need 12 segments cut to these dimensions for each layer. I have shown these in decimal format to 3 decimal places as identified in the chart. In reality you do not have to be this accurate. On a 12 segment turning, you can be within 1/32 inch and still get excellent results. On a 25 segment turning, the dimension C becomes a little more critical. To find dimension C in the chart, find the appropriate diameter down the left side then go across to the column for 12 segments.

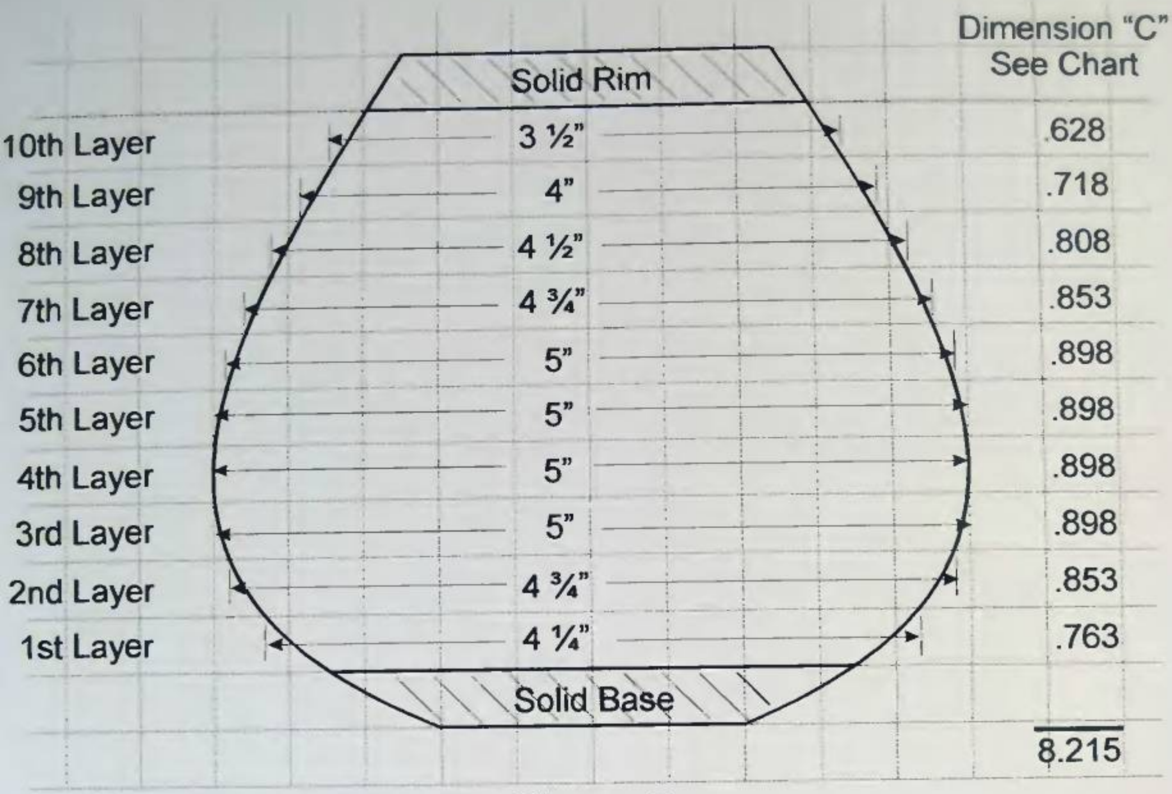


Diagram 6

I have now shown the dimension C for each layer. This is shown to 3 decimal places, which is more accuracy than needed in a 12 segment turning.

Find the column for the number of segments in your turning

Find the row for the diameter of the layer

Appendix I: Chart to find dimension "C"				
Segments	12	15	16	20
Mitre Gauge	10°	8°	7.5°	6°
Diameter				
4	.718	.570	.533	.424
4¼	.763	.605	.566	.451
4½	.808	.641	.600	.478
4¾	.853	.676	.633	.504

Diagram 7

To find the dimension C for the first layer, find the row for 4-1/4 inches and look in the column for 12 segments. If you use a rule for measuring you can round this to 24/32 inches.

Recap: Steps To Design Open Segment Vase

1. Select graph paper with the height of the squares equal to the height of each layer on the finished piece. The width of the squares is optional; I have found 1/2 inch to be convenient.

2. Draw the outline of the finished piece on the graph paper.

3. Measure the diameter of each layer. Be sure to measure the layer at the widest point and always round up to the closest 1/4 inch.

4. Based on the diameter of each layer, look up segment length C in the chart (Appendix I). Diameters are listed down the left column. Locate the diameter then read across to the column for the number of segments you are using (12 segments in our example). This will give the length of the value C for that layer in inches. Use this value to cut segments to length.

Making The Jigs

There are two attachments that you will need for your lathe in order to use my process for open segmented turnings. The first is an index wheel that incorporates a high degree of accuracy, is easy to set, and is flexible in the number of index positions available. If your lathe is equipped with a good 24 division index wheel, you can skip this section.

The other jig is a positioning fixture that rides on the ways of your lathe and is used to position the segments for gluing.

Index Wheel

Virtually every wood lathe on the market today comes with an indexing wheel—so why bother to make your own? Try using one for making an open segmented turning and you will quickly find out why. The factory ones I have used have a series of holes drilled into the largest pulley of the spindle. A pin is used to engage the holes as needed. The pin is usually in an awkward location, may be spring loaded, or hard to move. It can be rather difficult to position and glue a segment with one hand while holding the spring loaded pin with the other hand. In addition, these systems may not be very accurate due to the play in the pin mechanism and there are limitations on the number of divisions available. If you need something other than 2, 3, 4, 6, 8, 12, or 24 divisions you are out of luck. Many of my turnings are in multiples of 3, 5, and 7. The sample turning in this book is designed for 12 segments, allowing you to skip making an index wheel if desired and use the index wheel that came with your lathe, as long as it can index to 24 divisions.

The indexing system I use is not new; I am sure the idea came from a magazine article or book. It has the advantage of being inexpensive, quick to make, and very accurate with no play, plus it can be positioned easily and quickly. Best of all, you may have any set of divisions you need and both hands are free to do your gluing.

7. The finished index wheel. This is a 21 sector wheel, which I am making for a future project.

You will need the following materials:

- a copy of the 12 segment index wheel from Appendix II
- a piece of Plexiglas, 9 inches x 9 inches x 1/8 inch thick
- spray-on contact cement
- clear finish

When making the copy of the index wheel you may enlarge it to fit on 11 inch paper, however you will need larger Plexiglas to accommodate the larger wheel. The larger you make the wheel the easier it will be to use, and a larger wheel is more accurate than a smaller one. Be sure to check your lathe for clearance. For our project with 12 segments, an 8 inch wheel is sufficiently large.

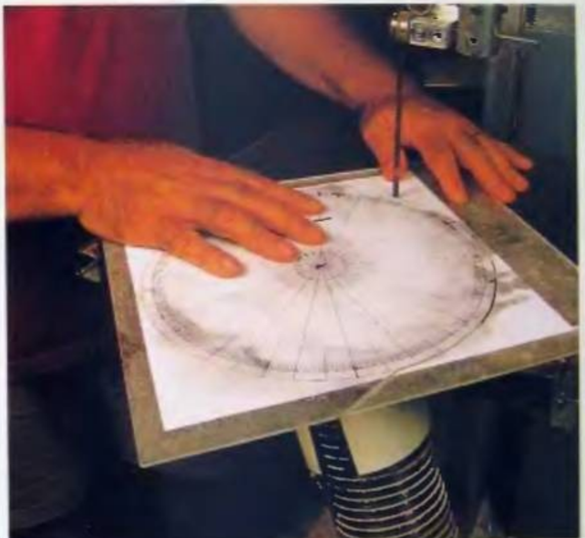
8. Materials needed to make an index wheel. Plexiglas, a copy of the wheel from Appendix II, spray-on contact cement, and clear finish.

Start by gluing the index wheel copy to the Plexiglas. Any glue that adheres to both paper and plastic will work. I have had good results using Super 77™ spray adhesive made by 3M™ Corporation. This seems to be available in my area at hardware and artists supply stores. When the contact cement is dry, spray on a coat of clear finish such as Krylon™ or Deft™. This will seal the paper and protect it from wear. Next cut out the circle with a band saw or coping saw and sand the edges until they are smooth. Refer to Pictures 9 through 13 for further detail.

9. Coat both the Plexiglas and copy of the index wheel with contact cement.

10. Allow the contact cement to dry until it is tacky, then carefully place the paper copy of the wheel on the Plexiglas. Avoid bubbles and creases and position the paper carefully. I usually cut the Plexiglas about an inch or two larger than the finished wheel to allow for positioning errors.

11. Spray on a couple of coats of clear finish to protect the paper from abrasion and tears.



12. Use a band saw to cut out the wheel. Leave a small amount of extra stock so that you can sand down to the finished size.

13. Sanding the edges is important. You want the smoothest edge possible should you accidentally touch the wheel when the lathe is running.

The final step is to drill a hole in the center of the wheel. I use a fostner bit to drill the hole so that the wheel fits the spindle of my lathe (Pictures 14 and 15). If you do not have the exact size bit, drill it undersize and file it for a snug fit. You can use either the inboard spindle or the outboard spindle if you have one and can attach things to it. I prefer to use the outboard spindle as it gets the index wheel out of the way for gluing and turning yet it is still readily available. The inboard spindle should work just as well.

14. Use a fostner bit to cut the center hole. This should be sized to fit your spindle.

15. The finished degree wheel mounted on the lathe.

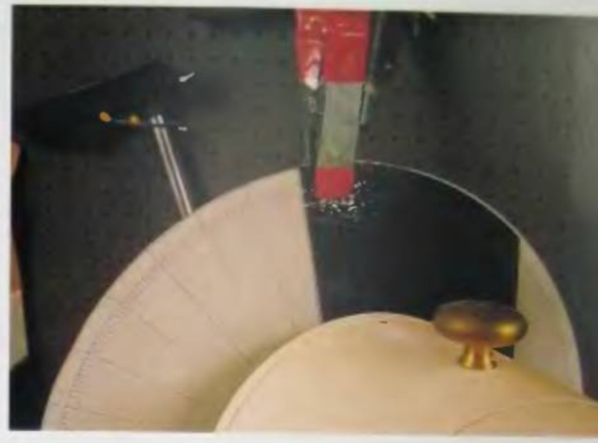
Now you will need a pointing or setting device to work with the wheel. A 2 inch to 3 inch wide piece of sheet aluminum mounted on the lathe or clamped to the tabletop for bench mounted lathes works well. On my OneWay there was a pair of bolt holes for the optional outboard ways that were in just the right location. I screwed a piece of aluminum to a wood support that was bolted to the lathe (Picture 16). On my Vicmarc minilathe (Picture 17), I bent a piece of aluminum into an L shape and screwed it to the top of the headstock. Another method is to screw the aluminum to a wood block that is held to the benchtop by a clamp (Picture 18). In all cases the aluminum pointer should be set so it is very close but not quite touching the index wheel.

16. Pointer attached to OneWay lathe.

17. Aluminum pointer attached to the headstock on Vicmark minilathe with two machine screws.

18. An alternate pointer that can be clamped to the benchtop.

To use the wheel, rotate the spindle until the wheel marking is lined up with the aluminum pointer. A 2 inch spring clamp is used to clamp the pointer to the wheel (Picture 19). To move to the next setting, unclamp, rotate to the next mark on the wheel and clamp. It takes about two seconds to reposition the wheel and once set you have both hands free to do your work.



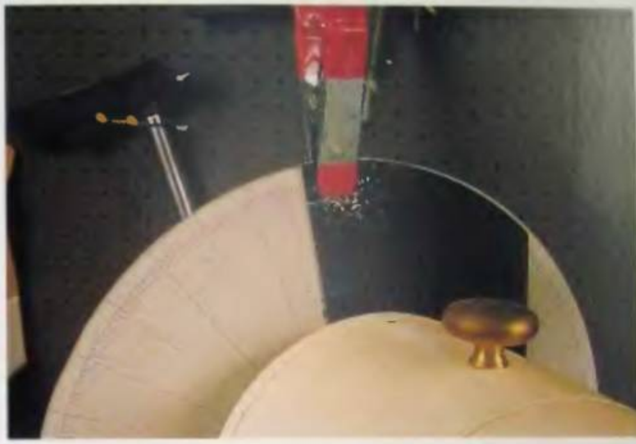
19. Use a small spring clip to clamp the index wheel to the pointer.

If you are not able to attach the index wheel to the outboard spindle, you can place the index wheel between the headstock and the faceplate. Do not use anything thicker than 1/8 inch Plexiglas for the backing material on the index wheel so it does not compromise the number of threads engaged by the chuck or faceplate. The only disadvantage other than having the index wheel in an awkward place is you no longer have steel butted against steel. This is not much of a problem as you do not need to do any heavy duty turning during the assembly stage and you could remove the index wheel to do the final turning. If you can somehow attach the index wheel to the faceplate that would also work. When the index wheel is mounted on the spindle, there is always a concern that it will shift during the glue-up. That can really ruin your day if you don't catch it.

17. Aluminum pointer attached to the headstock on Vicmark minilathe with two machine screws.

18. An alternate pointer that can be clamped to the benchtop.

To use the wheel, rotate the spindle until the wheel marking is lined up with the aluminum pointer. A 2 inch spring clamp is used to clamp the pointer to the wheel (Picture 19). To move to the next setting, unclamp, rotate to the next mark on the wheel and clamp. It takes about two seconds to reposition the wheel and once set you have both hands free to do your work.



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Positioning Jig

The positioning jig I developed for open segment work is made from two pieces of 3/4 inch plywood, a strip of 1 inch x 1 inch x 1/16 inch aluminum angle, and two small pieces of Plexiglas or hardwood. It consists of a base that slides along the ways of your lathe and an upright that holds the aluminum angle. A stop slides along the aluminum ramp. Overall dimensions are not really important except where noted. Two views of the completed jig are shown in Pictures 20 and 21.

20. Overall view of the positioning jig

21. Bottom view of completed positioning jig.

The upright plywood piece should be about 6 inches wide and slightly shorter than the distance between your ways and axis of the headstock. The base plywood piece should be about 6 to 12 inches wide and a depth equal to the height of your headstock axis over the ways plus about 3 inches. A complete set of materials is shown in Picture 22.

22. Materials needed to make the positioning jig.

A guide is screwed to the bottom of the base plywood to keep the jig aligned on the ways of your lathe (see Picture 23). I used a piece of scrap Plexiglas but hardwood will work just as well. The guide should be about 4 to 6 inches long and needs to be a good fit in the gap between the lathe ways so the jig cannot wiggle when sitting on the ways. If your lathe has two tubes for the ways you should use hardwood that is thicker than 1/2 the diameter of the ways. Attach the guide so it is square with the side of the base nearest the headstock and recessed back from the front edge of the base.

23. Attach the guide to the bottom of the base with two screws. The guide should be square with the edge of the base nearest the headstock.

Glue the two pieces of plywood together so they form a right angle (Picture 24). A couple of screws will help secure this joint while it is drying. The upright plywood is glued to the edge of the base nearest the headstock and positioned to the rear of the base.

24. Glue and clamp the two pieces of plywood together. The height of the upright plywood should be about 1/8 inch less than the height of the spindle from the ways.

Shown on the bottom view is a piece of oak that rides below the ways. Two bolts (1/4 - 20) go through the base and can be tightened by wing nuts on the top. These clamp the base to the ways. Use a drill to drill these holes through the base, guide, and clamp block (Pictures 25 and 26).

25. Drill two holes through the base, the guide, and the clamp block. These should be positioned on the centerline of the ways.

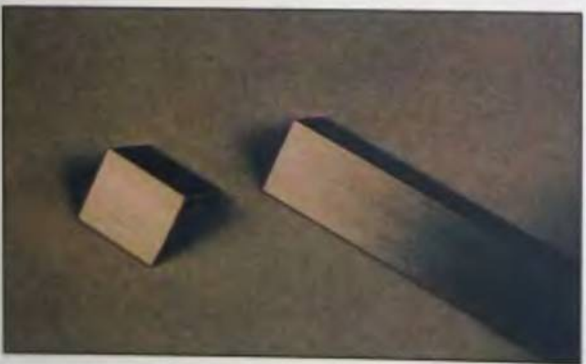
26. The clamp block attached to the positioning jig. In use, it goes under the ways and is used to clamp the jig to the ways.

Now you are ready to screw the aluminum guide rail to the jig (Picture 27). The only part of this jig that is critical is to be sure that the aluminum angle is positioned so the edge is in good alignment with the center axis of the lathe, as shown in Picture 28. If the guide on the bottom of the base is a good fit you will be able to slide the jig up and down the ways while keeping the front edge of the aluminum angle lined up with the axis of the lathe.

27. Attach the aluminum rail to the upright plywood.

28. It is important that the leading edge of the rail align with the center line of the lathe. This is the only truly critical part of the jig construction.

One final piece of the jig is a stop that can be moved along the aluminum angle. Shown in Pictures 29 to 34 is a stop made with a miniature C-clamp epoxied to a small cutoff from the angle aluminum. Cut a 1 inch piece of the aluminum left over from the rail. Next remove all but 1/16 inch of one side. Use a file to square up the edges. I got a small C-clamp from my hobby shop that is used to make model ships. A little epoxy will attach the clamp to the stop. Picture 34 shows the completed stop mounted on the positioning jig.



29. Cut off a 1 inch section of aluminum angle.

30. Remove all of one side except 1/16 inch.

31. Use a hand file to clean up the edges. Try to get the edges as square as possible.

32. Use epoxy or super glue to attach a small C-clamp.

33. Finished stop with C-clamp.

34. Stop positioned on the jig. By loosening the C-clamp the stop can be positioned any place along the aluminum rail.

Wood Selection, Preparation, and Cutting

Wood Selection

There are many woods you can use for open segmented turnings and some you should avoid. Generally you want to avoid anything that is not sound, has natural oils, or splits easily.

I have chosen maple and walnut for the book project. These are excellent woods to use for open segment construction.

Good Wood Choices:

Light Woods	Dark Woods
Holly	Walnut
Maple	Mahogany
Pau Amarello	Paduk
Poplar	Cherry

Marginal Wood Choices:

Light Woods	Dark Woods
Birch	Purpleheart
Oak	Bubinga
Ash	Cedar

Avoid These Woods:
Cocobola, Teak, Rosewood

35. Choose two boards that are clear and straight grained.

The best woods are generally those that are tight grained and do not split when cutting narrow pieces on a table saw. They glue well and turn cleanly. The marginal woods take glue well but tend to split and break when cutting thin sections. The oak was really marginal. I made one piece using white oak and had about one out of every three pieces split during cutting. The cedar is very soft but I have used it to make large containers to hold outdoor terracotta flowerpots.

Woods that do not glue well should not be used at all. The entire turning depends on the integrity of the glue joints. If one glue joint fails the entire project may be destroyed. Highly figured woods may be used but it is usually a waste as the grain patterns do not show well on the small segments. The gaps between segments further detract from the grain patterns. If you do select highly figured wood, be sure the grain is very tight.

36. The thickness of the boards becomes the wall thickness of the final glue-up.

The thickness of the boards you select will translate into the wall thickness of the final glue-up (Picture 36). A thicker wall gives you more room to play with shapes during turning. The down side of having a thick wall is that more wood is required and more turning is needed to get down to the final wall thickness. A 3/4 inch board is probably the minimum I would recommend.

37. Avoid wood with highly figured sections.

38. This is another type of flaw to avoid. Any checks or cracks will render the wood totally unacceptable for open segment work.

39. This board will be fine but I will have to cut around the small void. Otherwise it is a solid smooth grained board.

You can calculate the amount of wood to prepare from the design drawing (Diagram 6 in Chapter 1). Think of the turning as having twelve columns of segments with each column containing ten layers. We will add together the dimension C for each layer in the column to get the amount of wood needed for one column. Since there are six columns of maple and six columns of walnut we multiply the wood for one column by six and we have the amount of wood needed of each type.

In our project we would add .628 inch + .718 inch + .808 inch + ... = 8.215 inch. To this you must add something to cover the kerf, or wood lost due to sawing. On a table saw this is typically 1/8 inch per cut or 1-1/4 inches for the ten layers. On a bandsaw the kerf is usually .025 inch or 1/4 inch for the ten cuts. Assuming we are using a table saw you will need 8.215 inch + 1.25 inch = 9.465 inches of wood for one column of segments. Our project uses six columns of maple and six of walnut. Therefore we will need 9.465 inch x 6 = 56.79 inches of maple and a like amount of walnut. You should add a little extra to allow for mistakes and to provide something to hold onto during the final cuts. For our project I would round up to an even 60 inches of each wood.

Once you have selected your wood, you will need to cut it into strips (Picture 40). The strips will total 60 inches of maple and 60 inches of walnut as calculated above. The thickness of the strips should be 3/8 inch for our project. This corresponds to the height of the segments for each layer (see Picture 41).

40. Use a table saw to cut your board into strips.

41. The height of the segments is determined by the thickness of the strips you cut.

The exact thickness of the strips is not critical as long as the thickness is constant. It is very important that the thickness of the strips does not vary or the height of the segments within a layer will vary. More importantly, if two adjacent segments vary in height then the segment on the next layer will be crooked. This leads to a poor glue joint and, on a turning that has such good symmetry, a crooked segment really stands out. This is experience speaking!

There are several ways to solve this problem. If you have access to a thickness sander or planer, just run the stock through so it is a constant thickness. I built my own thickness sander (Pictures 42 and 43), which has served me well for years of open segmented turnings.

42. Shop made thickness sander constructed of mostly found materials.

43. Dust cover removed, showing 6 inch plywood drum and pillow block bearings. The Formica™ covered table is raised and lowered by the lead screw epoxied to the adjusting wheel. The 1/2 hp motor is more than enough power for the narrow strips used on open segmented turning.

If you do not have access to a thickness sander then all is not lost. Get the thickness as even as possible using a table saw to rip the stock. Use a sanding block to remove any saw marks from both surfaces of the strip (Pictures 44 and 45). Be sure you do not round over the wood during this sanding step. Picture 46 shows how to check for flatness. When gluing you will have to let each layer set, then make a facing cut to level the surface before gluing the next layer. This is not as bad as it sounds and I usually do this on my better work. If you let the glue dry for about ten minutes you will be able to take very light facing cuts with a sharp round nose scraper.

45. If a thickness sander is not available, use a sanding block to remove saw marks.

44. The strips will have saw marks when they come from the table saw. These must be removed for sound glue joints.

46. If you hand sand be sure you have not rounded over the surface of the strip. Use a straight edge to check for flatness. Do not use wood that has been rounded over as the glue joints will fail.

Cutting Segments

For our 12 segment book project the measurement of dimension C is not critical. As the number of segments per layer increases, the tolerances decrease. The chart for measuring segment length in Appendix I shows segment length in inches to three decimal places. In reality, I rarely measure any closer than two decimal places. I use a machinist's caliper calibrated to .001 inch to do my measuring but a good scale with markings to 1/32 inch should suffice for our twelve segment project. On a segment that is 5/8 inch long, an error of a 1/32 inch will not be noticed.

Angle measurements are also not critical with open segmented work. Any errors are evenly spread around the turning and are not discernible. A regular miter gauge is plenty accurate. I usually try to get angles to within about 1° of the optimum setting for a 12 segment vase. As with dimension C, however, as the number of segments increases, the angle becomes more critical. A 24 segment turning will require twice the accuracy as that required for a 12 segment turning.

Cutting the segments is an important part of open segmented construction. There are a lot of segments to be cut and you will need to use a safe, quick, and comfortable method to work. The table saw is my primary cutting device. I use an ancient renovated cabinet saw retrieved from a junk heap in an old barn that was being demolished. It only has a 1 hp motor but is equipped with a good cross cut blade and a shop made sliding table. The sliding table allows for better accuracy when doing turnings with many segments.

I also use a 14 inch band saw to cut segments. On very small segments (dimension C of 1/4 inch or less), the band saw works better than the table saw but is a little slower. The table saw tends to create a lot of wind and the smaller pieces do not always fall away and clear the blade. One nick and the smaller pieces will go zinging around the shop. With the band saw I have cut segments as narrow as 1/8 inch but the cutting is slower and the finish is not as clean, requiring significant cleanup. I also use a converted slitting saw made for cutting lead type in a print shop. The blade turns slower and has no offset to the teeth. This gives a very accurate cut on very small segments. To summarize, the cutting dimensions for our project are not terribly demanding so you can use just about any sawing device you have available. I have heard of people using a radial arm saw, a chop saw, and sliding miter saw to cut segments but I have no personal experience with these devices.

For the table saw, band saw, and slitting saw I have made sliding tables with a moveable miter arm. The sliding table for the table saw is birch plywood faced on both sides with Formica™. It is 24 inches square and uses a hardwood runner to ride in the miter slot (Pictures 47 through 50). The sliding table for the band saw is made from 3/4 inch MDF that is 18 inches wide and 14 inches deep. It also has a hard maple runner in the bottom to fit in the miter slot of the band saw table (Pictures 51 through 53).

47. Overall view of sliding table for the table saw. A hardwood strip on the bottom rides in the miter slot of the saw.

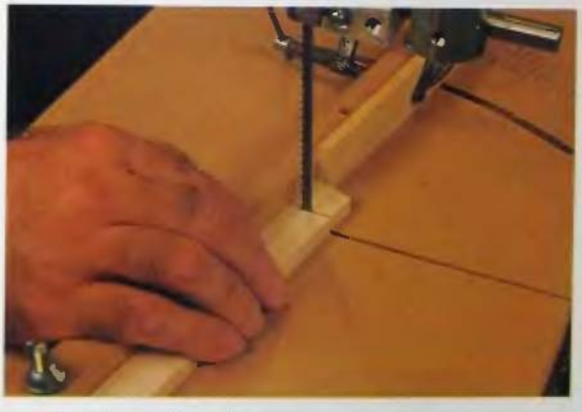
48. An advantage of the sliding table is the length of the miter arm. This makes it easy to get accurate degree settings. I can set the arm to about 1/4 of a degree, which is necessary on turnings with 35 or 40 segments per layer.

49. A ramp is positioned next to the blade so that cut segments will slide away from the blade.

50. A magnetic strip from a sign company holds the ramp securely to the table saw.

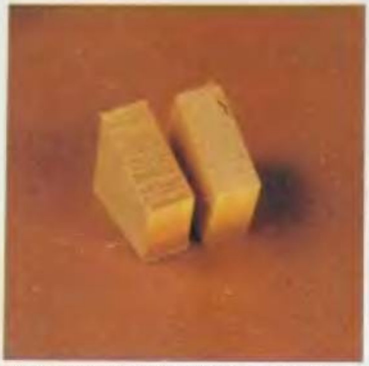
51. The sliding table for the band saw made of MDF with a hardwood runner for the miter slot.

52. The sliding table installed on the band saw. A regular miter gauge can be used in place of the table for our project.



53. Using the sliding table on the band saw to cut segments. A stop is made with a C-clamp and scrap of wood.

Cutting on the band saw is slower but more controlled than the table saw. The biggest disadvantage with the band saw is the quality of the cut. Picture 54 shows two segments that were cut from the same piece of maple stock. The one on the right was cut on the table saw using a Forrest Woodworker™ crosscut blade. The segment on the left was cut on the band saw using a new 1/4 inch by 14 teeth per inch blade. When I use the band saw to cut segments I will clean up the saw marks by making several passes on a piece of 240 grit sandpaper (Picture 55).



54. The segment on the left was cut on the band saw, on the right with the table saw. Note the poor finish on the bandsawn segment.

55. The saw marks can be removed with several passes on 240 grit sandpaper.

Remember that the cut surface will not be too visible, especially on smaller segments that are close together. On wider segments that have a wide gap between segments, the cut face will be more visible and therefore clean up is more important. It is also very important to remove any burs in order to get good glue joints.

The fence for the table saw is used as the stop. Shown is the Delta Unifence™, which can be adjusted forward and back as well as the normal left and right adjustments. I adjust the fence so it is located back behind the blade (Picture 56). This eliminates any chance of getting a segment trapped between the blade and the fence after it is cut. If you use any other type of fence that cannot be adjusted back behind the blade, you will have to use a spacer attached to the fence. The spacer can be any piece of wood or metal clamped to the fence that remains behind the blade. Three pieces of wood glued together in the shape of a U and about 6 inches to 12 inches wide would work well. Picture 57 shows a setup for a traditional fence using the spacer.

56. The Delta Unifence™ set back behind the blade to provide clearance for cut segments to slide away from the blade.

57. Alternate arrangement with standard fence. A spacer has been placed between the fence and blade to provide clearance for cut segments.

To cut the segments, first set the miter arm to the degree setting shown in Appendix I. Next position the fence to be used as a stop to dimension C. I approximate this setting, cut a segment, and check the length (Pictures 58 through 60). Adjust the fence as needed. The first cut will leave an angled face on the strip stock. By turning the strip over and sliding it against the fence you will be ready to make the second cut. The resulting cutoff will be the correct shape for a segment (Pictures 61 through 63). You need to make six maple and six walnut segments for the first layer of segments.

58. Use a scale to approximate the setting of the fence used as a stop.

59. Cut a segment, then check the Dimension C. Make adjustments to the fence/stop as needed.

60. When cutting segments the fence is used as a stop.

61. I have labeled the two faces of the stock "A" and "B". Here I am cutting the "A" surface.

62. After the "A" face is cut, I flip over the stock and cut the "B" face.

63. Three segments showing how they were originally arranged in the stock.

Construction

The assembly of the segments is done on the lathe. Begin by putting a waste block in a chuck or screwing it to a small faceplate. Glue the base piece of your turning to this waste block and allow the glue to cure completely. Face off the base so you have a flat surface to start building your open segment construction (Pictures 64 through 66). This surface will form the bottom of the inside of the turning. You should sand this surface at this time as you will not be able to easily get back to it later (Picture 67). Anyone who looks inside will see the base so I usually sand to 400 grit or finer at this point.

64. Glue the base piece to a waste block. I am using the tailstock in place of a clamp while the glue sets.

65. Use a scraper to face off the base. A nice smooth, flat surface is needed here.

66. Use a straight edge to check for flatness and correct any unevenness.

67. The base piece becomes the inside bottom of the turning. This is a good time to sand it but do not apply any finish as that could interfere with the glue joint.

We are now ready to start gluing segments. You should have six maple and six walnut segments with a dimension C of .763 inches. If you look closely at the segments you may notice a small burr from the saw blade (Picture 68). This must be removed to get a good glue joint. One swipe on 240 grit sandpaper will remove the burr and any other imperfections (Picture 69). As you clean the burr from each segment, line them up on a board in the order they will be used. On more complicated designs this is critical so that the correct wood type is glued in the correct sequence (Picture 70).

68. A small burr will usually be found on the edge of the segment. This must be removed for a good glue joint.

69. A quick swipe on 240 grit sandpaper will remove the burr.

70. Line up the segments in the order they are to be glued. This step can greatly reduce pattern errors, especially in more complicated designs.

At this point you will need the index system and the positioning jig described in Chapter 2. Place the positioning jig so that it is about 1/8 inch from the base. The stop is then positioned a distance from the end of the aluminum rail that is equal to 1/2 of the diameter of the layer or 2-1/8 inches for the first layer of our project (Pictures 71 and 72). Position your index wheel to any of the

71. Clamp the positioning jig to the ways so the aluminum rail is about 1/8 inch from the base.

'2. Place the stop at a distance from the rail edge of 1/2 of the liameter of the first layer. This would be 2-1/8 inches for the irst layer of our project.

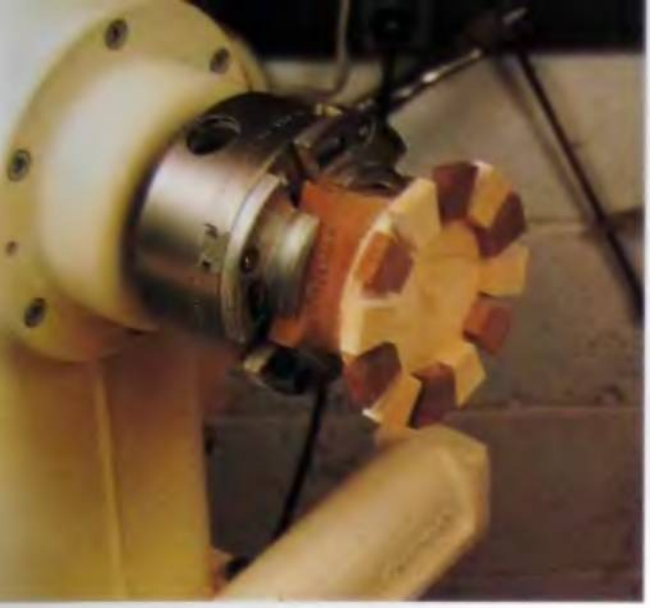
ong index marks and begin gluing segments (Picture 73). Any good yellow carpenter's glue works well. I normally use the original Titebond™ formula in the red accented container but others are just as good. Apply a small amount of glue to the segment, position it on the base using the luminum rail and the stop as a guide. Hold with light inger pressure for about five seconds (Picture 74). No lamping is necessary. Now advance the index wheel counterclockwise (top toward you) to the next long index ark, which should be 30° away. You are now ready to glue the second segment to the base (Pictures 75 and 76). Repeat these steps until all 12 segments of the first ayer are glued to the base (Picture 77) . This completes he first layer of our project.

73. Position the index wheel to any of the long index lines. We are now ready to glue the first segment.

74. First segment glued in place. Light finger pressure for about five seconds is all that is necessary. Here I used Titebond™ glue. Any similar carpenter's glue will work.

75. Advance the index wheel 30° to the next long index mark. You will be rotating the piece toward you.

76. Glue the second segment just as you did the first.



77. The first layer of segments glued to the base.

Before proceeding to the second layer you need to clean up the top of the first layer. If you take this time to cut the segments for the second layer, the first layer will be dry enough to make a very light facing cut (Pictures 78 and 79). An alternate if the layer is not too uneven is to use a piece of 240 grit sandpaper on a sanding block to flatten any irregularities (Pictures 80 and 81). Either the facing cut or the sanding can take place after the glue has dried for about ten minutes. Before doing any cutting please read the section on safety at the beginning of Chapter 5.

78. A very light facing cut is made after the glue has dried for about ten minutes. A round nose scraper works well for this cut.

79. Check for flatness after making the cut. Any unevenness must be removed to guarantee a strong glue joint with the next layer.

80. A sanding block can also be used to remove small amounts of unevenness.

81. You may want to put a chamfer on the leading edge of the sanding block so it will not get caught on a segment. The chamfer has been exaggerated in this picture for clarity.

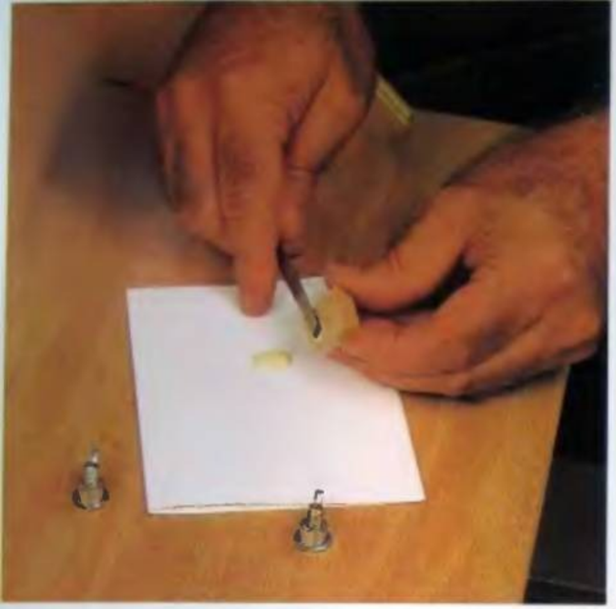
You are now ready to glue the second layer. Move the positioning jig along the ways until it is about 1/8 inch from the first layer and reposition the stop to 1/2 the diameter of the second layer (Picture 82). Then set the index wheel to one of the short index marks that are offset 15° from the long marks used for the first layer (Picture 83). This will insure proper overlap between layers.

83. Set the index wheel to one of the short marks for the second layer.

82. Adjust the stop to 1/2 the diameter of the second layer.

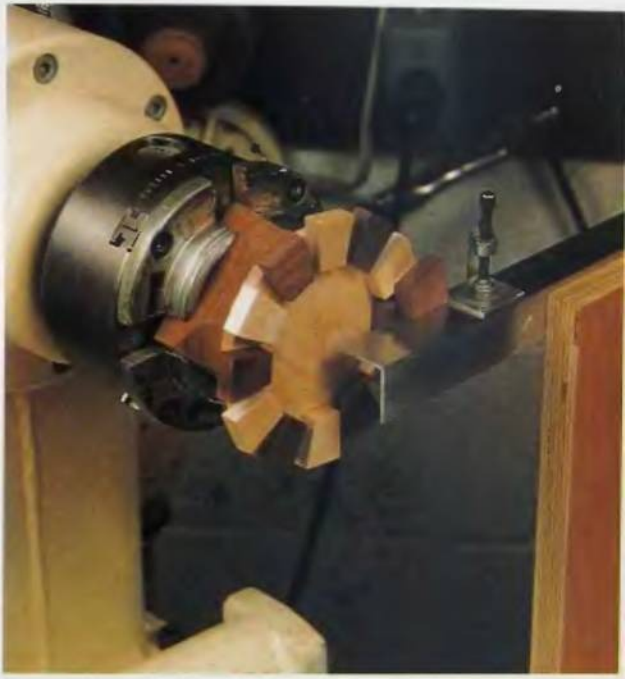
When gluing the second and subsequent layers you have to be a little more careful applying glue. I try to avoid getting glue in the area where there is no overlapping wood to glue. To accomplish this I put about a half teaspoon of glue on a piece of paper. I then use a small artist's palette knife to spread the glue down either side of the segment (Pictures 84 through 86). When the segment is glued to the previous layer, there is a small amount of squeeze out. I do not try to remove that as it forms a small filet that strengthens the joint. The squeeze out shrinks as it dries so it is nearly impossible to see on the finished turning. Picture 87 shows the first segment of the second layer glued in place.

84. Gluing the second layer requires a little more care. Place a half teaspoon of glue on a piece of paper.



85. I use a small artist's palette knife to spread the glue on the segment.

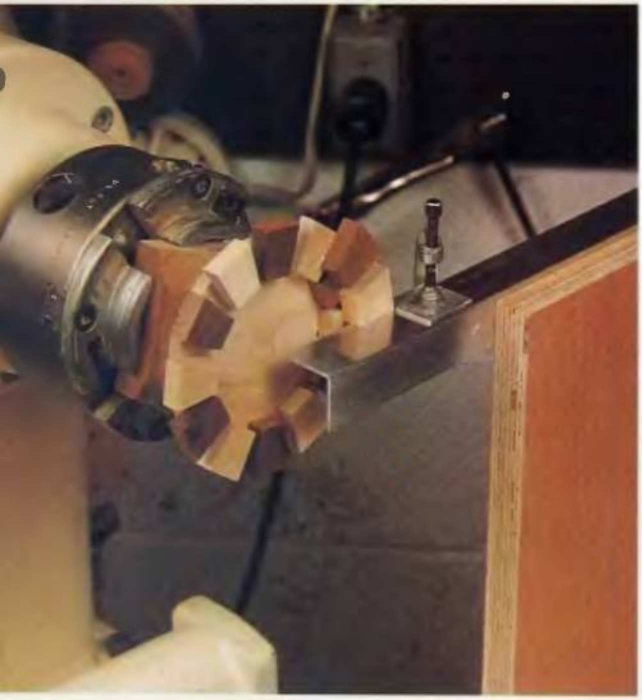
86. A walnut segment with glue applied to the edges but not the center.



87. The first segment of the second layer is glued in place. The small amount of squeeze out will shrink and disappear during drying. Hold in place with light finger pressure for five seconds before going to the next segment.

When gluing the third layer go back to using the long index wheel marks. Be sure to position the first segment of the third layer so it continues the spiraling effect. Pictures 88 and 89 show progress on gluing the layers. Once all of the segments are glued in place you need to make a careful facing cut to join the rim piece (Pictures 90 and 91). This must be flat so the rim makes full contact with the top layer. A glue joint failure will likely occur if there is not a good mating between the rim and top layer of segments (Pictures 92 and 93).

89. The glue-up about half completed. For each layer, alternate between the long and short marks on the index wheel. Be sure to watch the order in which the segments are glued to get the spiraling pattern.

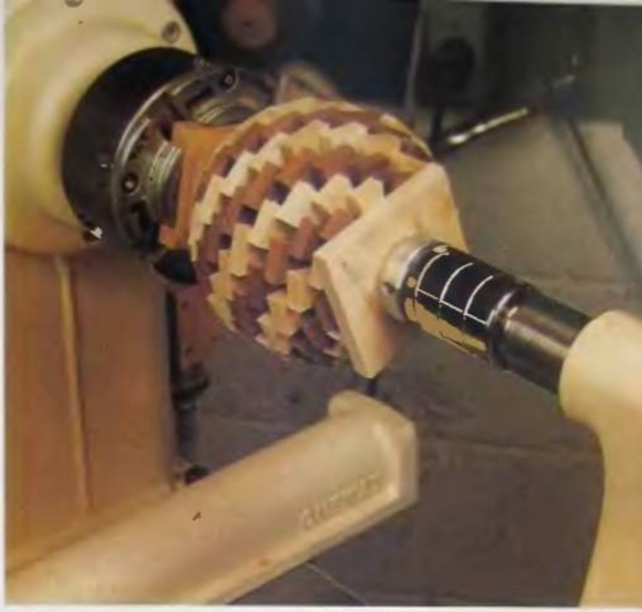


88. Advance the index wheel to the next short mark and glue the second segment in place.

90. All segments glued in place and ready for the rim.

91. A facing cut must be made to flatten and true the top layer of segments.

92. The rim piece must be sanded flat so it forms a good joint with the top layer of segments. Any unevenness in either side of this joint may lead to joint failure.



93. Glue is applied to the top layer of segments and the rim piece is glued in place. The tailstock is used as a clamp to hold it in position.

Once the rim is glued in place let it sit for four hours or, better yet, overnight before proceeding to the turning stage. Picture 94 shows the completed glue-up.

94. Glue-up complete and ready to turn.

Turning

Safety

There are a few important safety considerations with open segmented turnings. The finished glue-up will look like a pretty threatening thing to turn, with lots jagged chunks of wood sticking out at weird angles. You should consider it threatening and take a few extra precautions. You definitely do not want to put your hand on the turning to slow it down when shutting off the lathe. The glue-ups are rugged and hold together better than some of the burls and spalted woods I have turned. However they can fail if any of the glue joints are not sound or you have a really solid catch. Always wear eye and face protection. There are a lot of segments with sharp corners that can travel pretty fast. Use slightly slower turning speeds and make lighter cuts than normal. I usually turn around 800 rpm to 900 rpm but start out slower until you feel comfortable at higher speeds. Do not touch the piece while it is turning; think of it as a cheese grater with a 2 hp motor attached. Above all else, do not put your fingers inside while it is turning.

Tools and Turning

You can use many of the same tools for open segmented turnings as regular turnings. In actuality it is only slightly different than a regular turning with a big benefit of no end grain to deal with. I am often asked if my tools don't get caught in the gaps. The answer is no! This does not seem to be a problem. I use gouges, scrapers, and various hollowing tools. My favorites for the outside are a 1 inch round nose scraper and a 3/8 inch bowl gouge sharpened at about a 45° angle with plenty of sweep back on the sides (Picture 95). I use the gouge to do the rough turning and the scraper to finish up. There is no end grain to worry about so the scraper leaves a very nice surface.

95. Tools I use to turn the outside include a 3/8 inch bowl gouge and a 1 inch round nose scraper. The small gouge and scraper are used to form the rim and foot region on more intricate turnings.

Begin by smoothing all of the sharp edges from the segments so that the segments flow into a continuously smooth surface from top to bottom (Picture 96). Always work uphill when doing this smoothing step to minimize splitting. After removing all of the sharp edges you will see how much wood you have to work with to get the final shape.

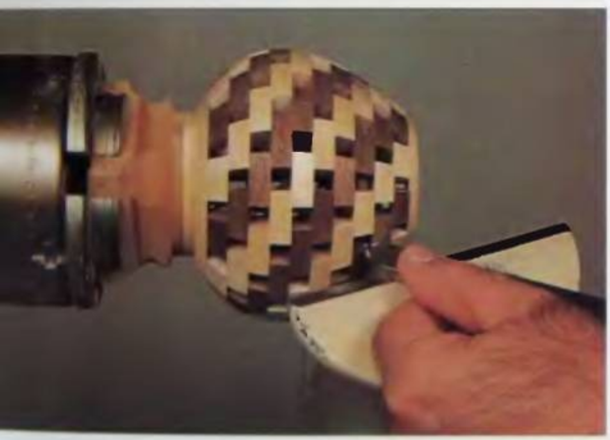
96. Begin turning by using the gouge to take off the corners and smooth the steps between layers. Read the paragraph on safety before doing any turning.

Next I develop the final outside shape. I spend quite a bit of time perfecting the shape I want. People looking at the finished piece will first be amazed by the open segmented construction. In short order they tend to look beyond the novelty of the construction process to the shape and form. A turning with poor form dies at that point. Open segmented construction is a cleaver gimmick to get people's attention but you must follow through with good shape and finish.

As I get close to the finished shape I will use a parting tool to cut a recess in the base that delineates the bottom, as shown in Picture 97. I find this helpful when developing the shape so I can visualize the final form. This recess should be about 1/4 to 1/2 inch deep; you do not want to weaken the base as you still have to turn the inside. At this point I switch to sharp scrapers (Picture 98).

97. Use a parting tool to cut a shallow groove where the bottom will be located. This helps visualize the shape when developing the final form.

99. My favorite tools for hollowing. At top is the Sorby system, followed by a David Ellsworth tool, a miniature Sorby, and a Robert Rosand hollower. These all work well for open segmented turning.



98. Use scrapers for finalizing the shape. Scrapers are very effective, as all cutting in this project is side grain with no end grain.

100. I use a gouge to cut the inside rim and top segment layer. The gouge seems to cut the inside better than scrapers but there is only so deep you can go with a gouge.

With the outside shape finalized I turn my attention to the inside. Turn one layer at a time starting at the rim. Each layer is turned to final wall thickness before proceeding to the next layer. I will use a gouge to form the inside lip and to cut the first one or two layers. I then switch to hollowing tools (Pictures 99 through 101). I have used many different hollowing tools both commercial and home made. So far they all do a good job. Try to stay with a cutter size of about 1/4 inch and work slowly.

101. I switch to the hollowing tools as I get further down inside the turning.

During hollowing you will find that you do not have to keep stopping in order to clear chips. The chips are small and tend to be thrown out of the piece through the gaps between segments (another advantage of open segmented work). Always complete one layer before going to the next. You can back up one or two layers to make blending cuts but you will not be able to go back to the rim area when you have hollowed down to layer 2 or 3 from the bottom of the turning.

Wall Thickness

This is always a hot topic in wood turning discussions. Wall thickness becomes important in open segmented work as it is easy to see the thickness of your walls. Probably the most important issue is to keep the thickness uniform from top to bottom. As with many turnings, thinner, to a certain degree, is better. On pieces around 6 inches in diameter I will go for about 1/8 inch and on my larger pieces that are 18 to 20 inches in diameter I will try for about 1/4 inch. On miniatures I try to get the thickness down to about 3/32 inch. For your first couple of pieces I would double these dimensions. You will find as the wall thickness decreases the turning acquires a nice feeling of airiness. On your first piece try for a thickness of about 1/4 inch. This will look good, is a little forgiving, and will not be too hard on your nerves.

Finishing

When the inside is complete you are ready to sand. If you have access to power sanding use it. Heavy hand sanding will give the segments a pincushion look as the edges of each segment will become slightly rounded. I use a rotary sander in a hand drill starting with 80 or 120 grit paper. I power sand up to 240 grit then hand sand up to 400 or 600 depending on the wood (Pictures 102 and 103).

102. Use a power sander if available for rough sanding.

103. For fine sanding, or if you do not have a power sander, cut the sandpaper into strips and use as shown. Do not use sanding pads or your fingers as the segments will get a pincushion look as the edges are rounded over.

With finishes you are limited to sprays. My favorite is spray Deft™ satin finish. I can't imagine how a wipe on finish would work. As shown in Picture 104, I like to start by using compressed air to blow off sanding dust and chips. I then lightly spray the inside of the turning with the lathe running about at 200 rpm to 300 rpm (Picture 105). Much of this inside spray will be thrown out of the gaps between segments so you may want to wipe the outside before it dries. Finally, with the lathe still running, I give the outside three coats of finish sprayed very lightly (Picture 106). I do not buff my open segmented turnings but I have seen others who have achieved good results with the Beal buffing system.

104. Compressed air does a great job of removing sanding dust and chips that may still be inside.

105. One or two shots of spray finish inside while the lathe is running will seal the interior. Excess will be thrown out the gaps so wipe the outside before it dries. Deft™ satin finish is one of my favorites.

106. The outside is finished with three light coats of the same finish.

The final step is to part off using regular parting tools. I never part my turnings all the way through. I leave a small amount of stock and use a hand saw on the last 1/4 inch or so with the lathe turned off (Pictures 107 and 108). A sweep carving gouge will make short work of the nub left behind. Sand and finish the bottom just as you would any other piece. Do not forget to sign your work (Pictures 109 through 112).

107. Use a parting tool to cut the bottom.

108. I do not completely cut all the way through with a parting tool. The last 1/4 inch or so is cut with a hand saw while the lathe is turned off.

109. A carving gouge is used to remove the nub in the center left by the saw.

110. Sand and put a little finish on the bottom.

111. Be sure to sign all of your work.

112. The finished open segmented turning.

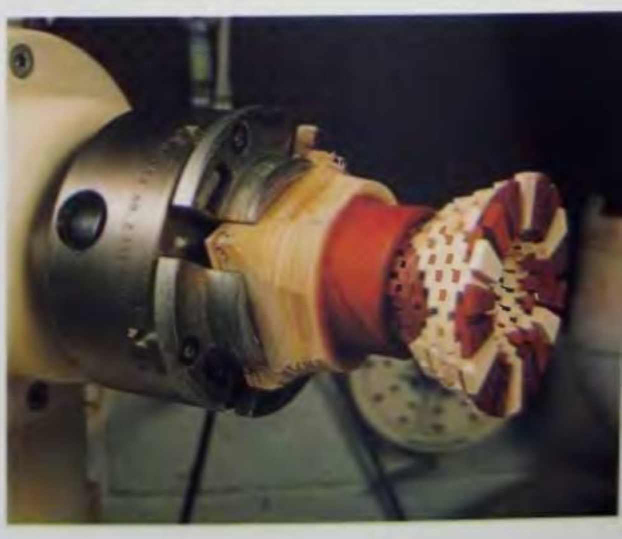
Advanced Techniques

Split Construction

Split construction is a technique I use on many of my open segmented turnings. It makes the hollowing step easier and improves wall thickness control. On tall turnings and turnings with a small opening it is a must. The idea is to build the turning in two sections, a lower and upper. The division occurs at the widest diameter. The sections are joined to turn the outside shape then split apart to turn the inside. I will demonstrate this on a very small turning in order to show a few other techniques along the way. Picture 113 shows the piece we will develop. It is a vase that is 18 segments around by 17 layers high and is made from holly and paduk.

113. The finished piece used to demonstrate the split turning technique. The split will occur in the middle of the central decorative band, dividing the turning into an upper and a lower section.

Start the assembly process with the bottom section. Build up from the base to the layer with the widest diameter (Picture 114). Note that the segments are quite small in this turning. It is very difficult to cut such small segments on a regular table saw. Pictures 115 and 116 show an adaptation I made to a slitting saw used to cut lead type in a print shop. The table slides in a miter slot and the adjustable fence stops short well behind the blade. Some key ingredients that make this successful are a low blade speed, thin kerf, and no tooth offset. I believe other types of saws could be converted in a similar fashion.



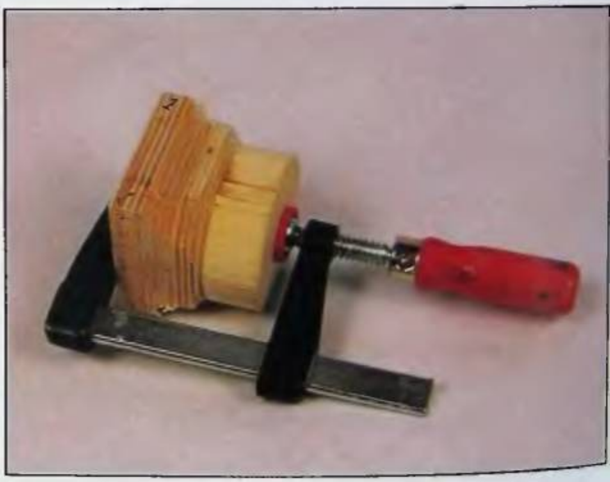
114. The lower section is assembled in a normal fashion, building up to the widest diameter.

115. The converted lead type slitting saw used to cut very small segments. It uses a 6 inch blade with a thin kerf and no tooth offset.

116. During the cutting process the fence remains behind the blade so the cutoff segment will not become wedged between blade and fence.

Once the bottom is built you will need to make the top section. The waste block for the top is mounted in a four jaw chuck and a 1/4 inch to 1/2 inch hole is drilled in the center (Picture 117). Next glue the wood for the rim to the waste block and build the top section in a normal fashion down to the widest layer of segments (Pictures 118 through 120). Be very careful with your pattern when doing this section. It is easy to have swirls going the wrong way between sections or some other calamity. This completes the segment gluing stage of the project.

117. Mount a waste block in a chuck and drill a 1/4 inch hole in the center. The numbers on the corner of the waste block are used to indicate the corresponding chuck jaw so the block can be repositioned exactly.



118. Glue the rim section to the waste block. Since this is a large glue joint I will use a wood clamp or the tailstock to clamp it while it dries.

119. Build the top section from the rim piece down to the widest diameter.

120. You should have two glue-ups at this point that, if joined together, would be the complete turning. Use care to insure the pattern will come out correctly when the two sections are joined.

We now want to temporarily join the two sections so the outside may be turned as a single piece. I always use thin double sided tape such as the inexpensive indoor carpet tape. I would not use the outdoor variety or the double sided tape used for holding wood to faceplates. You want something that is not too thick and comes apart easily. I usually use from four to six small pieces. As shown in Picture 121, place them near the inside of the turning so they will not interfere with gouges or scrapers working on the outside shape.

121. Four to six small pieces of indoor carpet tape will hold the two sections together. Note placement of the tape near the inside of the turning.

Stick the two sections together and you are ready to do outside turning. The base goes in the headstock while the top section can be supported in the tailstock. A cone live center will fit in the hole drilled in the waste block for the top section (Pictures 122 and 123). Note that the carpet tape only serves to drive the top section and keep both sections aligned. There is very little stress on the tape.

122. The hole previously drilled in the waste block for the top section is supported with a cone center while the base is mounted in a chuck.

123. Overlap the segments where the layers are taped together in order to provide a little extra strength. This joint will be split apart and glued with the normal offset during final assembly.

At this point you can use normal turning techniques to turn the outside shape (Picture 124). On smaller turnings I will leave the bottom two or three layers thicker than normal to provide strength during hollowing. The segment thickness on the bottom layer will be slightly over 1/16 inch in its final form, much too thin to support hollowing and heavy sanding. When you have the outside turned you will need to split the piece back into its two sections. A thin knife can be used as a wedge to break the bond of the tape (Picture 125). There is usually a little cleanup required to fully remove the tape from both sections. Be sure no residue remains as this will interfere with the final assembly (Picture 126).

124. Use normal turning techniques to turn the outside, paying close attention to the final shape. Note the lower three layers have been left purposefully thick to provide strength during hollowing.

125. A thin bladed knife can be used to carefully split the sections apart.

126. All residue from the tape must be removed to get a good glue joint during final assembly.

The bottom can now be hollowed using gouges. This is similar to turning the inside of a small bowl (Picture 127). As with the 12 segment project, hollow one layer at a time and remember that you will not be able to back up more than two or three layers for cleanup. I try to get as clean a finish as possible to minimize sanding. The top is then turned (Picture 128). Spend a little extra time adjusting the wall thickness of the first layer so it matches the thickness of the lower section. You will also need to spend a little time getting the rim area as close as possible to its final shape (Picture 129). Working on the rim at this point is easy compared to working it when glued to the base. Finally, part off and glue the top section to the base (Pictures 130 and 131).

127. Turning the bottom is comparable to turning a small bowl. Pay attention to wall thickness as you go.

128. Turn the top section next. Pay close attention to the wall thickness in the beginning so it matches the wall thickness on the bottom section.

129. Finish the inside of the top section. It is difficult but get the rim as close to the final shape as possible.

131. The two sections may now be glued together. Place a small drop of glue at each glue point, align the pattern and press them together lightly. The total area to be glued is small, so excess clamping pressure may squeeze out too much glue leaving a weak glue joint.

130. The top section is parted off. The rim should be close to the final desired shape.

Now the tricky part. You must clean up the rim using small tools, sandpaper, or whatever else you have at your disposal. Proceed slowly and use sharp tools as even a modest catch at this point can wreck your turning (Picture 132). When possible I will use a cone center placed in the neck of the vase to support it. On some turnings I end up working this region by hand with a rotary tool. When the rim is finished I will do any rough sanding down to where I have left the base thick. You will most likely have to do a small amount of blending where the two sections meet as there is invariably a small ridge.

132. The rim is cleaned up using small tools and very light cuts. When possible I will use a cone center in the neck of the turning to stabilize it.

The bottom several layers may now be turned down to their finished shape (Picture 133). A shallow undercut with a parting tool is used to define the bottom of the vase (Picture 134). Do your finish sanding with strips of sandpaper held as shown in Picture 135. Finish is applied first to the inside and then several light coats to the outside (Picture 136).

133. Cut away the excess wood on the lower three layers. The turning will be very delicate at this point.

134. A small parting tool is used to define the bottom. This helps visualize the final shape.

135. Use a strip of sandpaper for your final sanding. Do not use sanding blocks as they deform the segments.

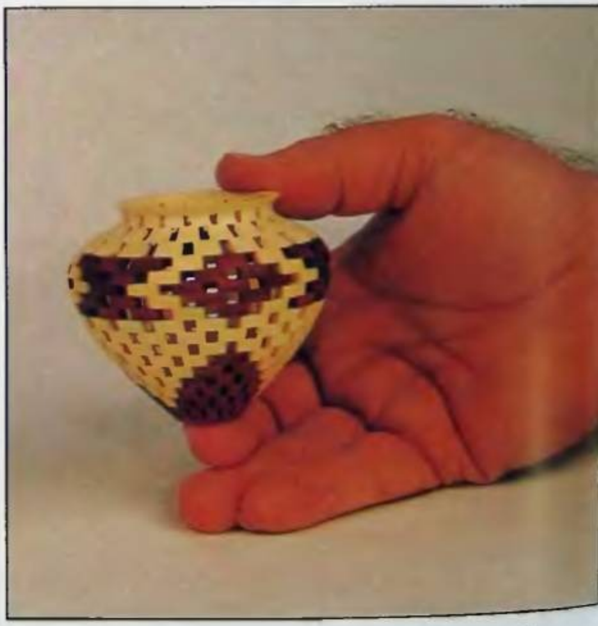
136. Apply a light spray of finish to the inside. This will be drawn into the turning by the centrifugal force of the air being thrown out through the gaps. Turn the lathe off and wipe the outside before the finish can dry. Several thin coats of finish are then applied to the outside.

As with the first project, I use a small handsaw to cut the tenon holding the vase to the waste block (Pictures 137 and 138). On turnings with very thin bases, it is possible to tear a plug out of the bottom if you try to use a parting tool to completely part off the turning. The saw method, while a little more trouble, is completely safe. Sign your piece and you are done (Pictures 139 and 140)

137. Use a handsaw with the lathe turned off to cut the tenon on the base.

138. A carving sweep is used to clean up the tenon.

139. I am using a pyrography pen to sign the base. These are handy when real estate for signatures is at a premium.



140. The finished turning. This became a gift to a special friend and supporter.

Dish With Segmented Lid

I enjoy making boxes and shallow dishes with lids. Open segmented construction is ideal for the lids (Picture 141). You get a hint of what lies inside so the allure to open it is that much stronger. My wife loves to use them for potpourri.

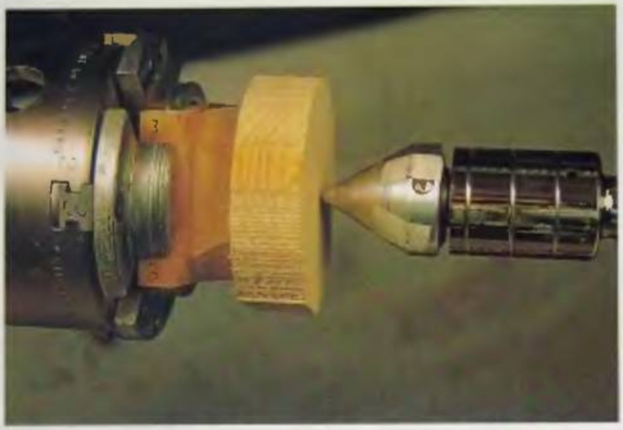
141. Shallow dishes with open segmented lids. The lid will be the subject of this section.

Start by making a dish or box you want to cover with a segmented lid (Picture 142). I made this one 6 inches in diameter from ash. I will use ash for the segments and hub while the rim and finial are black walnut (Picture 143). The finished size of the hub (the circular piece where all of the spokes are joined) is 2 inches but you will need a piece 4 inches in diameter for construction purposes. The 15 spokes are 1 inch thick and designed for a diameter of 6-1/4 inches to allow a little room for trimming. Using the chart, you will find these are cut on an 8° angle and with a dimension C of .890 inches. Since there is only one layer and no overlap is required between layers we can make the spokes a little narrower. Therefore, I have reduced dimension C and the angle so that the gap and segment width are equal. To do this, divide the angle and dimension C by 1.33 giving a revised angle of 6° and dimension C of .67 inches. The walnut rim should also be made with a 6-1/4 inch outside diameter to allow for trimming. The inside of the rim is rough cut to 5 inches.

142. Ash makes a very nice wood for the dish. I will leave this part up to your creativeness.

143. Materials needed for the lid: 15 ash spokes, an ash hub, and walnut for the finial and rim.

Glue the hub piece to a waste block and face it square when dry (Picture 144). It must be flat for tight glue joints with the spokes. With a pencil, draw a circle with a 2 inch diameter to use as a guide to cut a groove. I use a sharp gouge to cut the groove and angle the gouge so the inside of the groove slants away from the center (Picture 145). The groove should be about 1/4 inch deep. The wood outside the groove will be turned away later and the slanted side of the groove will form an undercut where the segments meet the hub. If you look ahead to Picture 156 you can see how this undercut will look on the finished turning.



144. Glue the hub to the waste block. When dry this must be faced perfectly flat.

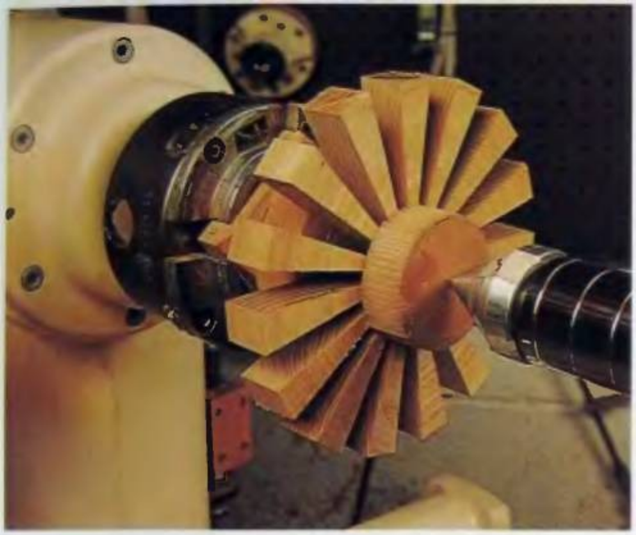
The segments are positioned and glued just like any other segment (Pictures 146 and 147). The portion of the hub outside the groove adds a little extra gluing surface. This gives the glue-up enough strength for you to turn the rim and outer portions of the segments. If you are copying this you will need to make a 15 segment index wheel or adjust the segment size to work with your 12 segment index wheel.

145. Cut a 2 inch diameter groove 1/4 inch deep and slanted away from the center. The portion outside the groove will later be turned away.

146. The segments are glued in a normal manner.

A 2 inch waste block is glued over the segments, using the tailstock as a clamp (Picture 148). This waste block provides additional support for the next step. Before gluing the rim to the segments you need to make a facing cut to flatten the area where the rim is to be glued (Picture 149). If this is not done, the lid will not sit flat when it is finished. The rim is sanded smooth to 400 grit before it is glued to the segments. Finally apply glue to each segment and clamp the rim to the segments. Allow it to dry completely before proceeding to the turning phase (Pictures 150 and 151).

147. All 15 segments glued in place.



148. A 2 inch waste block is glued to the segments to provide additional support.

150. Glue is applied to all of the segments and the rim positioned and clamped. Allow this to dry thoroughly before proceeding.

149. Make a facing cut in the area where the rim is to be glued. I use scrapers for this cut. A flat surface is a necessity for good glue joints.

151. Many clamps are required. Each spoke must be clamped securely to the rim. I found these clamps at my home center for $1.00 each.

The rim is the first part turned (Picture 152). I make mine about 3/16 inches high and about 1/4 inch or slightly more wide. Cut the rim to seat on the box with a close fit but not too tight. This is not the strongest construction ever devised for a lid and a lid that requires muscle to remove will end up in pieces.

152. Back on the lathe the rim is turned so it is a good fit with the box or dish you are covering.

After the rim is fitted turn the inside and the outside. Starting at the rim work your way to the center by doing a little on the inside then a little on the outside, gradually working to the desired shape (Picture 153). Gouges seem to work best at this step. You will only be able to turn the outside to the hub but the inside must be turned, sanded, and finished at this time (Pictures 154 and 155). The excess hub material is then turned away until the undercut is reached (Picture 156). The outside may now be sanded and finished, then parted off (Pictures 157 through 159).

153. Using gouges, turn the inside and the outside, working from the rim toward the hub. As the spokes get thinner you will not be able to do much turning near the rim.

154. Inside finished. Sanding is very difficult so try to get a good finish with the gouge. I try to make my spokes about 1/4 inch thick for a 6 inch lid.

155. The top should be finished to the hub at this point.

156. Carefully turn away the excess material on the hub to reveal the undercut made before gluing the spokes to the hub. This undercut is a nice decorative feature for the transition between spokes and hub.

157. The outside can be sanded with strips of sandpaper or a power sander. Use light pressure and work through the grades carefully.

158. A parting tool is used to cut through the excess on the hub. Leave the hub about 1/2 inch thick for detailing. I apply spray finish to the inside at this time.

159. A small hand saw is used to cut through the final 1/4 inch.

You will have to mount the lid facing out on a jam chuck in order to finish cutting the hub. I like to use MDF for jam chucks and use a live center in the tailstock for further support (Pictures 160 and 161). A 1/8 inch or 3/16 inch hole is drilled part way through the hub to make room for a tenon on the finial (Picture 162). The finial is turned from walnut and glued in place to complete the lid (Pictures 163 through 169).

160. Use a jam chuck to remount the lid for work on the hub.

161. A small gouge is used to finish off the hub. I usually add one or two undercuts to match the undercut between the spokes and the hub.

162. A 1/8 inch hole is drilled to accept a tenon on the finial. This should NOT go all the way through the hub. Apply spray finish to the outside at this point.

163. Mount and round a 3/4 inch square walnut piece for the finial.

164. Using gouges or skews, form the finial. I usually end up making two or three before I get one I like. Spend some time on this as the finial is very prominent and can make or break an otherwise perfect turning.

165. A 1/4 inch parting tool is used to form a tenon on the bottom of the finial to fit in the hole made in the hub.

166. Check the diameter of the tenon with a caliper to be sure it matches the hole drilled in the hub.

167. Apply finish to the finial before removing it from the lathe.

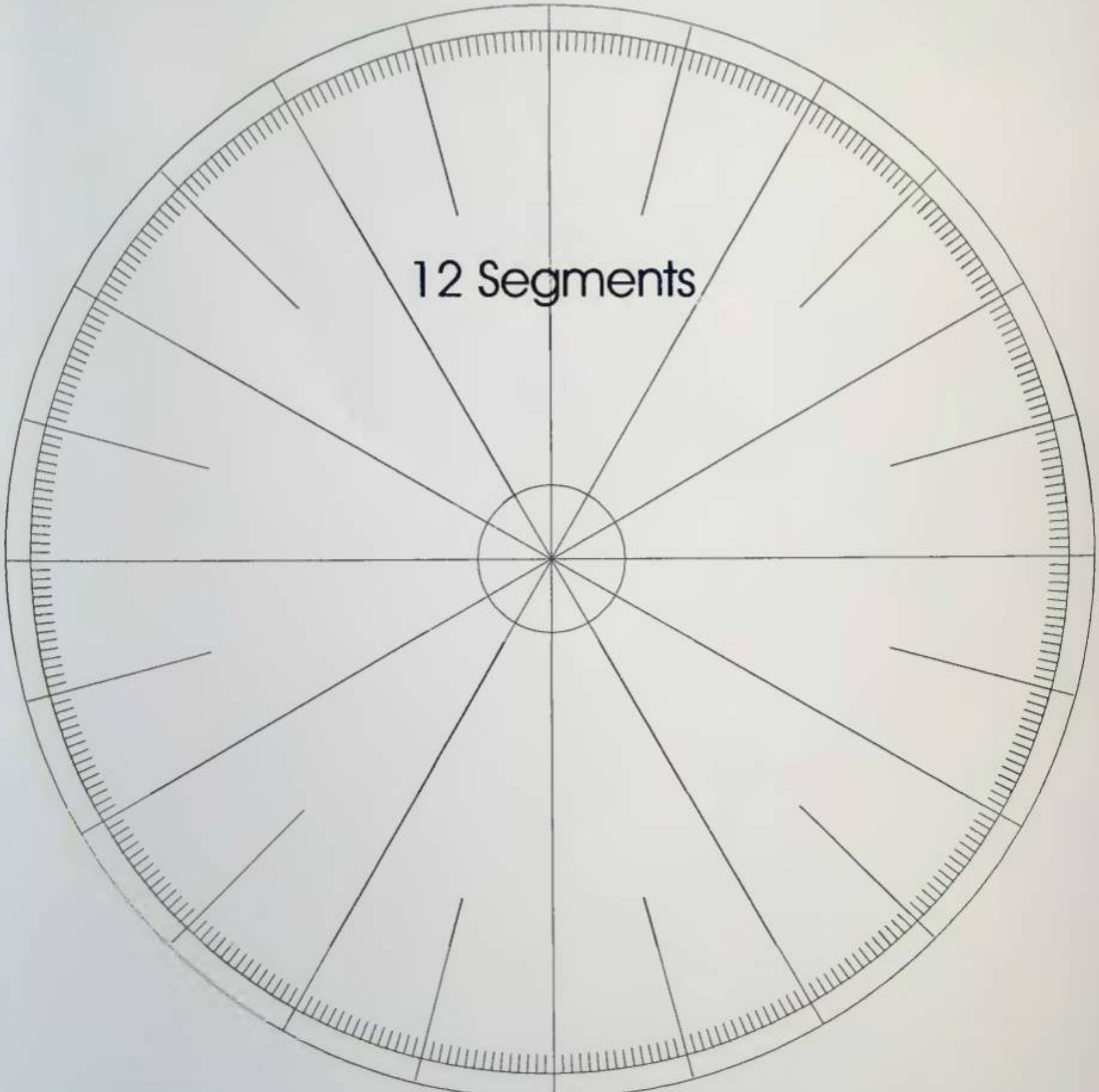
168. Part off the finial leaving enough of the tenon to hold the finial securely to the hub. Glue the finial to the hub.

169. The completed turning ready for signing.

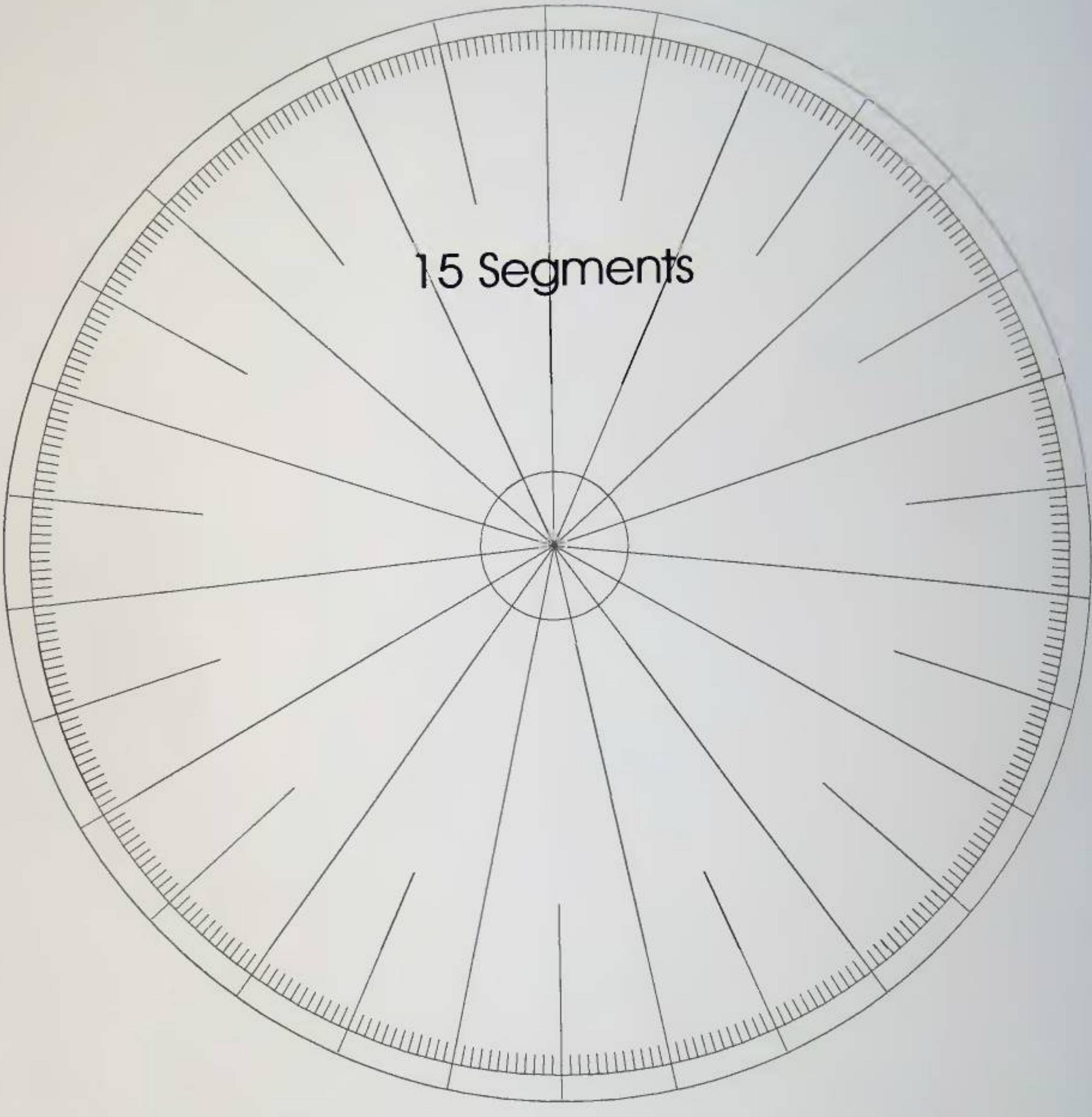
Chart To Find Dimension C

Segments	12	15	16	20	24	25
Mitre Gauge	10°	8°	7.5°	6°	5°	4.8°
Diameter						
2	.359	.285	.267	.212	.176	.169
2-1/4	.404	.320	.300	.239	.198	.190
2-1/2	.449	.356	.333	.265	.221	.212
2-3/4	.494	.392	.366	.292	.243	.233
3	.539	.427	.400	.318	.265	.254
3-1/4	.583	.463	.433	.345	.287	.275
3-1/2	.628	.498	.466	.371	.309	.296
3-3/4	.673	.534	.500	.398	.331	.317
4	.718	.570	.533	.424	.353	.339
4-1/4	.763	.605	.566	.451	.375	.360
4-1/2	.808	.641	.600	.478	.397	.381
4-3/4	.853	.676	.633	.504	.419	.402
5	.898	.712	.666	.531	.441	.423
5-1/4	.943	.748	.700	.557	.463	.444
5-1/2	.987	.783	.733	.584	.485	.466
5-3/4	1.032	.819	.766	.610	.507	.487
6	1.077	.854	.800	.637	.529	.508
6-1/4	1.122	.890	.833	.663	.551	.529
6-1/2	1.167	.926	.866	.690	.573	.550
6-3/4	1.212	.961	.900	.716	.595	.571
7	1.257	.997	.933	.743	.617	.592
7-1/4	1.302	1.032	.966	.769	.640	.614
7-1/2	1.346	1.068	1.000	.796	.662	.635
7-3/4	1.391	1.104	1.033	.822	.684	.656
8	1.436	1.139	1.066	.849	.706	.677
8-1/4	1.481	1.175	1.099	.875	.728	.698
8-1/2	1.526	1.211	1.133	.902	.750	.719
8-3/4	1.571	1.246	1.166	.929	.772	.741
9	1.616	1.282	1.199	.955	.794	.762
9-1/4	1.661	1.317	1.233	.982	.816	.783
9-1/2	1.705	1.353	1.266	1.008	.838	.804
9-3/4	1.750	1.389	1.299	1.035	.860	.825
10	1.795	1.424	1.333	1.061	.882	.846

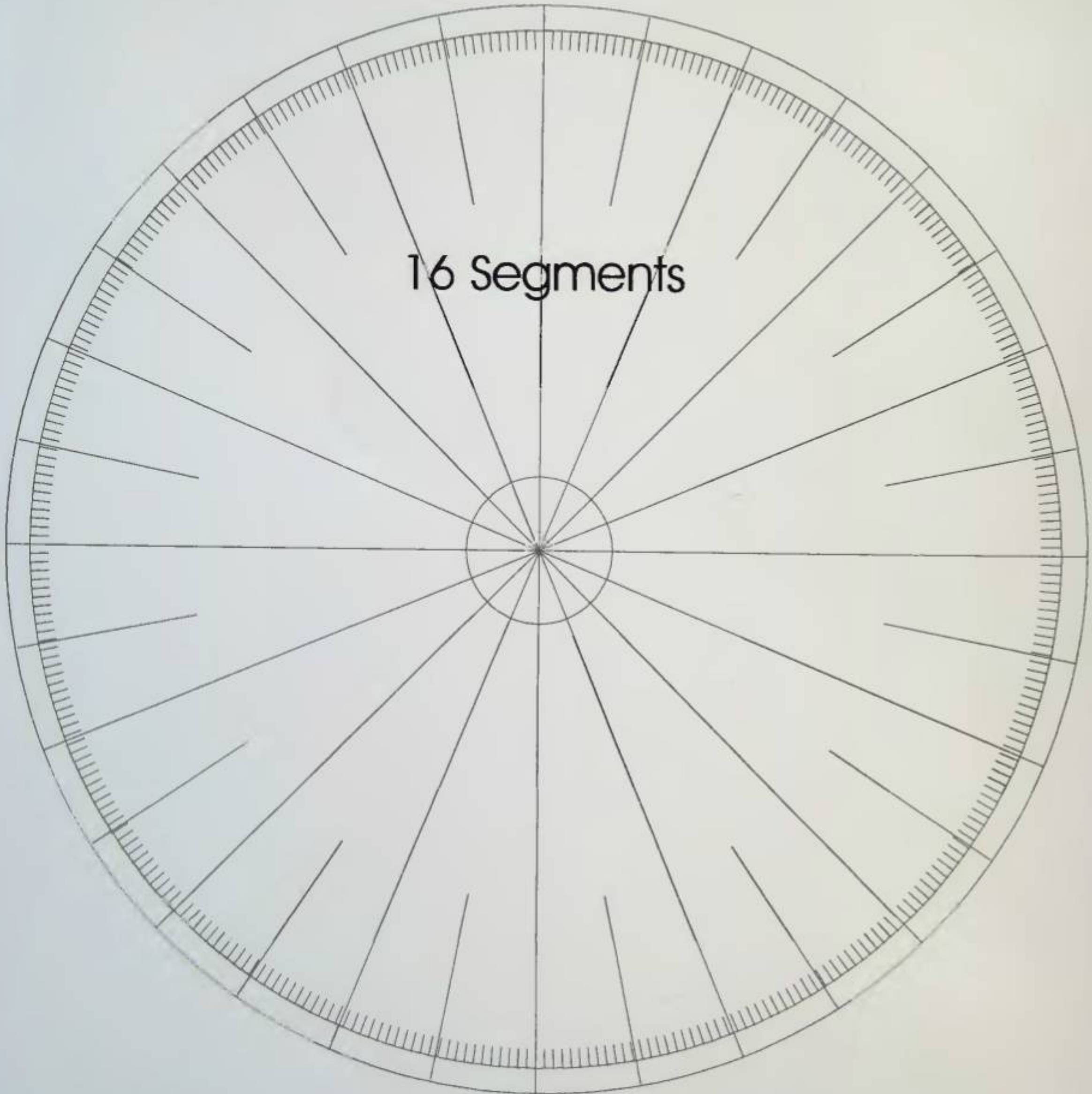
Index Wheels



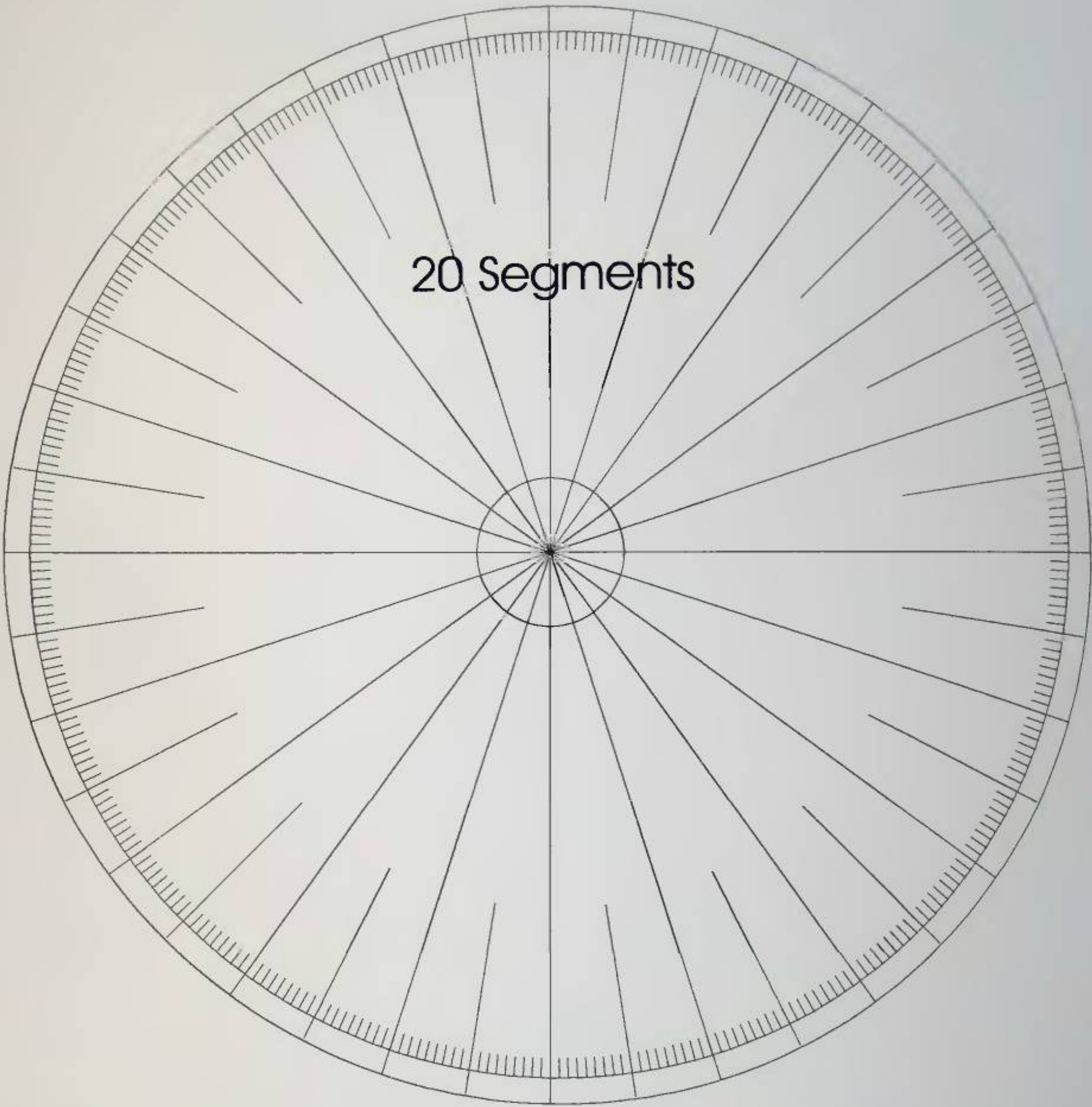
Index wheel for 12 segment turning



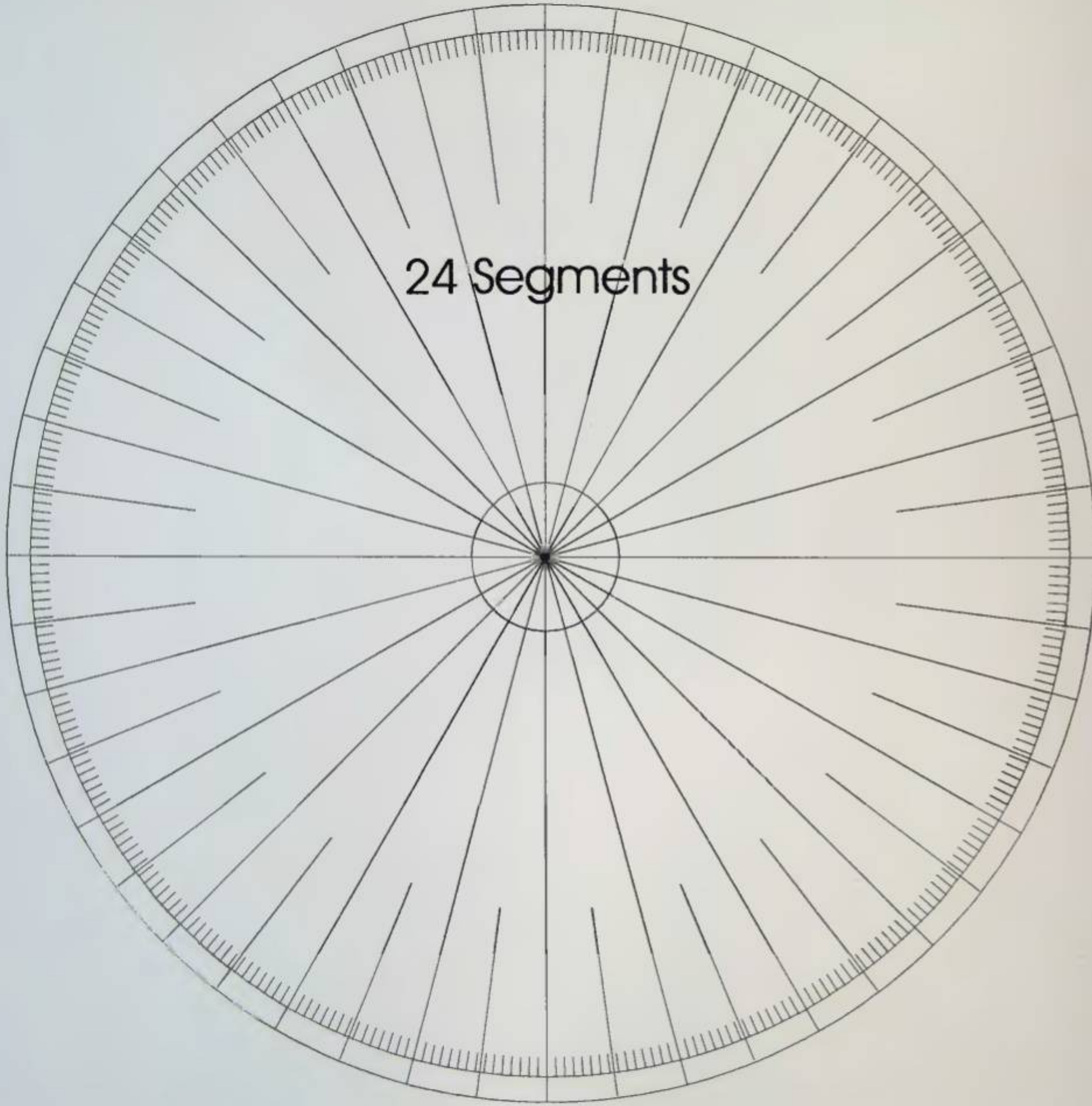
Index wheel for 15 segment turning



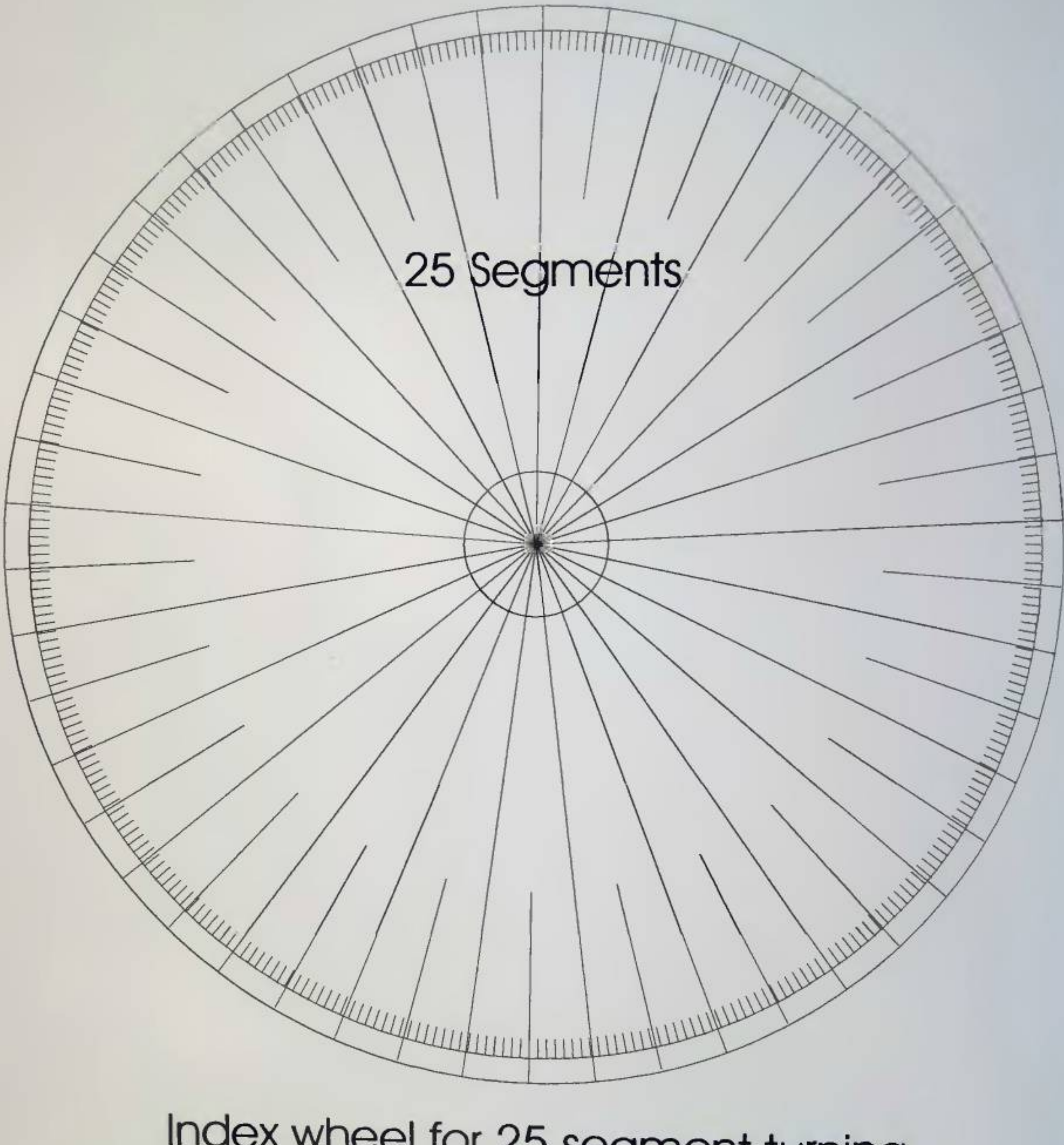
Index wheel for 16 segment turning



Index wheel for 20 segment turning



Index wheel for 24 segment turning



Index wheel for 25 segment turning

Gallery

These pictures should give you many ideas for more advanced work. All of the turnings are constructed using the same basic techniques described in this book. The only variations are the number of segments, the number of layers, and the wood. There is an endless variety of patterns, shapes, and designs awaiting the ambitious woodturner.

This 13 inch diameter vase is made of maple, pau amarello, mahogany, and paduk using 32 segments by 31 layers.

This miniature is 3 inches in diameter and is made of holly and purpleheart. It is 25 segments by 15 layers with the lid and base of 15 segments.

A cone shaped turning of paduk and pau amarello with 25 segments by 32 layers. The outside was left unturned and painted indigo.

An 8 inch walnut bowl with maple segments accenting the rim.

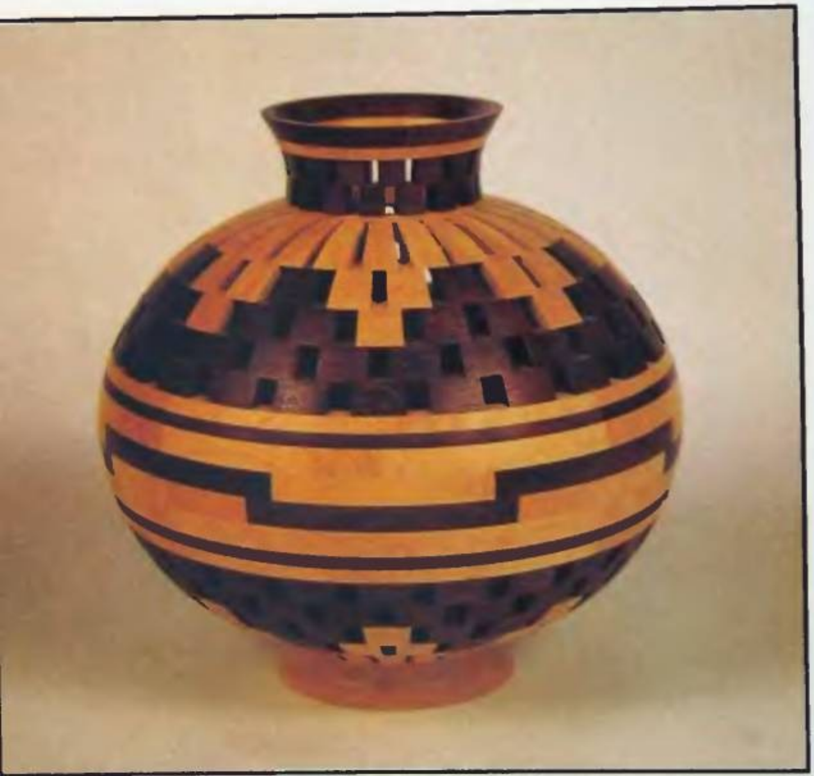
A mahogany and maple sculptural piece, 15 segments by 55 layers. The central section was formed by gluing up pairs of layers and sanding them into wedge shapes. These wedges formed the twists and turns.

This turning was made from the 12 segment project described in this book. A small oil lamp adds interest.

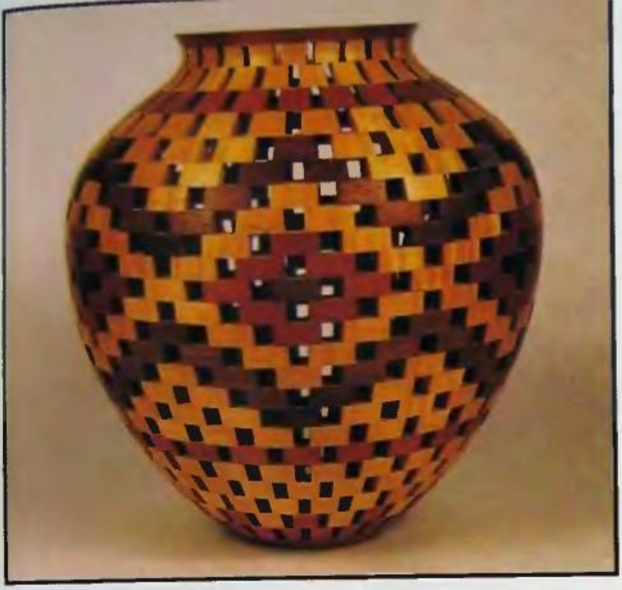
Holly and purpleheart are used in this 25 segment tall vase. The rim and foot are 15 segments.

32 segments by 34 layers provides room for a nice Southwestern design on this maple, mahogany, and walnut vase measuring 15 inches tall.

Another Southwestern design in maple and paduk. This vase is 18 segments by 17 layers and measures 6 inches in diameter. I used the same pattern as the miniature described in the advanced techniques section.



Open segmented construction can be mixed with regular segments to good affect. This 7 inch diameter maple and paduk turning is a favorite.



An interesting design in maple, mahogany, and walnut. This piece suffered a major catch while the inside was being turned but I was able to repair it well enough that it can be displayed in a dark corner. I have found that I am able to repair most pieces damaged during turning.

A hygrometer made of white oak and bubinga. The brass weight moves up and down about 2 inches between summer and winter in the Northeast. It uses five pulleys to magnify the movement of the wood.

The unthinkable does happen from time to time. This one was not repairable.

A 4 inch walnut vessel that is one layer high

Walnut and pau amarello lidded box. The 5 inch diameter box uses the same design as the basic project in this book only the layers have been reduced to 1/4 inch high. The lid was made using the technique described in the advanced section.

A birch, walnut, and maple vase 5 inches high and using 16 segments by 16 layers.

This would make a nice second project. It is 12 segments by 6 layers and about 4 inches in diameter. This was my first successful open segmented turning.

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