Segmented Vessels

Our Definition

A Vessel
(bowl, vase, goblet, etc.)
made from rings of segments!

Some Vessels

Rings versus Staves

- There is a difference

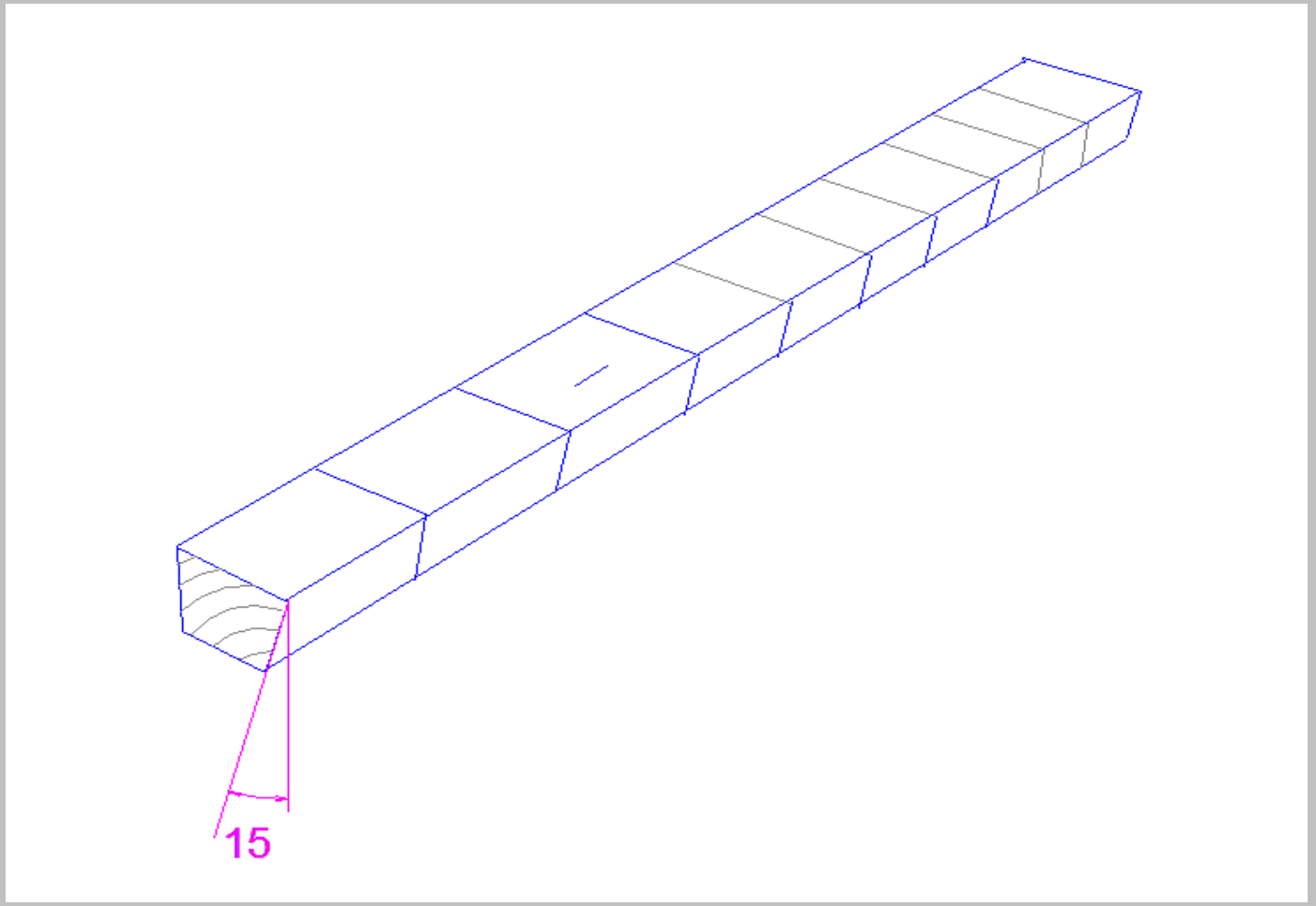
- Rings of segments
  - ***What we're doing here!***
- Stave construction
  - Similar but different
- They can be combined with care.

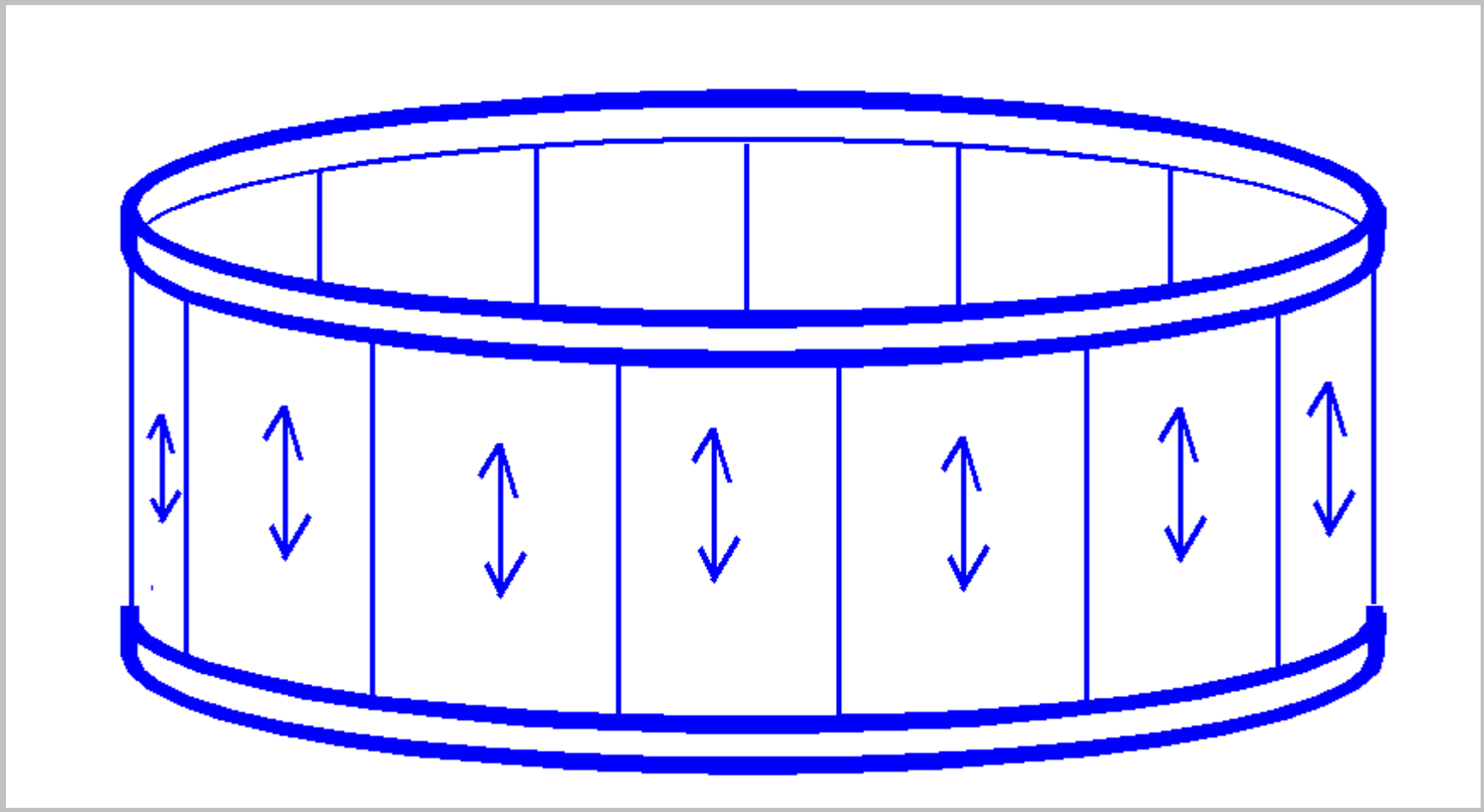
Segmented and Staved

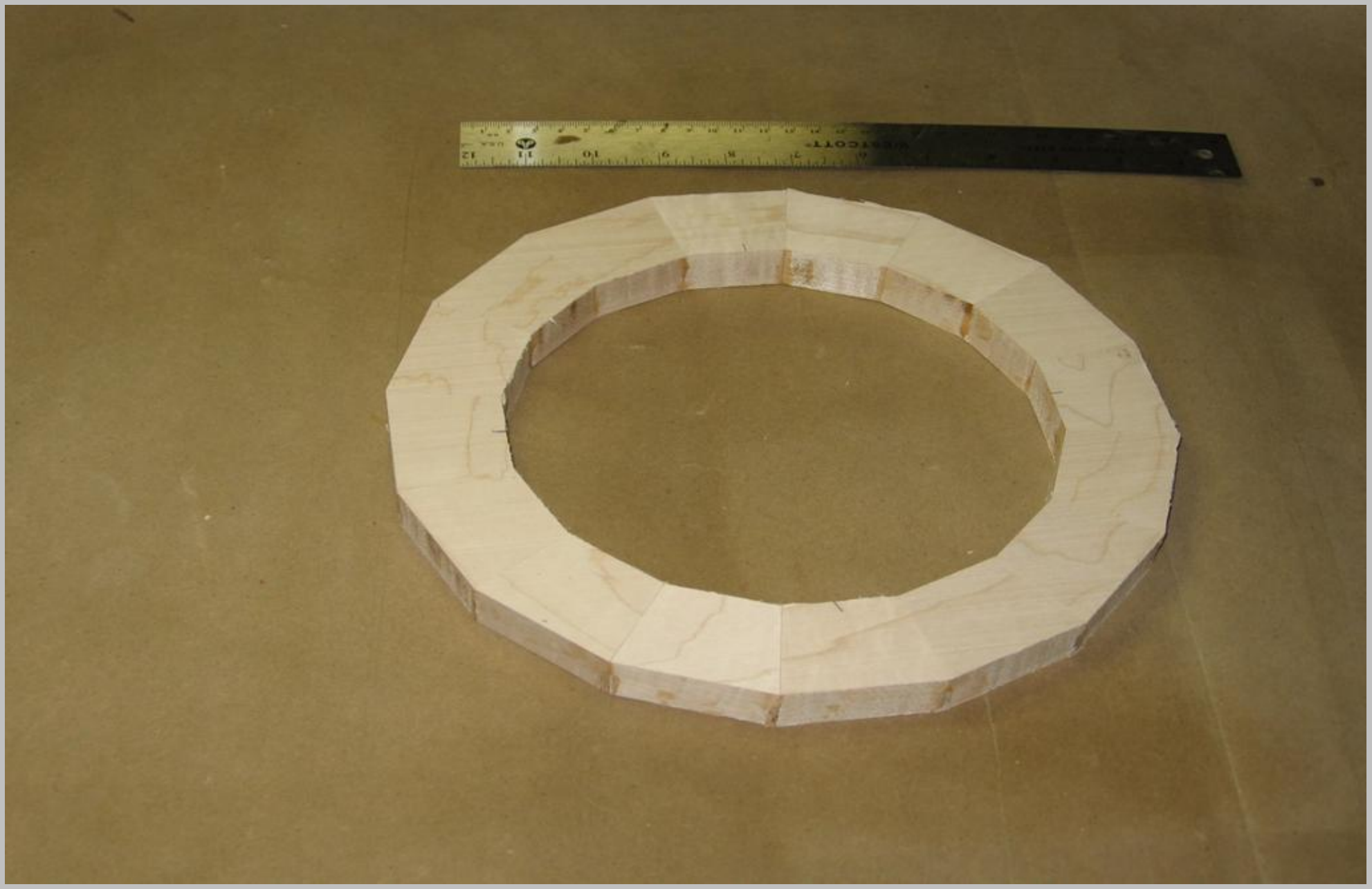
Stave Vessel

Segment/Stave Mix

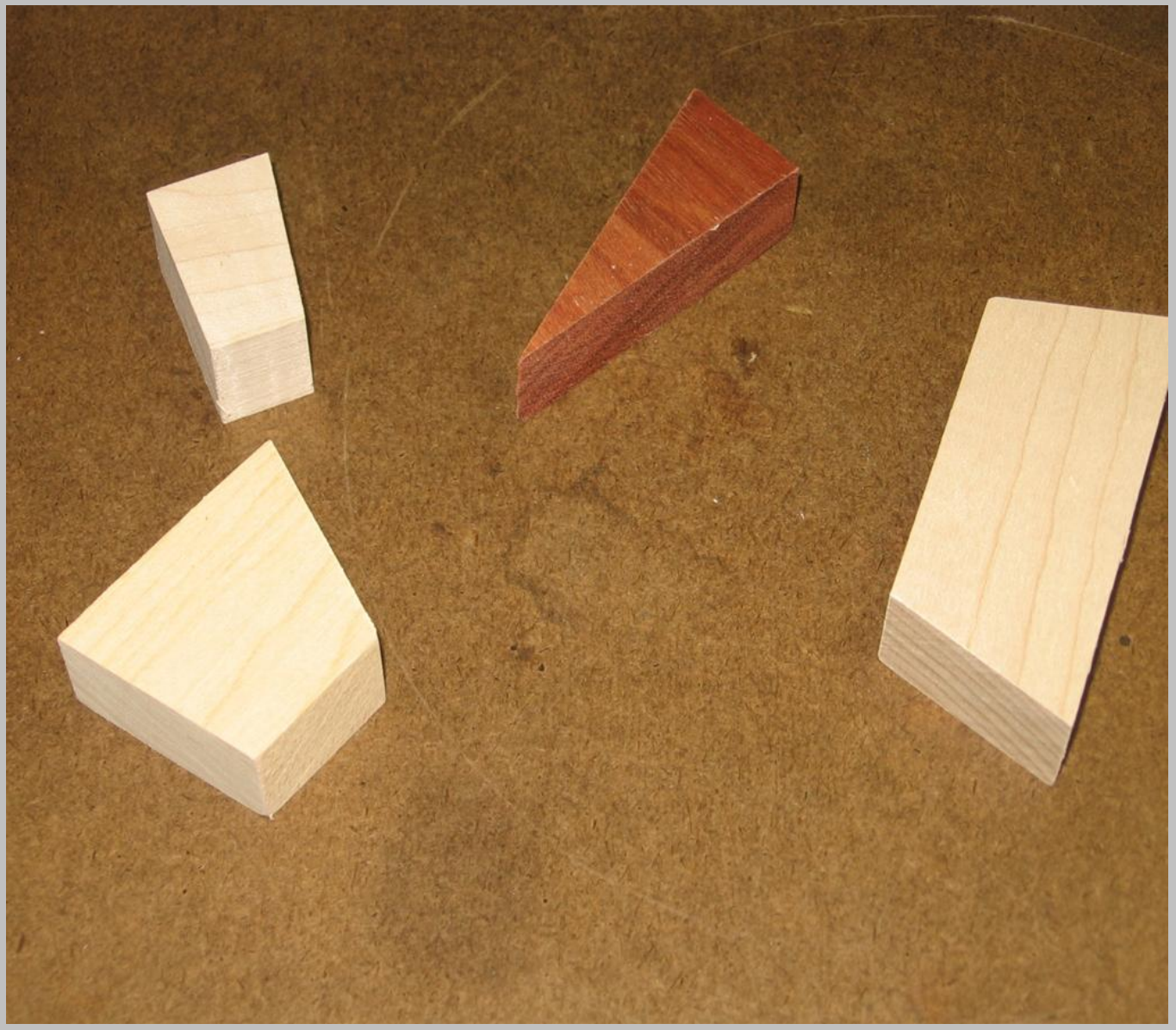
Stave Construction



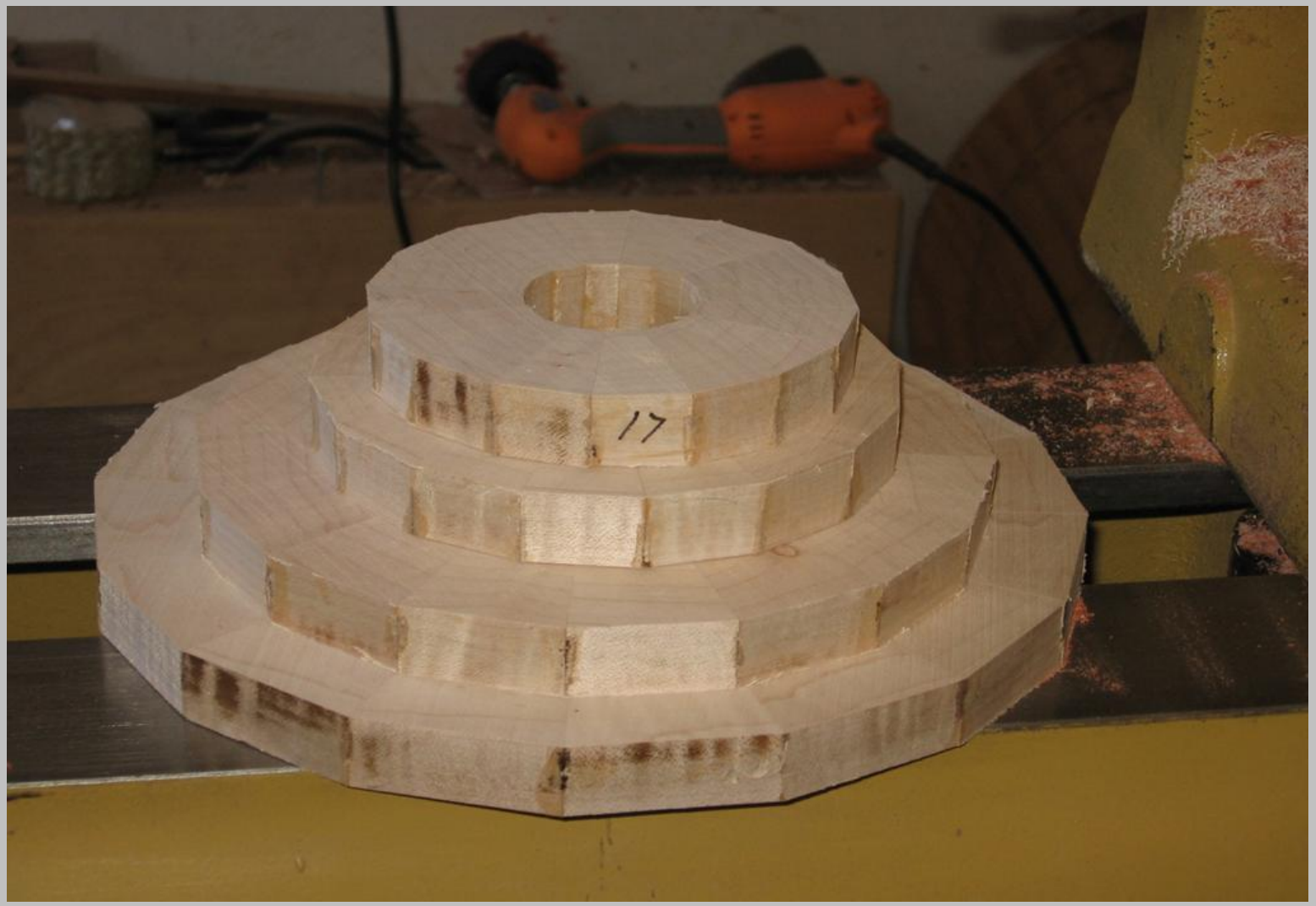




A Ring of 16 Segments

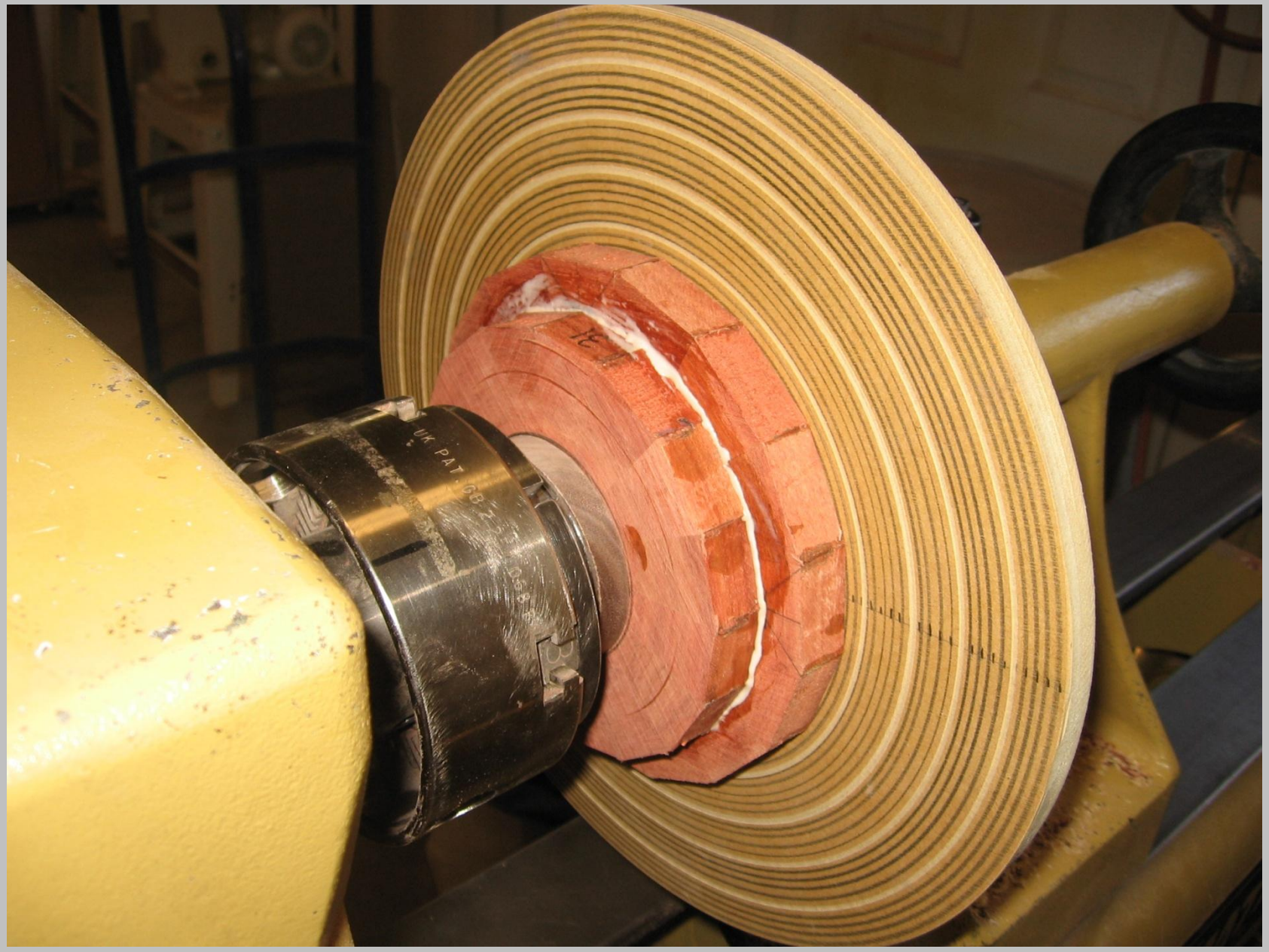


Examples of Segments



Stacks of Rings

One way to Assemble the Stacks



Another way to Assemble Stacks

Turning your Stacks of Rings

Putting Things Together

Review

- Vessels are made from Rings
- Rings are made from Segments
- Segments are made from Lumber
- Rings are assembled into Stacks
- Stacks are Assembled into Vessels
- And turned

Where to Begin ?

The Process

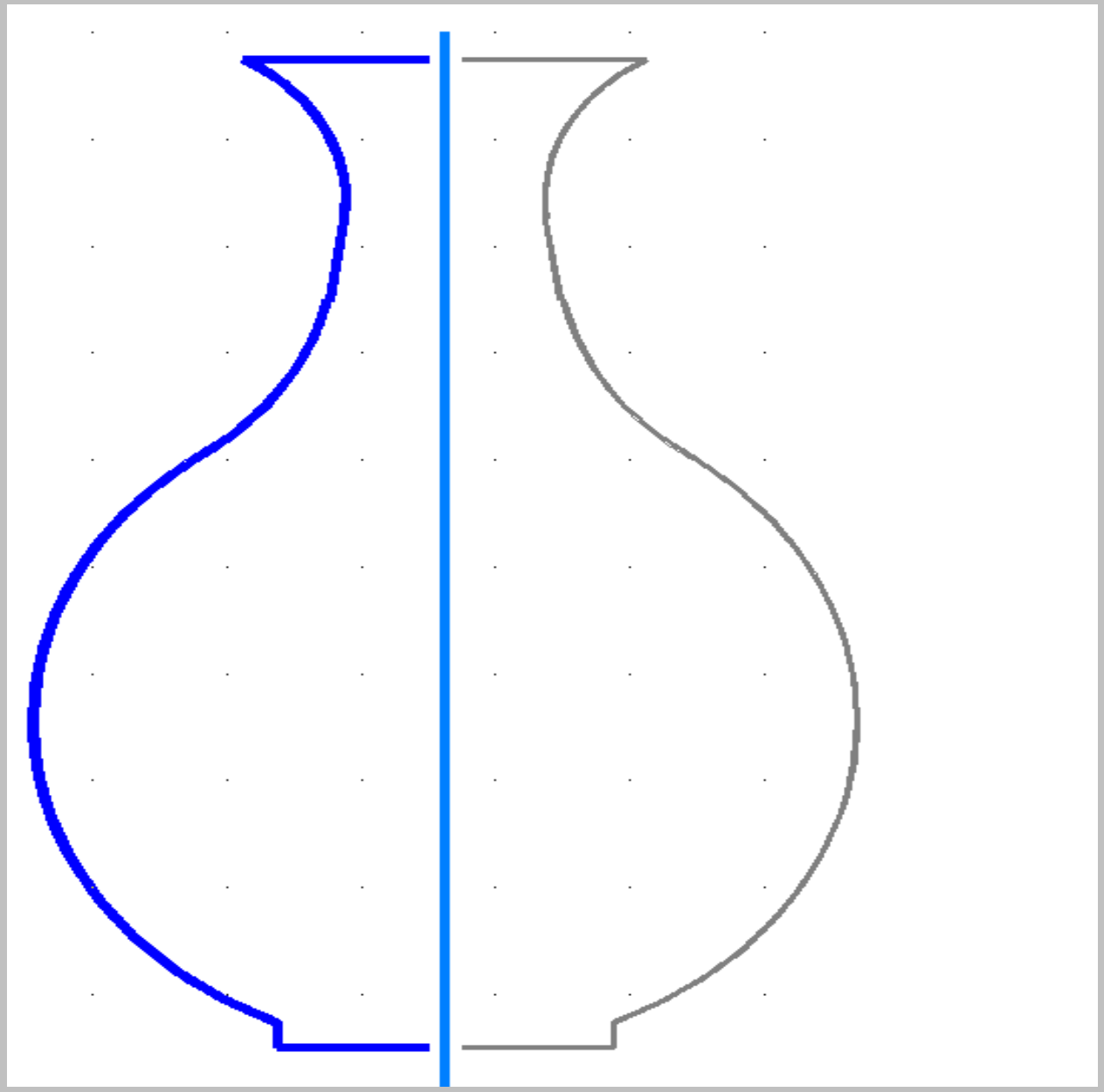
- Design – Shape, Size, Features
- Detailing – Create the Cut List
- Collect and Mill the Lumber
- Cut Segments
- Make Rings
- Assemble Rings into Stacks
- Turn the Stacks

Design

Tools & Materials:

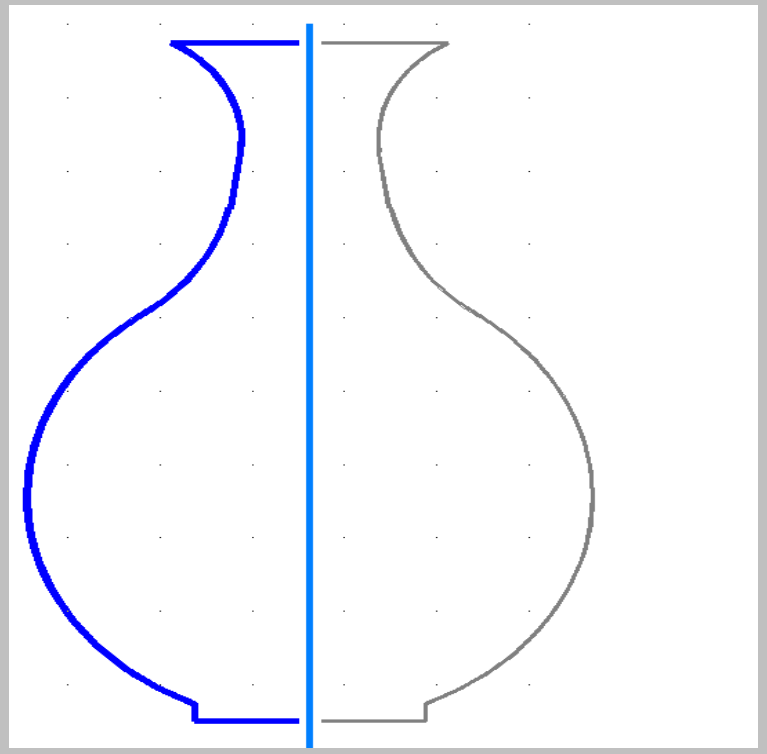
- Pencil, Eraser
- Quadrule Paper
- Straight Rule
- Curve Drawing Aids?

Refine, Select, Darken



Work period

- Take out piece of paper
- Draw a line down it’s center
- Draw left half of form
- Refine form on left side
- Darken form
- Fold paper down line
- Trace form to both sides



Detailing

Tools and Materials:

- Your pencil (and eraser?)
- A Straight Rule
- A Calculator (or strong constitution)*
- Your Sketch of the Design

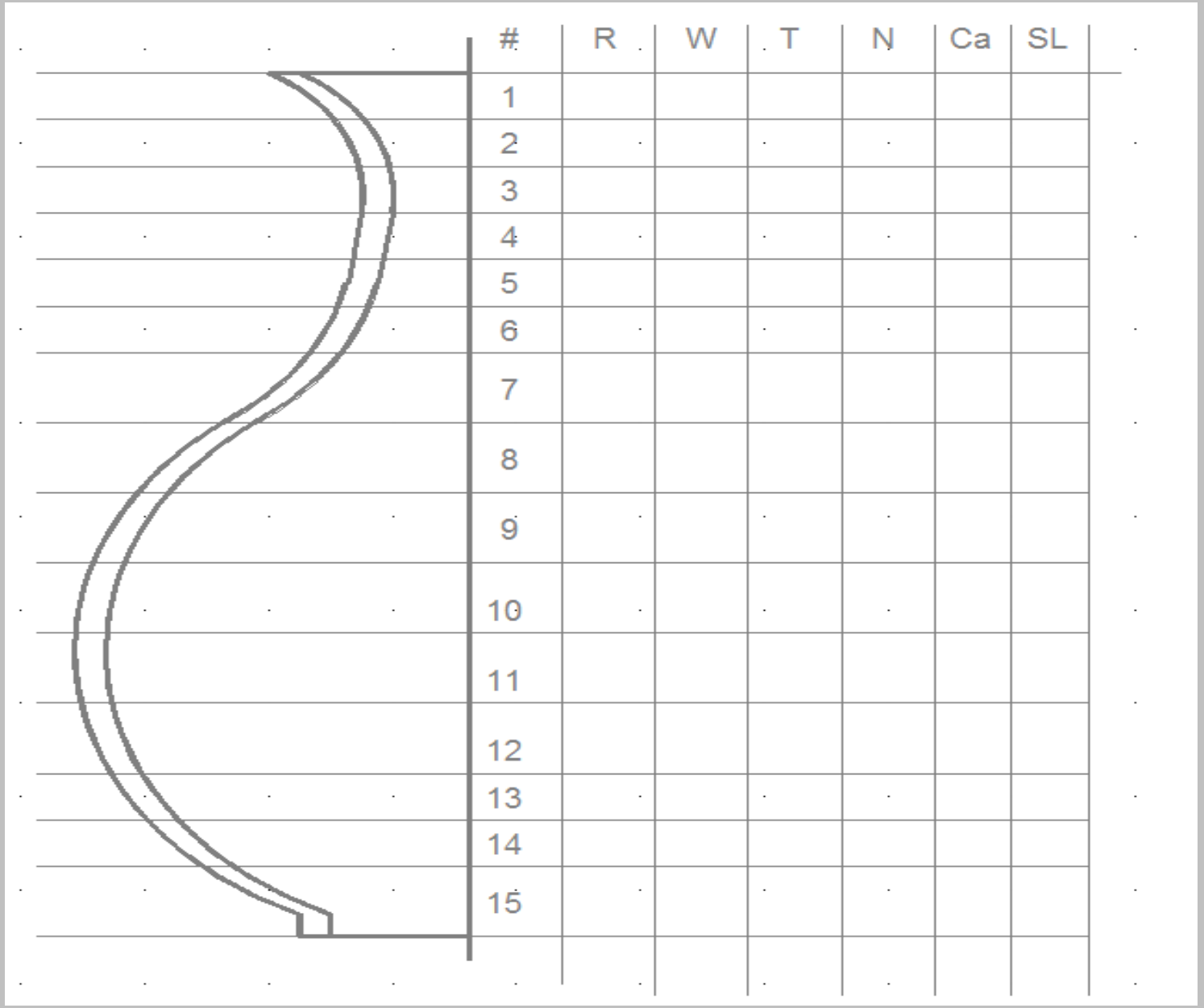
* Spread sheet programs will help and are available.

Detailing

Objective: Turn Your Design into a Cut List

- Draw in Segment Profiles on your Sketch
- Measure and record Profile Parameters
- Calculate Cut Angle and Segment Length
- Calculate Length and Width of Lumber for each Ring
- Create Cut List

Detailing Sheet



#	R	W	T	N	Ca	SL
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Ground School

Put down the pencil for a minute !

Let’s discuss segments

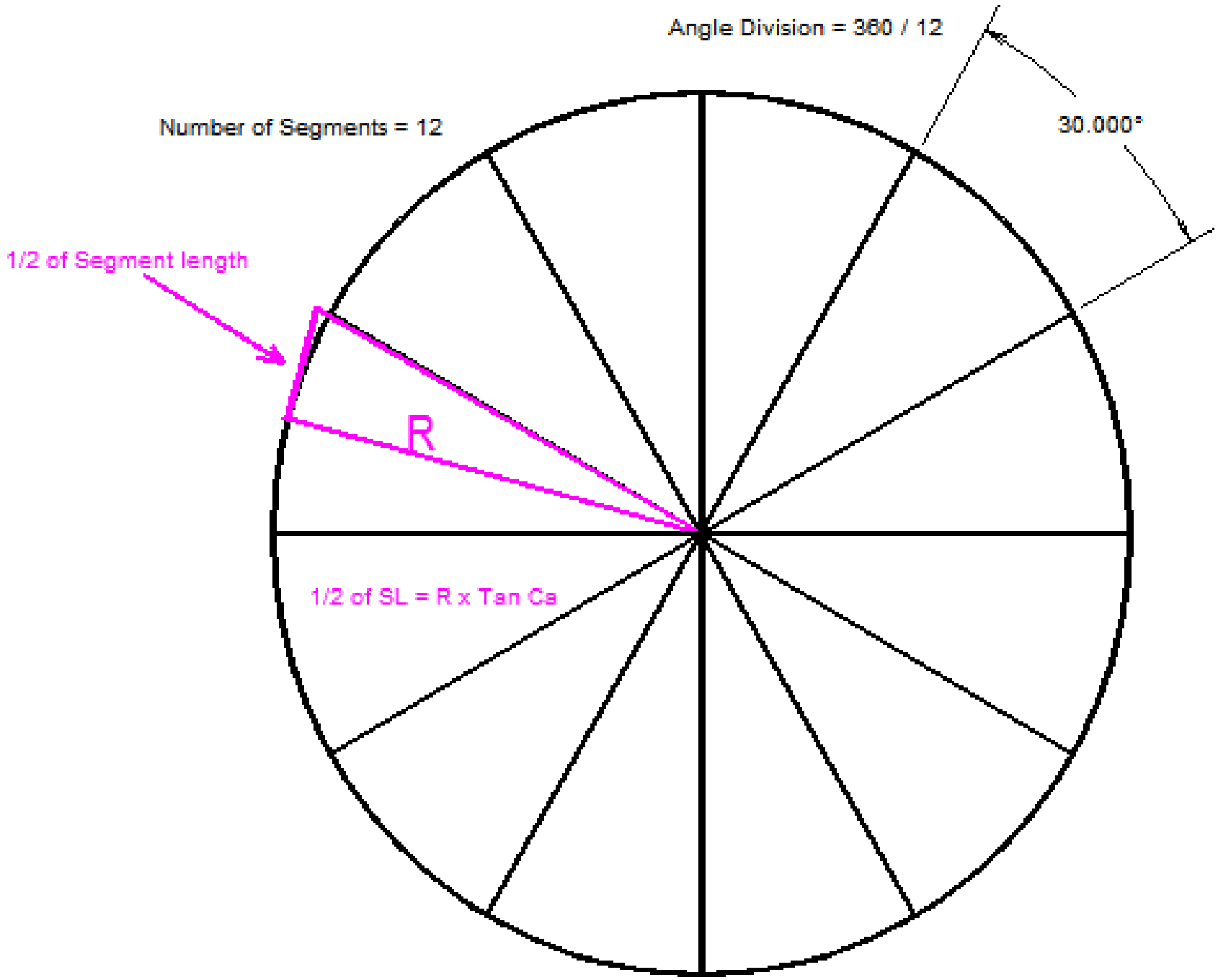
Understanding Segments

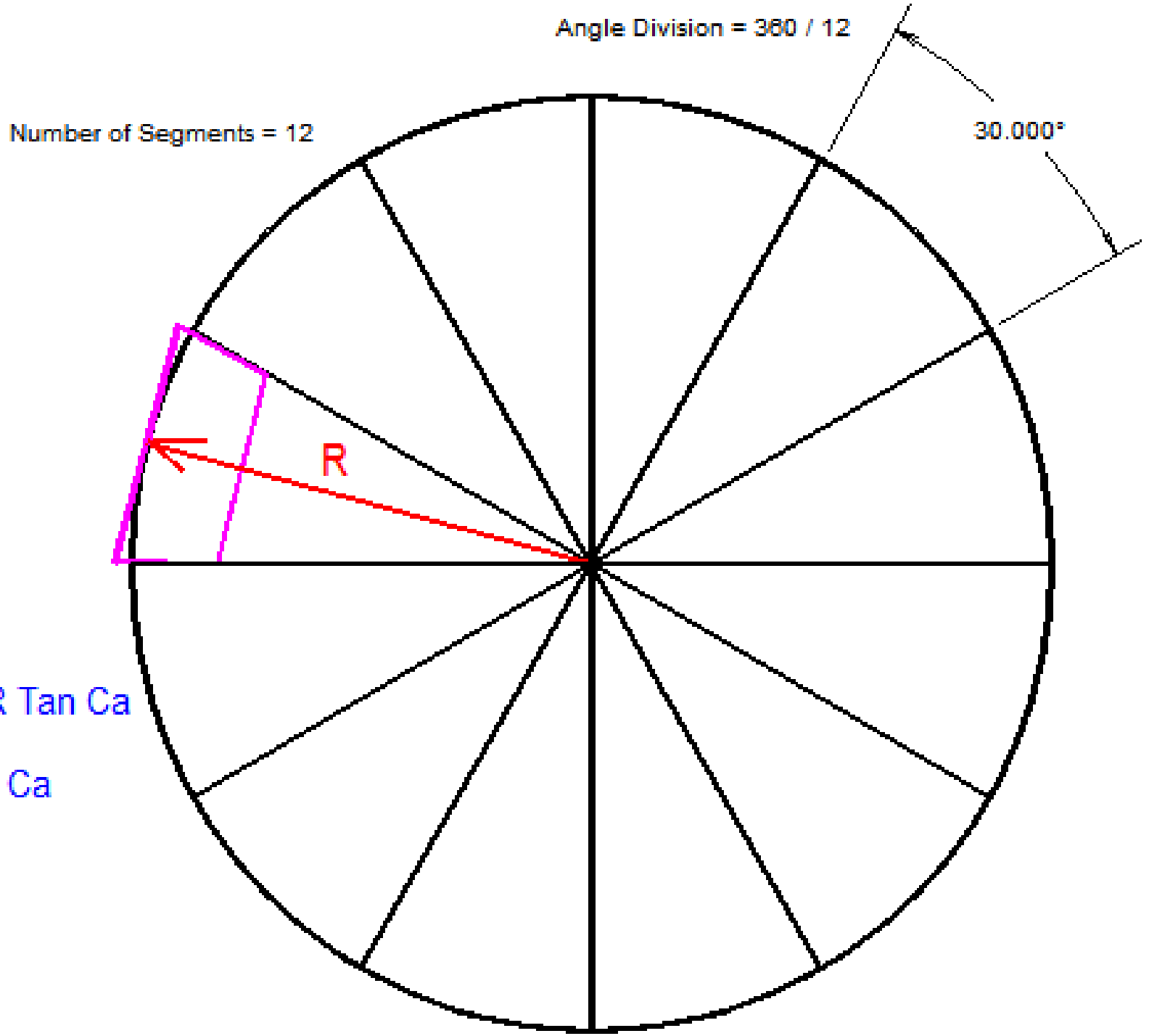
Critical Parameters

Ca == Cut Angle

SL == Segment Length


CA
SL


Angle Division = 360 / 12
30.000°
Number of Segments = 12
1/2 of Segment length
R
1/2 of SL = R x Tan Ca



If 1/2 SL == R Tan Ca
Then
SL = 2 R Tan Ca

Wait a Minute!!

Why the Trigonometry ??

Why not just divide the Circumference by the Number of Segments?

Because: The ring gets smaller if N is small !

But if N is large enough it's OK !

SL Calculation Options

- For N equal to or greater than 12 use:

  SL = 6.28 x Radius / N

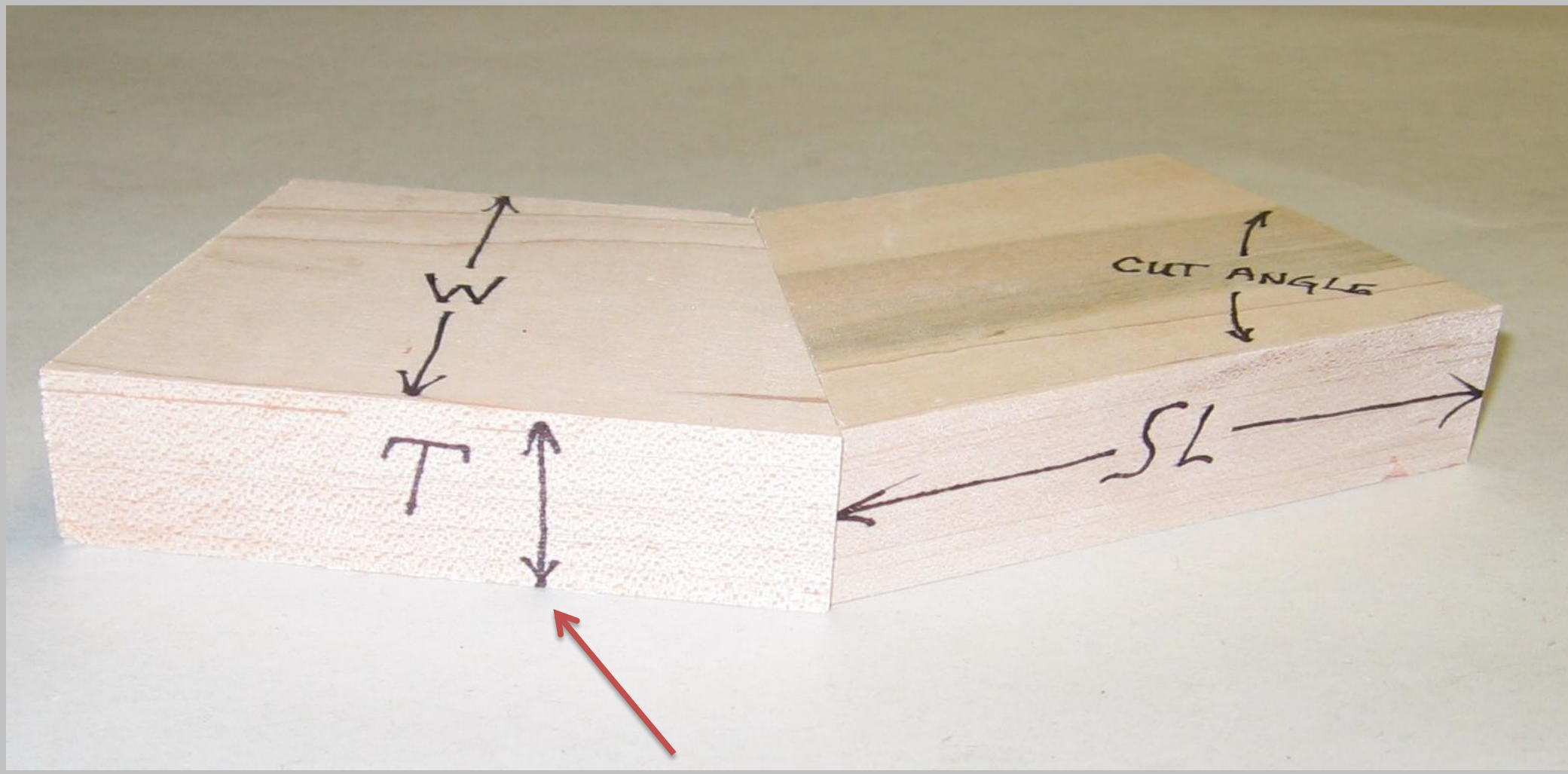
  Hint: 6.28 x Radius ~ = Circumference

- For N less than 12 use:

  SL = 2 x R x Tan(Ca)

- For all Spreadsheet use:

  SL = 2 x R x Tan(Ca)



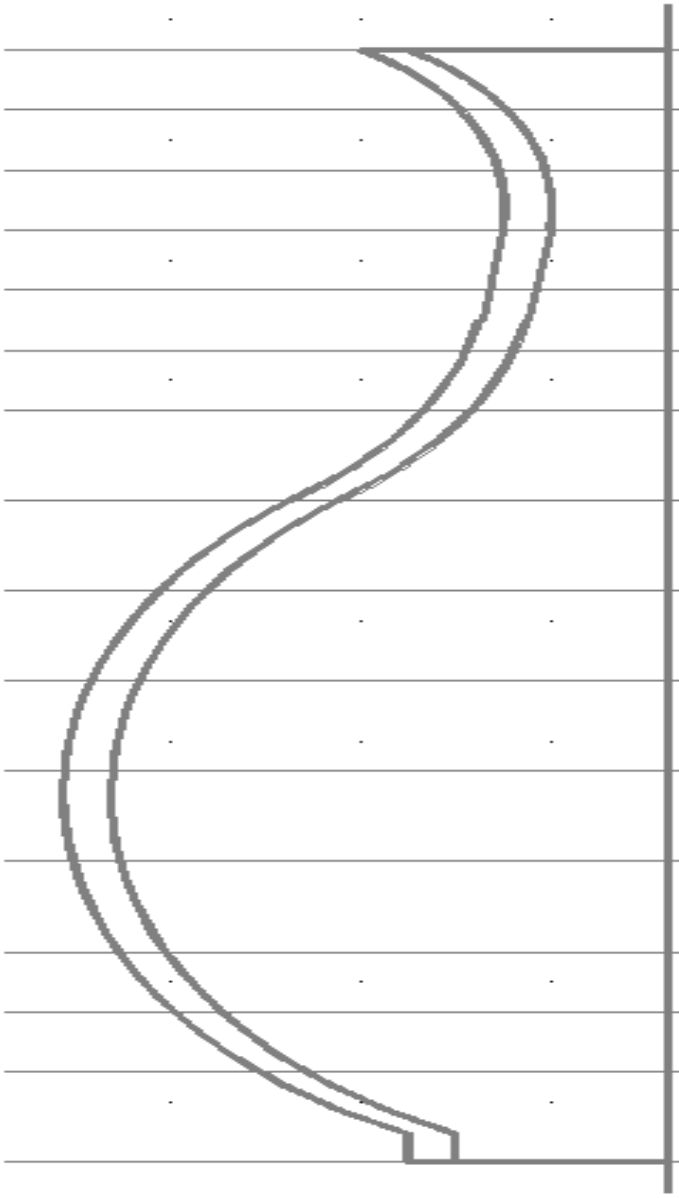
The not so critical parameters

W == Width

T == Thickness

Determining Parameters

- Create your Detailing Sheet
- Transfer left side of vessel onto it
- Sketch the Inside Wall of Vessel
- Sketch in the Segments
- Measure and Write in Parameters
- Calculate Segment Length and Cut Angle



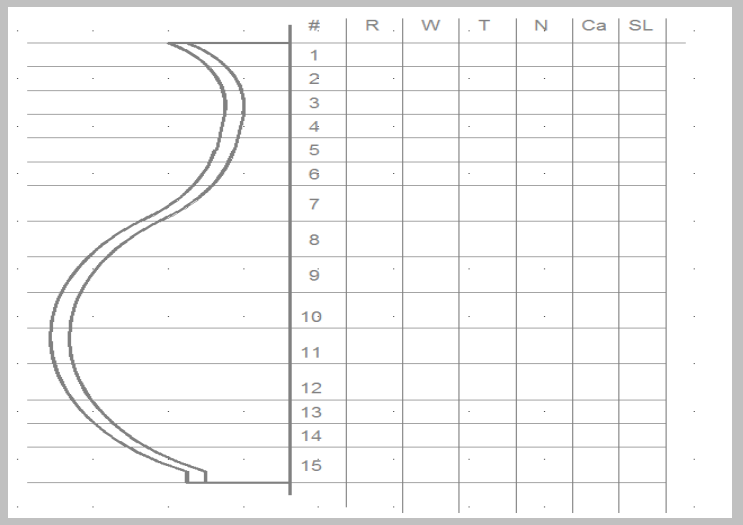
#	R	W	T	N	Ca	SL
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

 # is sequential number of each ring

R == Radius W == Width T == Thickness
N == Number of Segments Ca == Cut Angle
SL == Segment Length

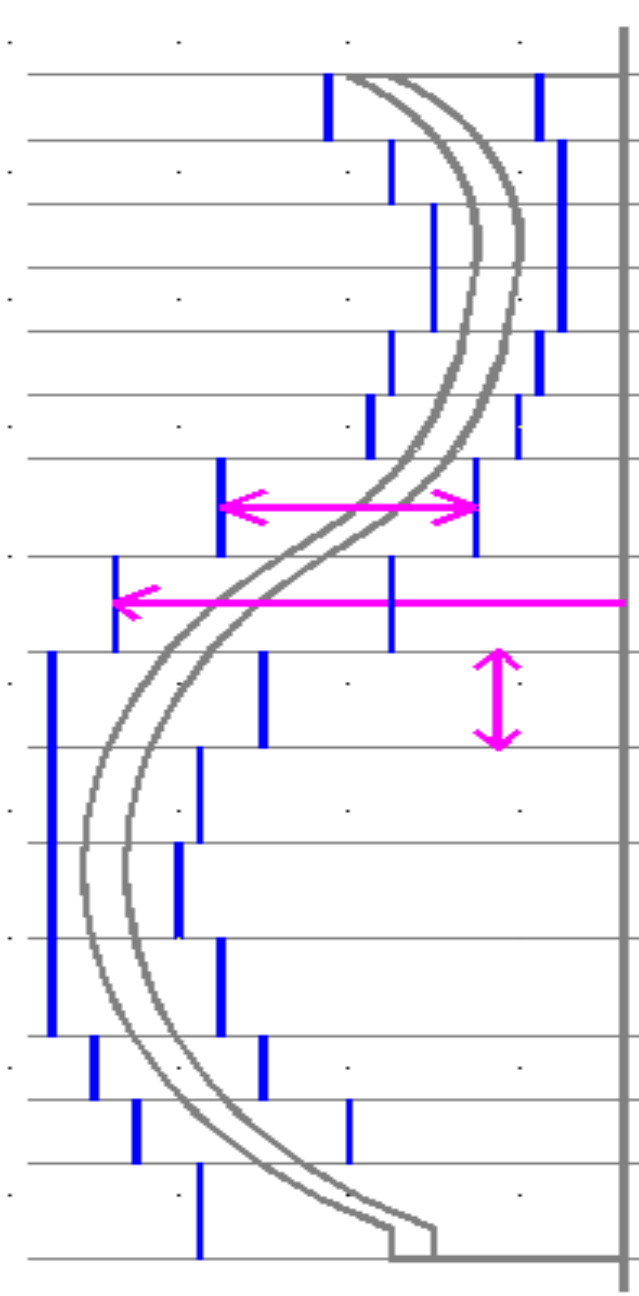
Work period

- Create your Detailing Sheet
- Write in Ring Number #
- Transfer left side of vessel onto it
- Sketch the Inside Wall of Vessel

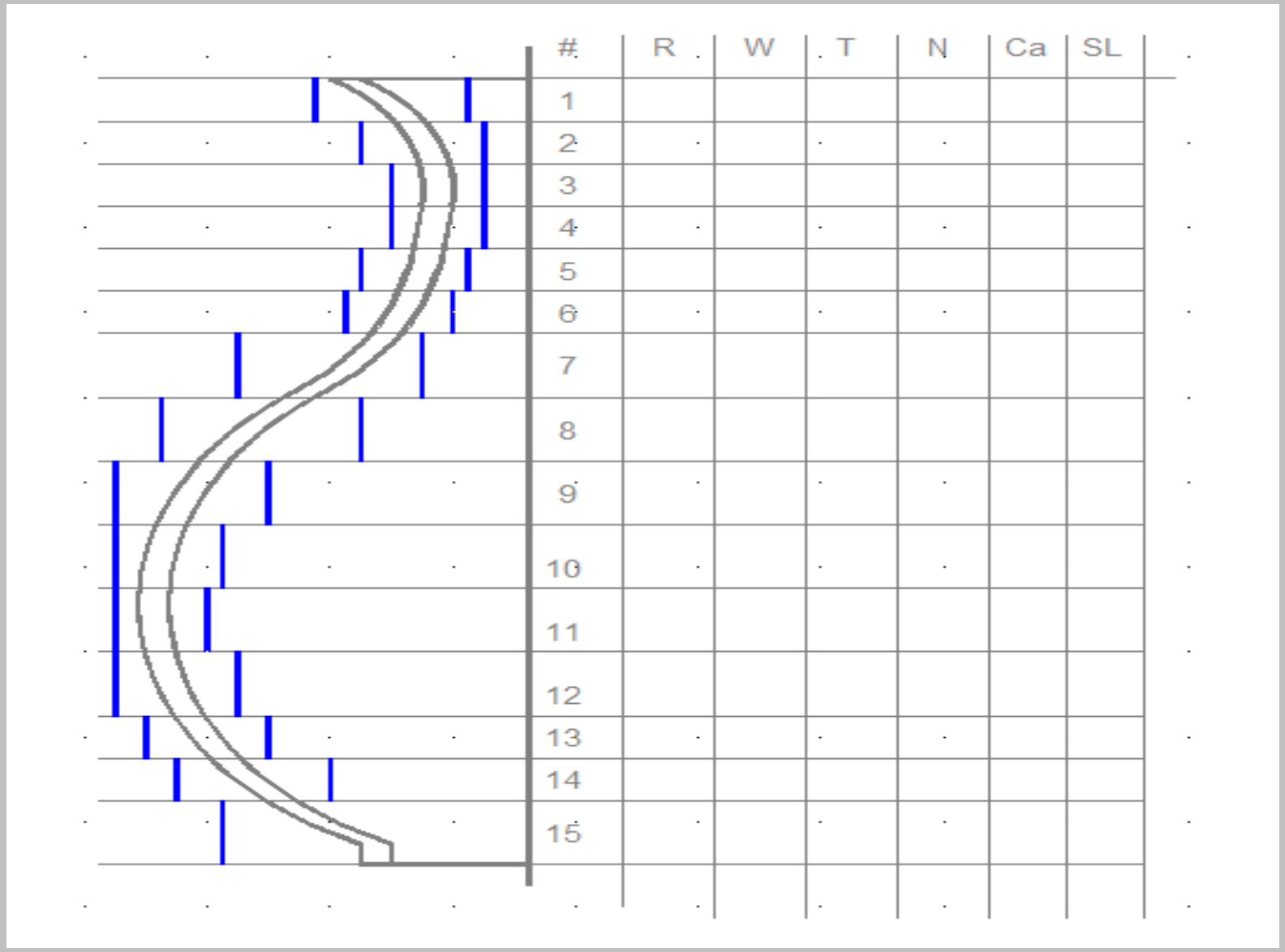


Ground School

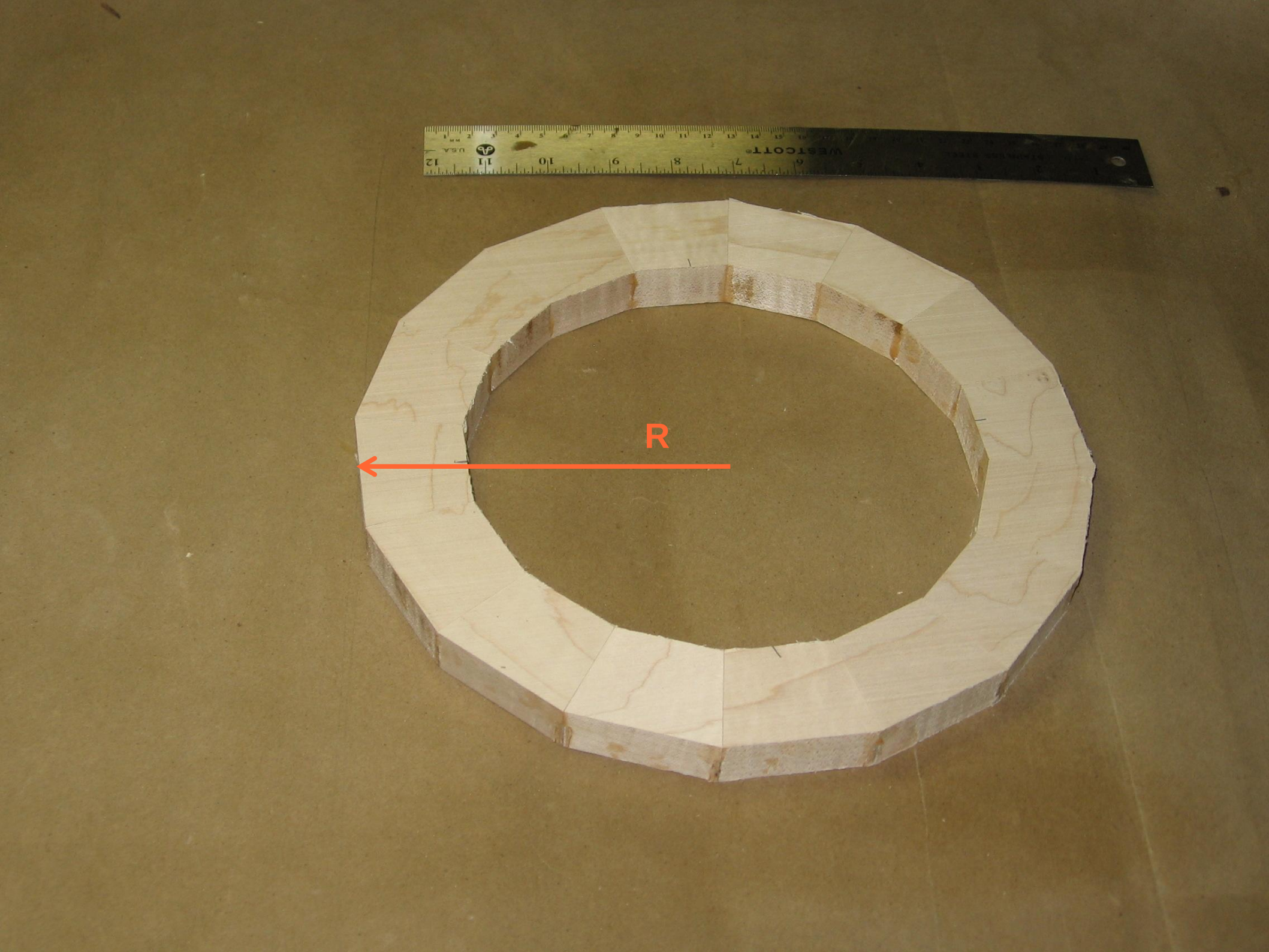
Put down the pencil for a minute !

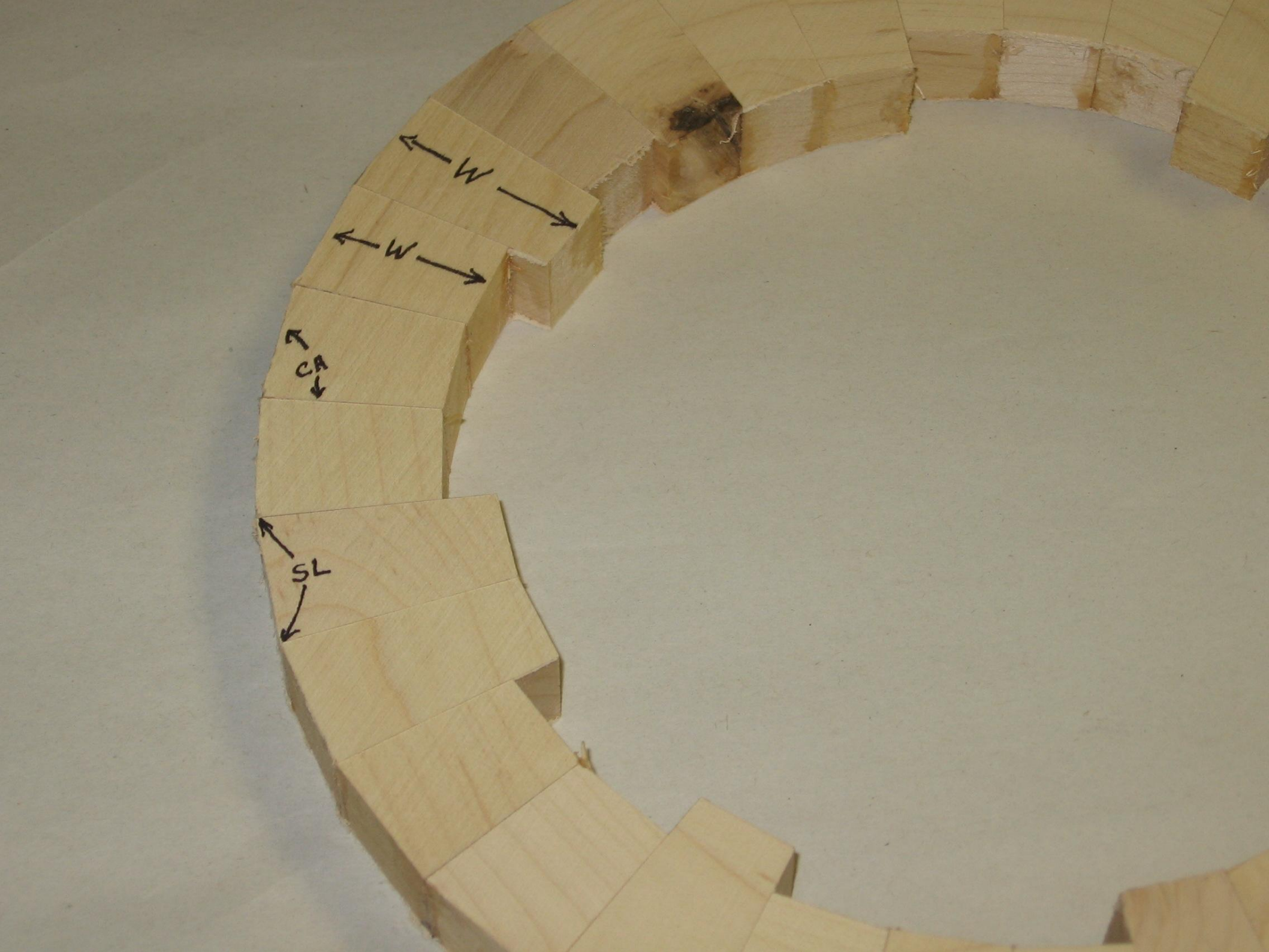


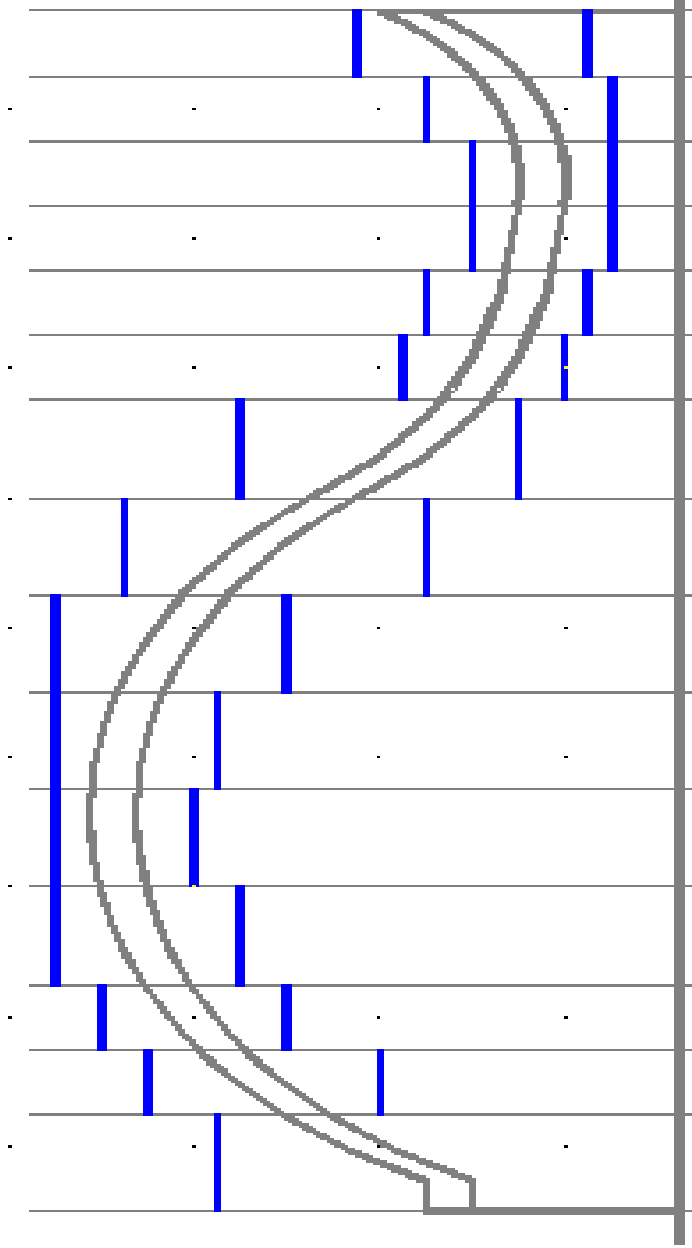
#	R	W	T	N	Ca	SL
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						



R == Radius W == Width T == Thickness
N == Number of Segments Ca == Cut Angle
SL == Segment Length


R

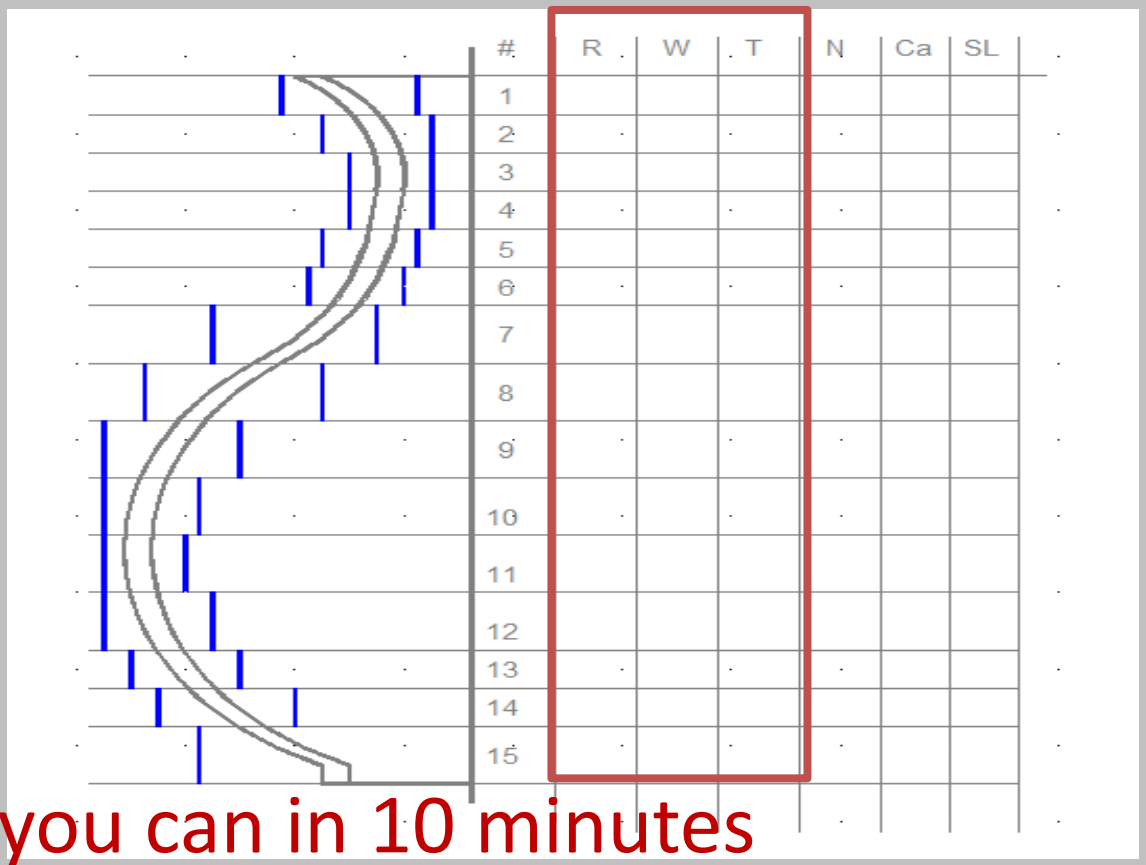

W
W
CA
SL



#	R	W	T	N	Ca	SL
1						
2						
3						
4						
5						
6						
7	3	2	1	16		
8						
9						
10						
11						
12						
13						
14						
15						

Work Period

- Draw in segments
- Write in your measurements



Do as many as you can in 10 minutes

Ground School

Put down the pencil for a minute !

Mixing Segments

- As a general rule:
  - Segments are in ***even*** multiples
    - Mix 4 segment rings with 8, 16, 32 segment rings
    - Mix 6 segment rings with 12 or 24 segment rings
    - Mix 10 segment rings with 20 or 40 segment rings
  - Segments need not be even numbers though
    - Mix 9 segment rings with 18 segment rings
    - Mix 7 segment rings with 14 segment rings
  - Don’t let rules inhibit your creativity

The Calculations

$$Ca = 180 / N$$

and

$$SL = 2 \times R \times \tan Ca$$

or

$$SL = 6.28 \times R / N$$

Ca == Cut Angle
N == Number of segments in the ring
R == Radius from the chart

Plug in the numbers

(Example: Assuming Radius is 3 and 16 segments)

Ca = 180 / 16 = 11.25 Degrees

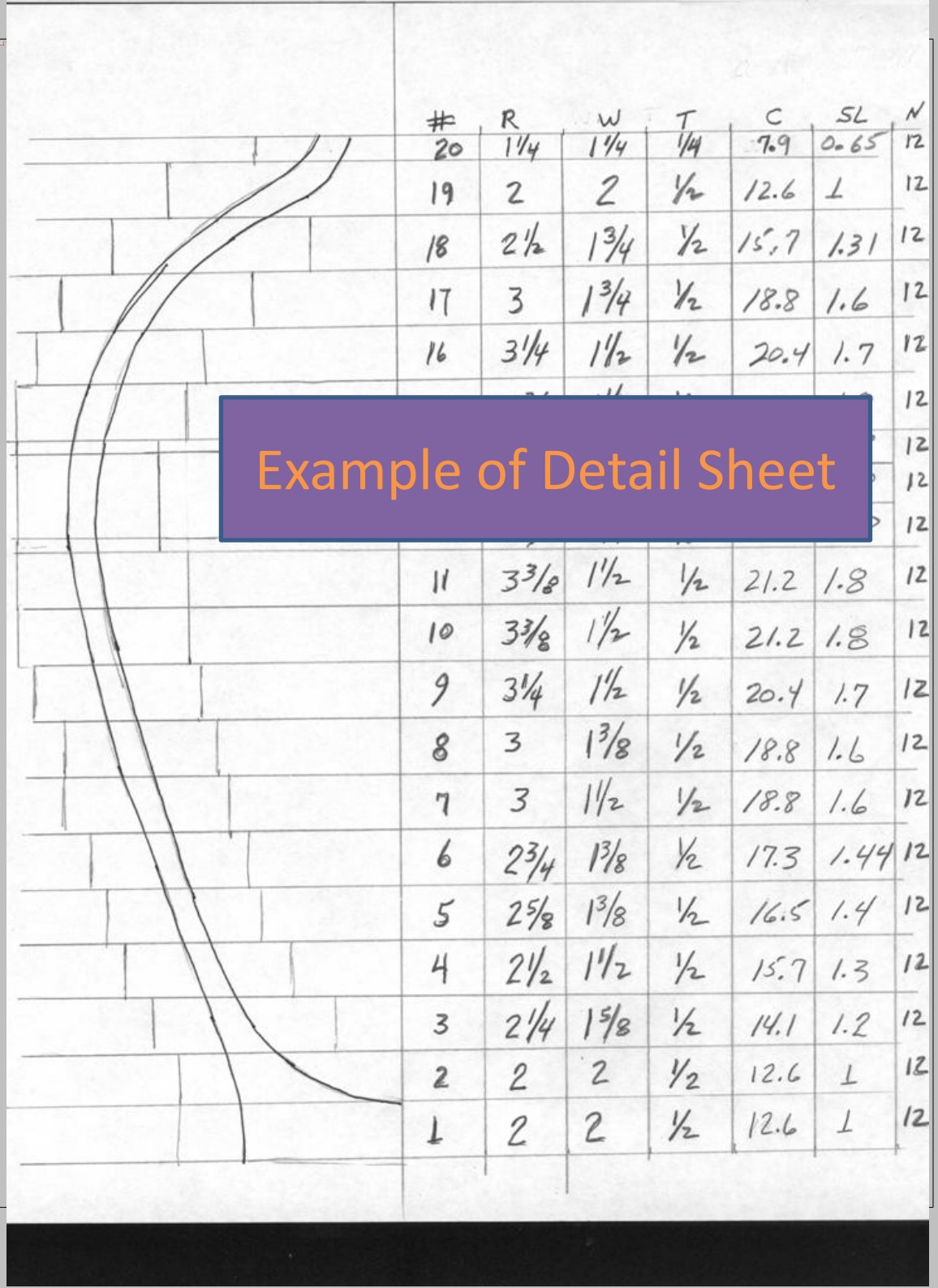
SL = 2 x 3 x Tan 11.25 = 1.193”

< Or >

SL = 6.28 x R / N = 1.1775

Put down the calculator. The Tangent of 11.25 is 0.1989

Num Seg	CUT ANGLE	TANGENT
4	45.00	1.0000
5	36.00	0.7265
6	30.00	0.5774
7	25.71	0.4816
8	22.50	0.4142
9	20.00	0.3640
10	18.00	0.3249
11	16.36	0.2936
12	15.00	0.2679
13	13.85	0.2465
14	12.86	0.2282
15	12.00	0.2126
16	11.25	0.1989
17	10.59	0.1869
18	10.00	0.1763
19	9.47	0.1669
20	9.00	0.1584



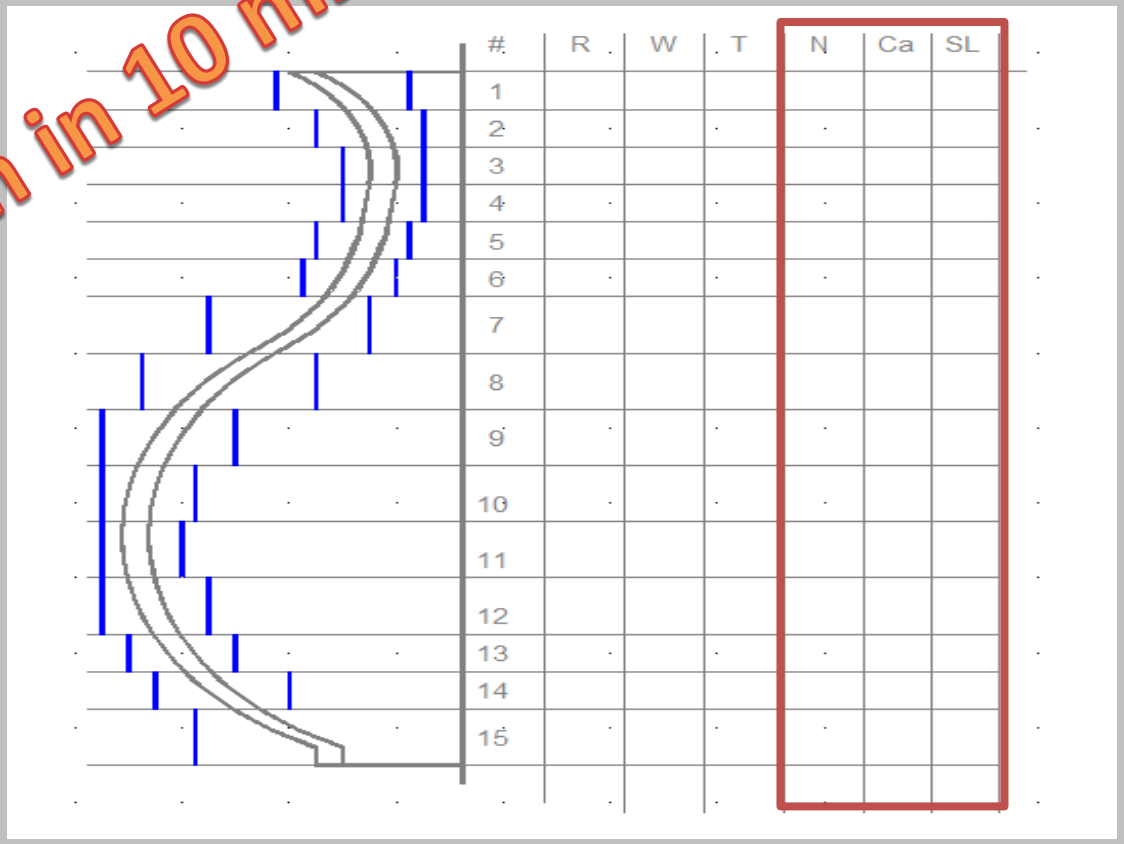
#	R	W	T	C	SL	N
20	1 1/4	1 1/4	1/4	7.9	0.65	12
19	2	2	1/2	12.6	1	12
18	2 1/2	1 3/4	1/2	15.7	1.31	12
17	3	1 3/4	1/2	18.8	1.6	12
16	3 1/4	1 1/2	1/2	20.4	1.7	12
						12
						12
						12
						12
11	3 3/8	1 1/2	1/2	21.2	1.8	12
10	3 3/8	1 1/2	1/2	21.2	1.8	12
9	3 1/4	1 1/2	1/2	20.4	1.7	12
8	3	1 3/8	1/2	18.8	1.6	12
7	3	1 1/2	1/2	18.8	1.6	12
6	2 3/4	1 3/8	1/2	17.3	1.44	12
5	2 5/8	1 3/8	1/2	16.5	1.4	12
4	2 1/2	1 1/2	1/2	15.7	1.3	12
3	2 1/4	1 5/8	1/2	14.1	1.2	12
2	2	2	1/2	12.6	1	12
1	2	2	1/2	12.6	1	12

Example of Detail Sheet

Work period

- plug in Segment raw data
- perform calculations
- fill in worksheet

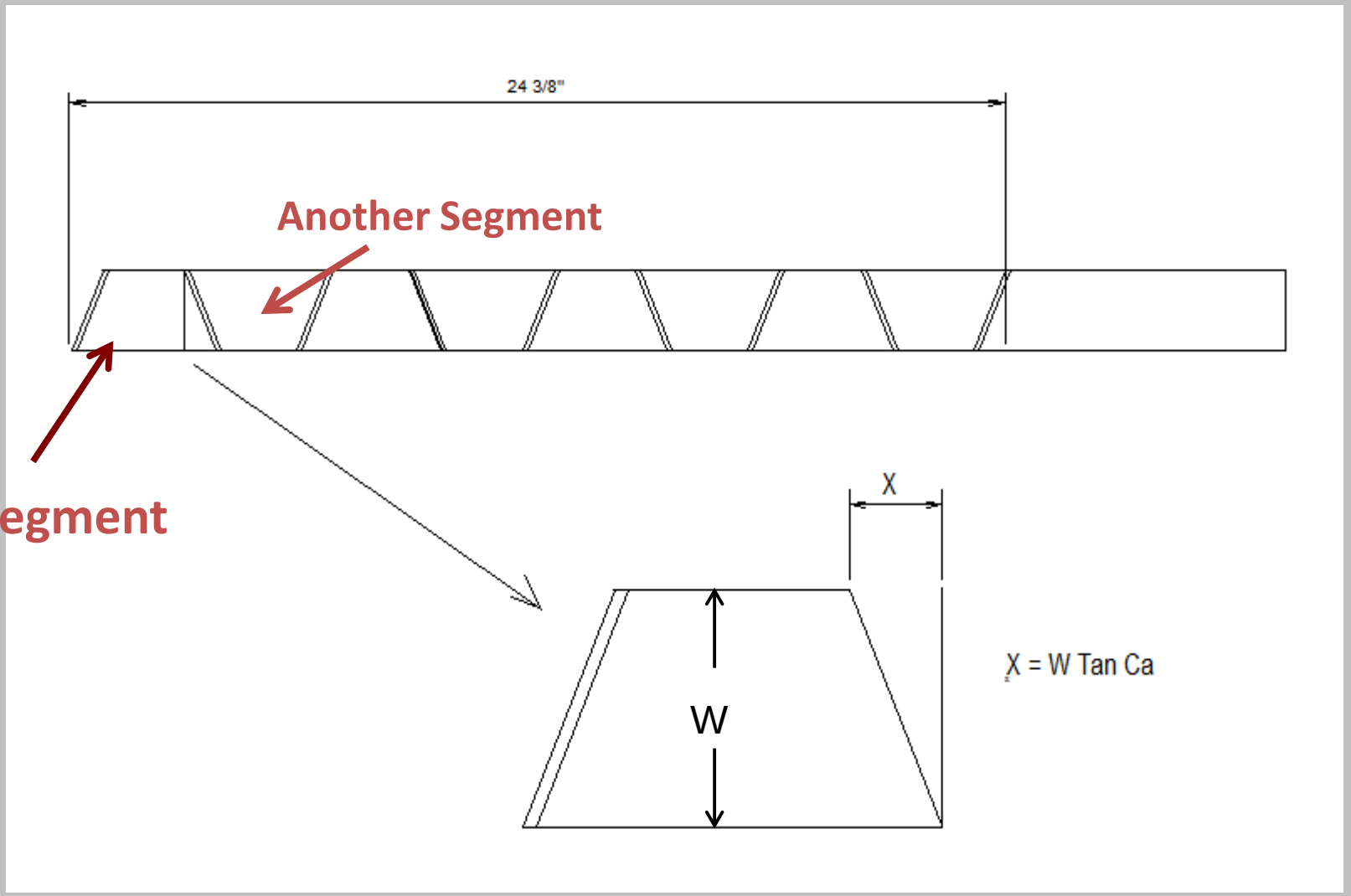
Do all you can in 10 minutes !



Ground School

Put down the pencil for a minute !

Calculating Board Length



Calculating Board Length

BL = Safety section + N x {(SL + Blade width) – W x Tan (Ca)}

Again: **N = Number of segments**

SL = Segment Length

W = Width of the segment

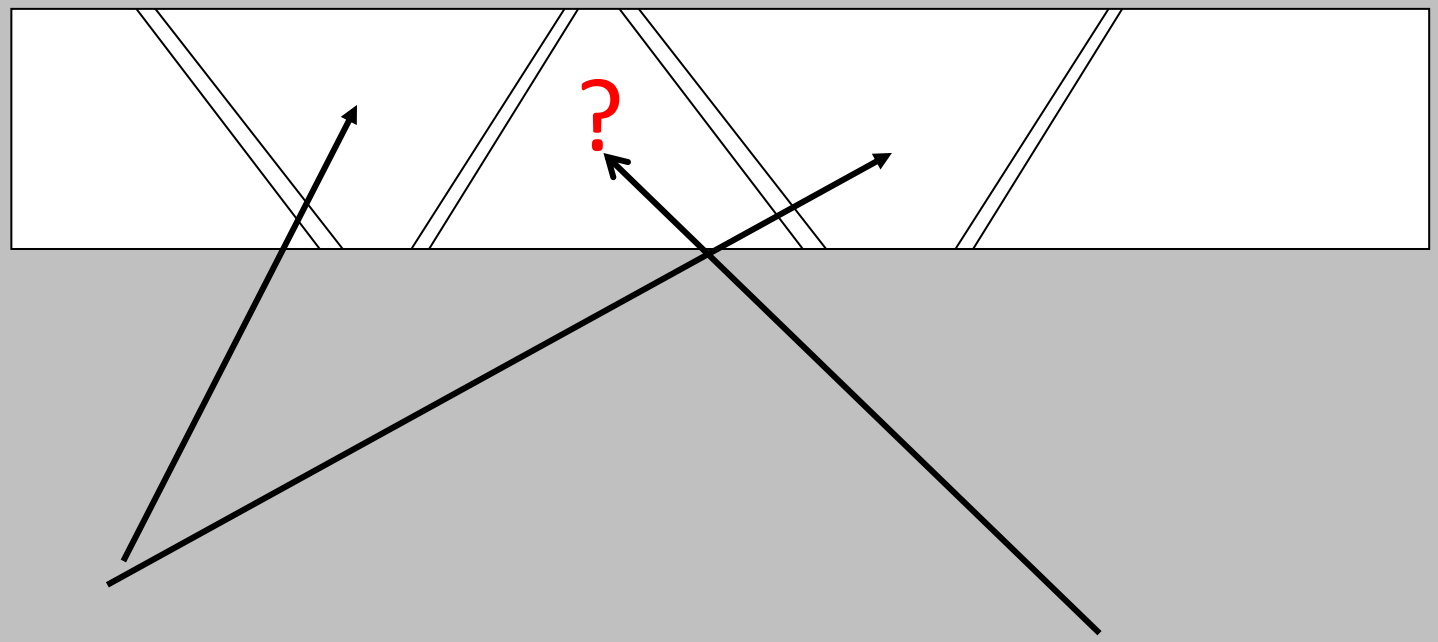
Ca = Cut angle

BL = Board length

The safety section is between 4 and 6 inches.

Did I mention the spreadsheet program ?

Alternative Board usage



Segments **Waste**

BL = Safety section + N x (SL+BW+?)

Typical Cut List

Segment Cutting			Board Dimensions		
Ring #	N of Seg	SL' (mm)	Length	Width	Thickness
1	16	34.7	27.1	1.00	0.250
2	16	37.2	28.7	1.00	0.250
3	16	37.2	28.7	1.00	0.250
4	16	37.2	28.7	1.00	0.250
5	16	37.2	28.7	1.00	0.250
6	16	37.2	28.7	1.00	0.500
7	16	37.2	28.7	1.00	0.500
8	16	37.2	28.7	1.00	0.500
9	16	37.2	28.7	1.00	0.500
10	16	34.7	27.1	1.00	0.500
11	16	32.2	25.5	1.00	0.500
12	16	29.7	22.3	1.50	0.500
13	16	24.8	16.0	2.50	0.500
14	16	19.8	12.8	2.50	0.500

Why metric ?

- Conversion from SAE simple
  - 1 inch = 25.4 mm
- Measurement setting easier
  - Not finding fractional settings
  - Not converting to decimal inches

Work Period

- Make a cut list

Segment Cutting			Board Dimensions		
Ring #	N of Seg	SL' (mm)	Length	Width	Thickness
1	16	34.7	27.1	1.00	0.250
2	16	37.2	28.7	1.00	0.250
3	16	37.2	28.7	1.00	0.250
4	16	37.2	28.7	1.00	0.250
5	16	37.2	28.7	1.00	0.250
6	16	37.2	28.7	1.00	0.500
7	16	37.2	28.7	1.00	0.500
8	16	37.2	28.7	1.00	0.500
9	16	37.2	28.7	1.00	0.500
10	16	34.7	27.1	1.00	0.500
11	16	32.2	25.5	1.00	0.500
12	16	29.7	22.3	1.50	0.500
13	16	24.8	16.0	2.50	0.500
14	16	19.8	12.8	2.50	0.500

Do as many as you can in 10 minutes

Cut list Calculations

BL = Safety section + N x {(SL + Blade width) – W x Tan (Ca)}

Segment Cutting			*Board Dimensions*		
Ring #	N of Seg	SL' (mm)	Length	Width	Thickness
1	16	34.7	27.1	1.00	0.250
2	16	37.2	28.7	1.00	0.250
3	16	37.2	28.7	1.00	0.250
4	16	37.2	28.7	1.00	0.250
5	16	37.2	28.7	1.00	0.250
6	16	37.2	28.7	1.00	0.500
7	16	37.2	28.7	1.00	0.500
8	16	37.2	28.7	1.00	0.500
9	16	37.2	28.7	1.00	0.500
10	16	34.7	27.1	1.00	0.500
11	16	32.2	25.5	1.00	0.500
12	16	29.7	22.3	1.50	0.500
13	16	24.8	16.0	2.50	0.500
14	16	19.8	12.8	2.50	0.500

Collect and Mill the Lumber

- This is not your wood scraps
- Select lumber to accomplish your design
- Cut to length and width and mill just like for Furniture
- Straight and true / edges square with faces
- Mark each piece for its intended ring

Cutting Segments

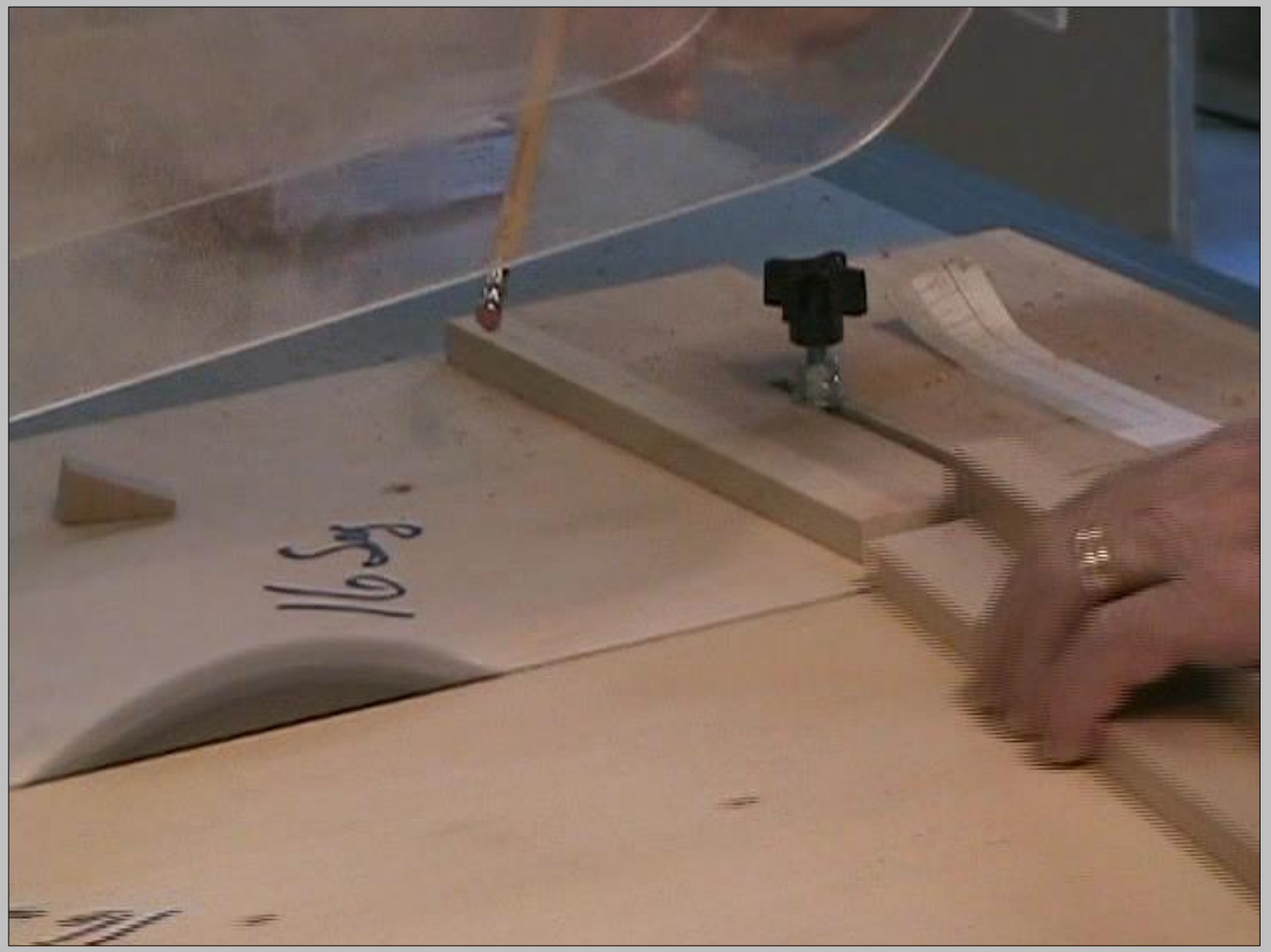
Tools Required:

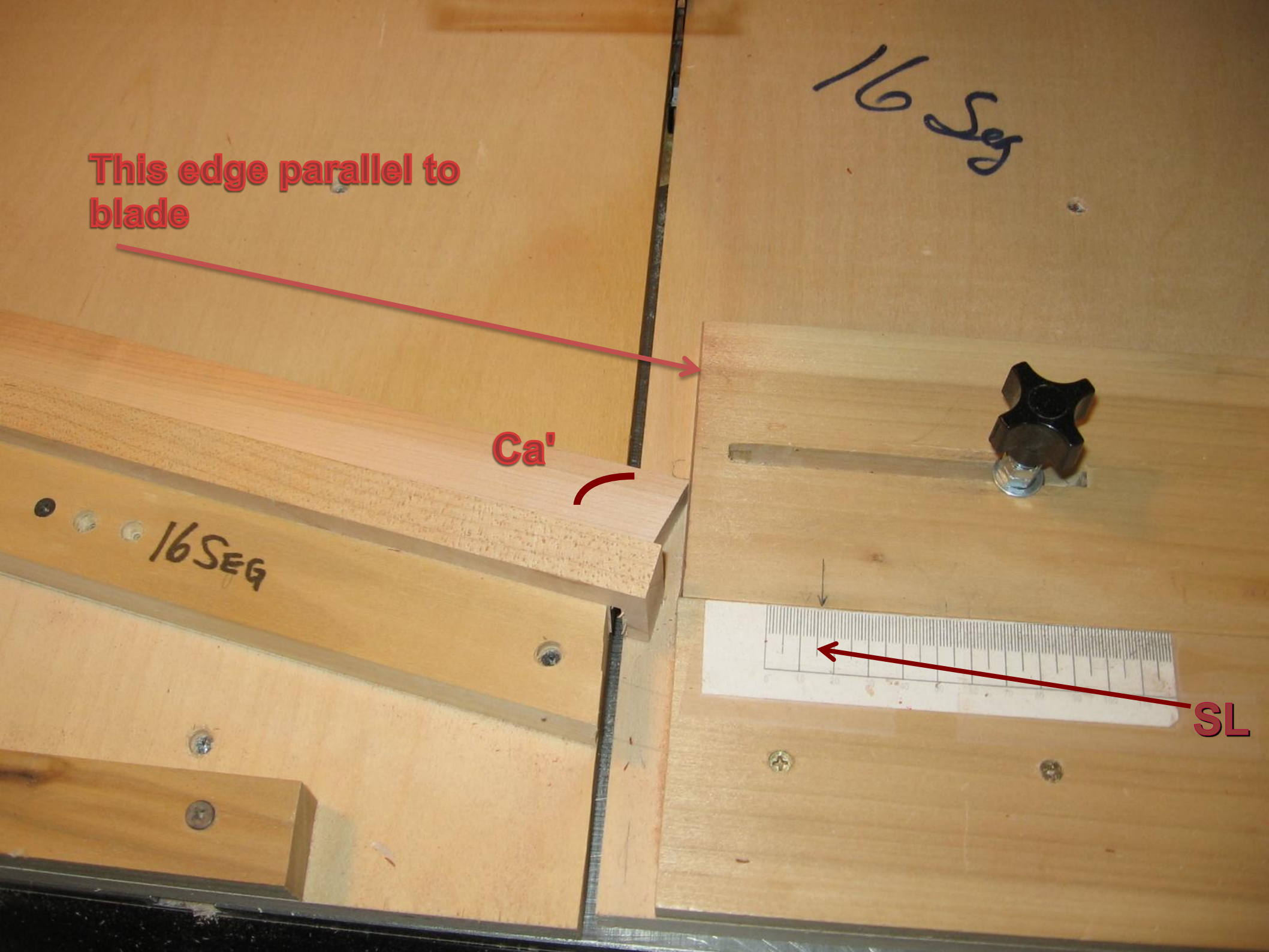
- Very Good Miter Gauge

or

- Precise Sled

Cutting
Segments




This edge parallel to blade
Ca'
16 Seg
16SEG
SL

Making the Ring

1. Gather the Segments
2. De-burr if necessary
3. Dry Fit with Hose Clamp
4. Apply Glue
5. Assemble into Ring
6. Make sure it's all Flat
7. Tighten the Hose Clamp

Dry Fit

Sanding the Rings

1. Start with Dry Rings
2. Run them through a Drum Sander

or

Sand using your preferred approach

Requirements:

Flat and Parallel Sides

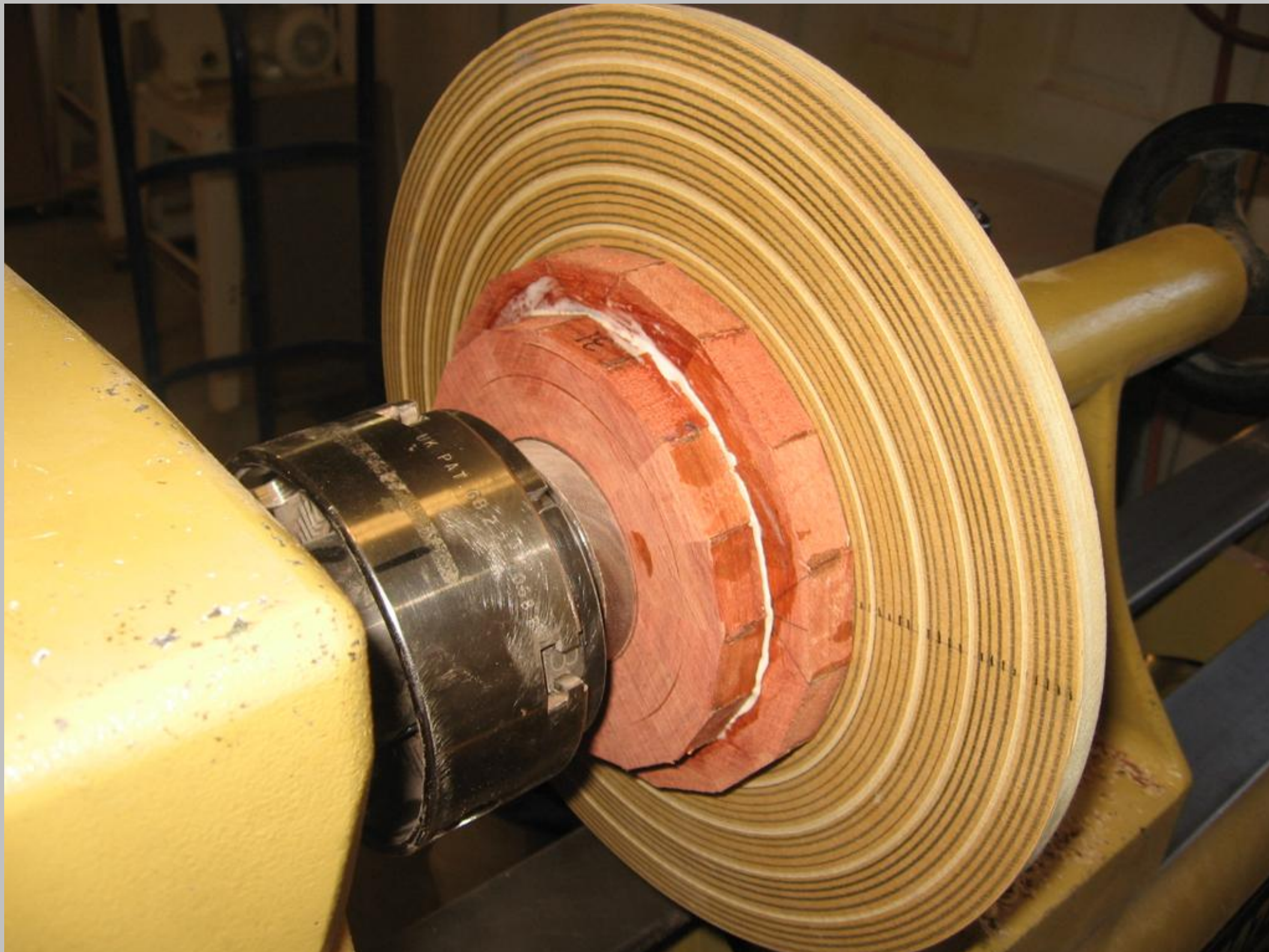
Sanding Alternative

Sanding Review

- Key is flat and parallel sides
- Drum Sander (~100 grit)
- Sanding on the Lathe with Flat Board
- Tooling on the Lathe (Advanced Skill)

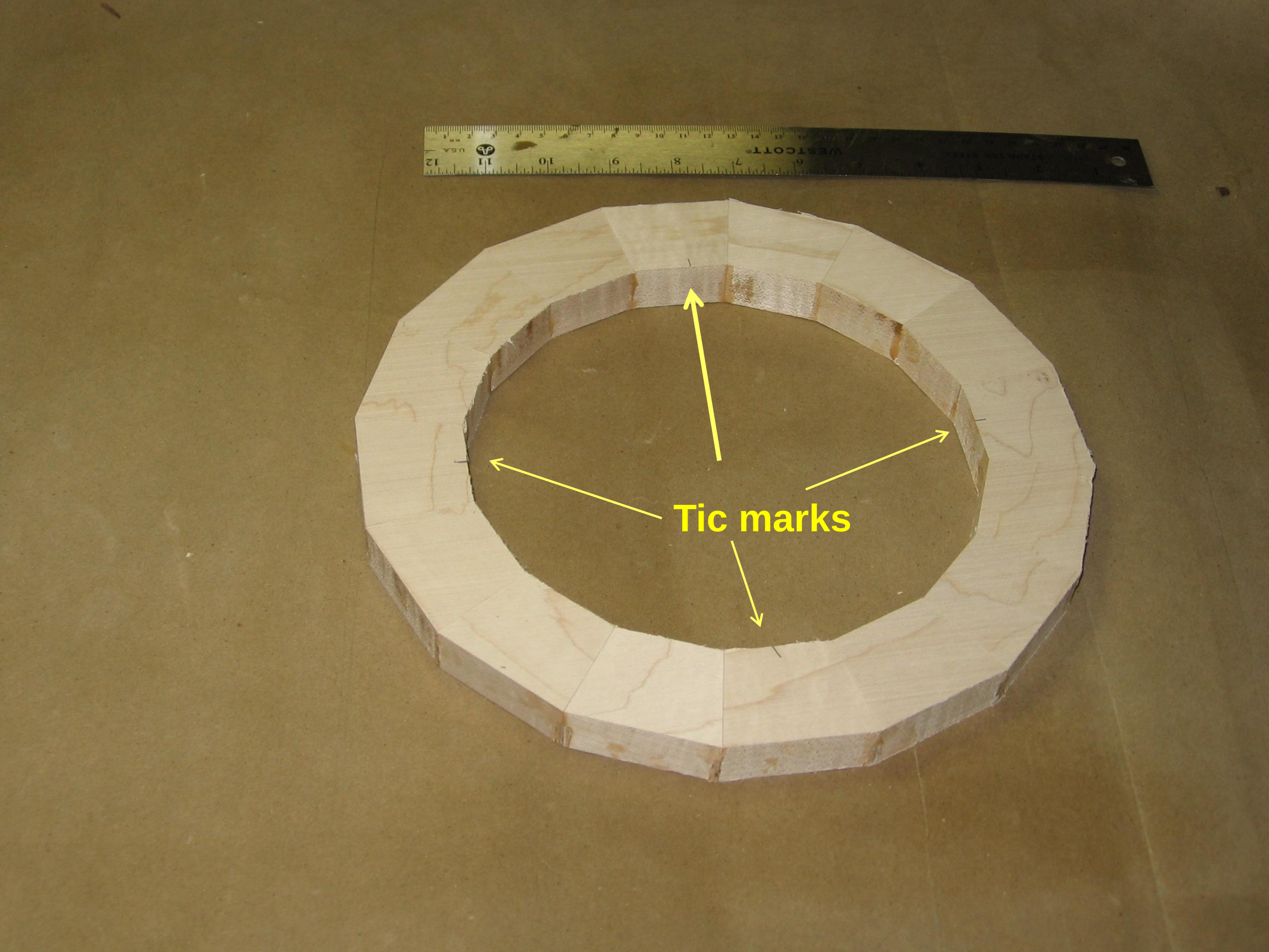
Assembling Rings

- Align Adjacent Rings (Co-axial)
- Joint on one Ring to Center of Segment on Adjacent Ring
- Complete Glue Coverage
- Even Clamping

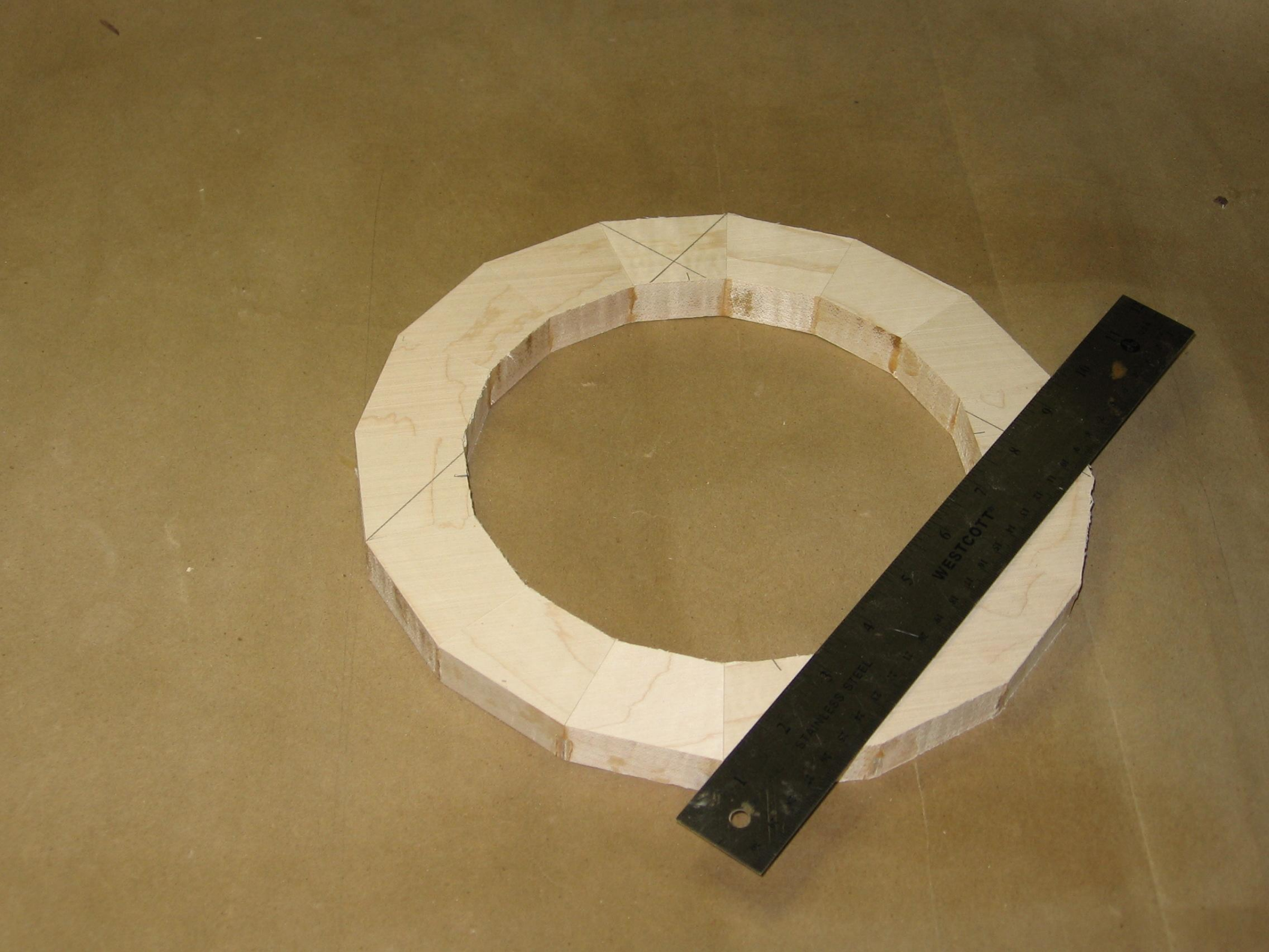

UK PAT

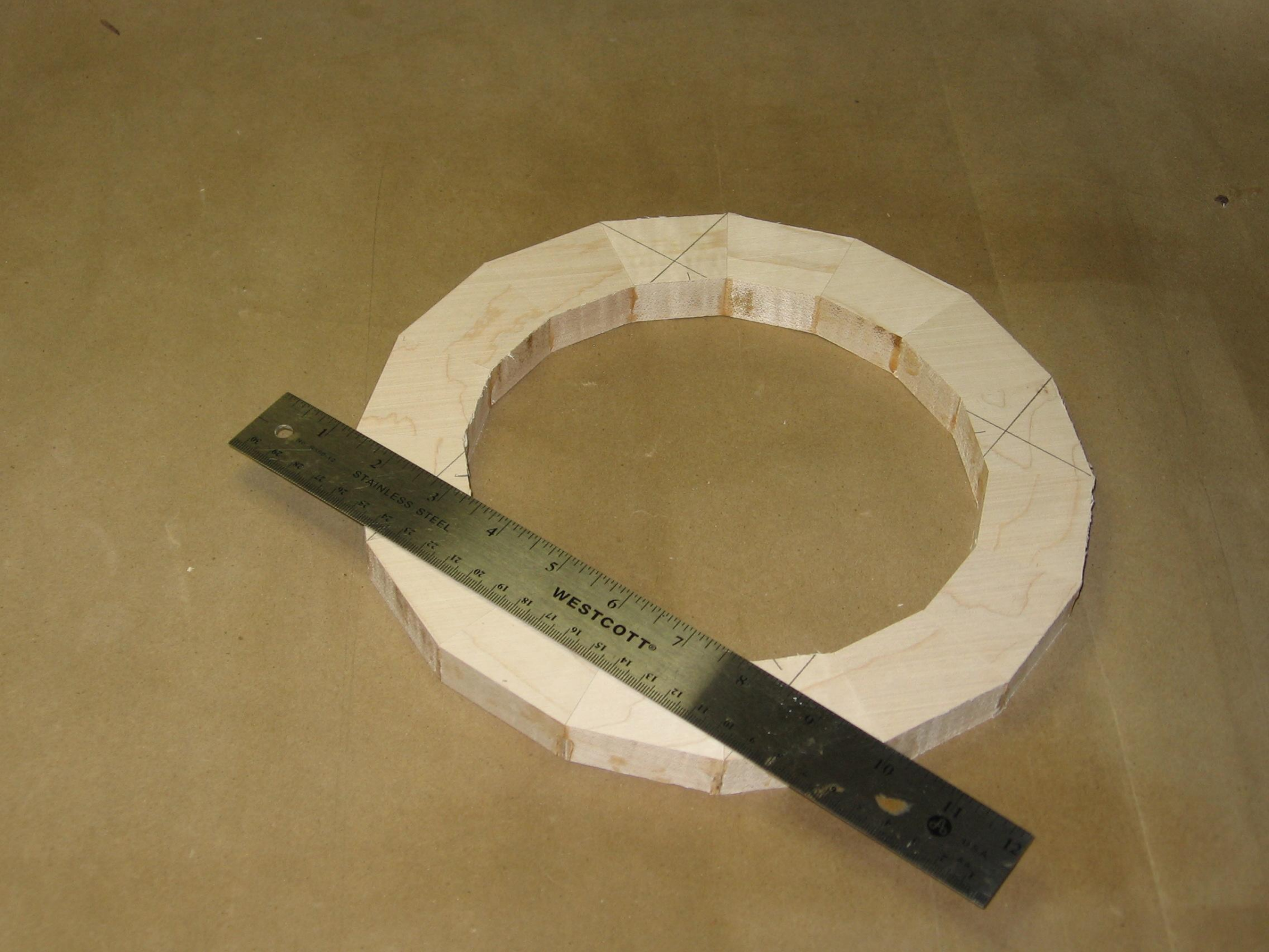
Ring Alignment

- Mark Center of Segments at 4 Quadrants on Ring (0, 90, 180, 270 Degrees)
- Overlap to Edges if Necessary
- Align all 4 Marks with Joints on Adjacent Ring

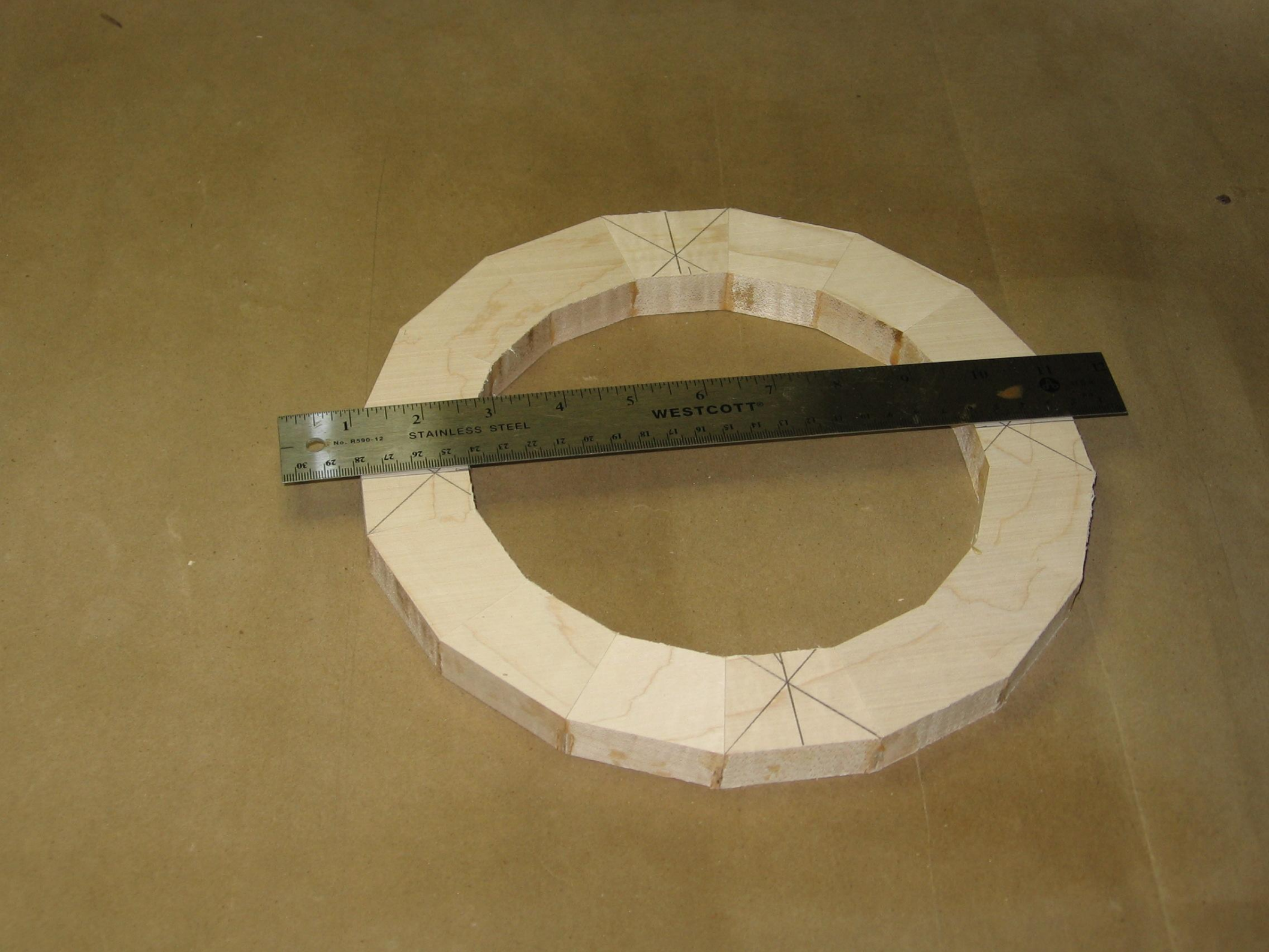

Tic marks


STAINLESS STEEL
WESTCOTT

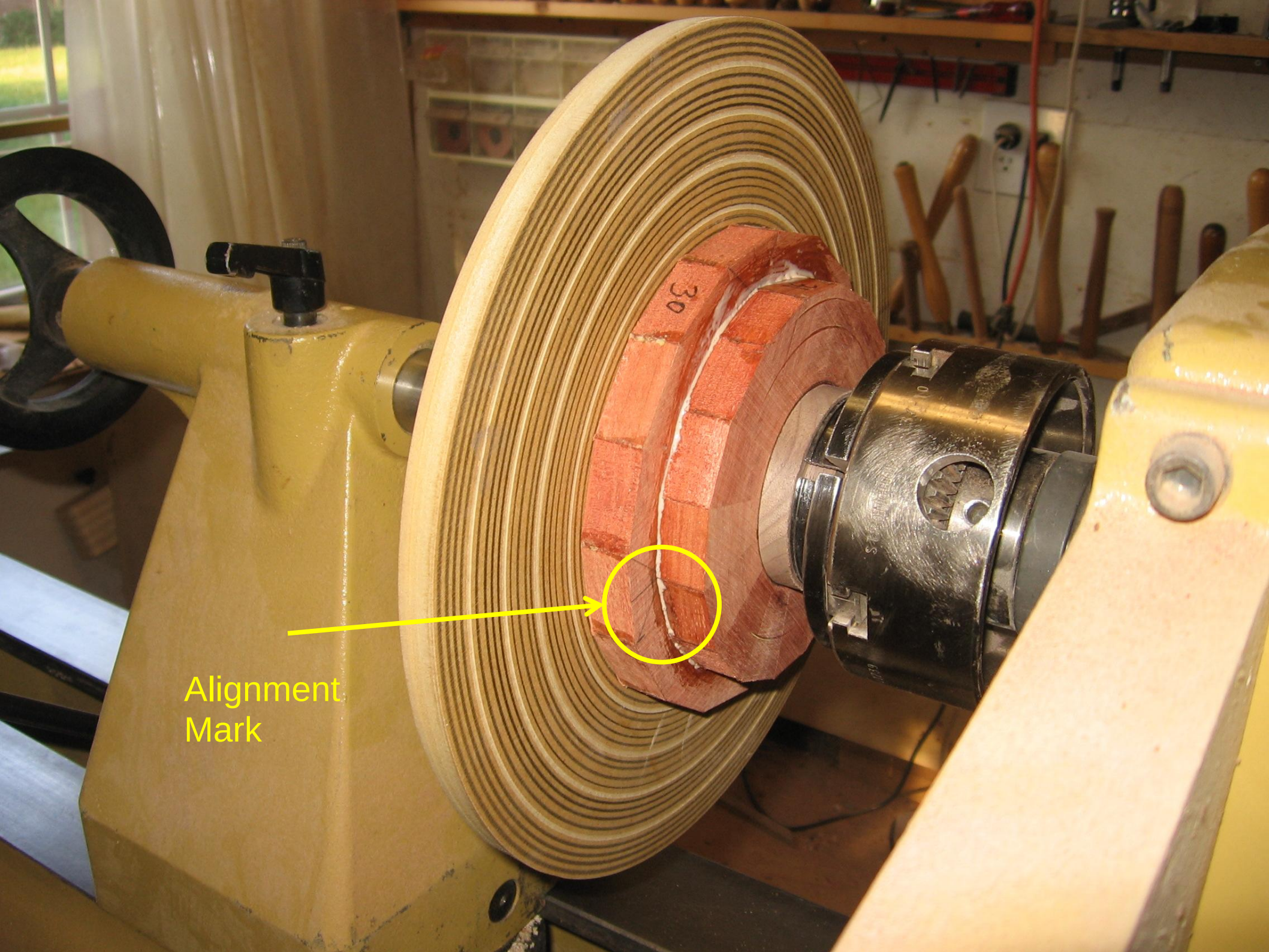

WESTCOTT
STAINLESS STEEL

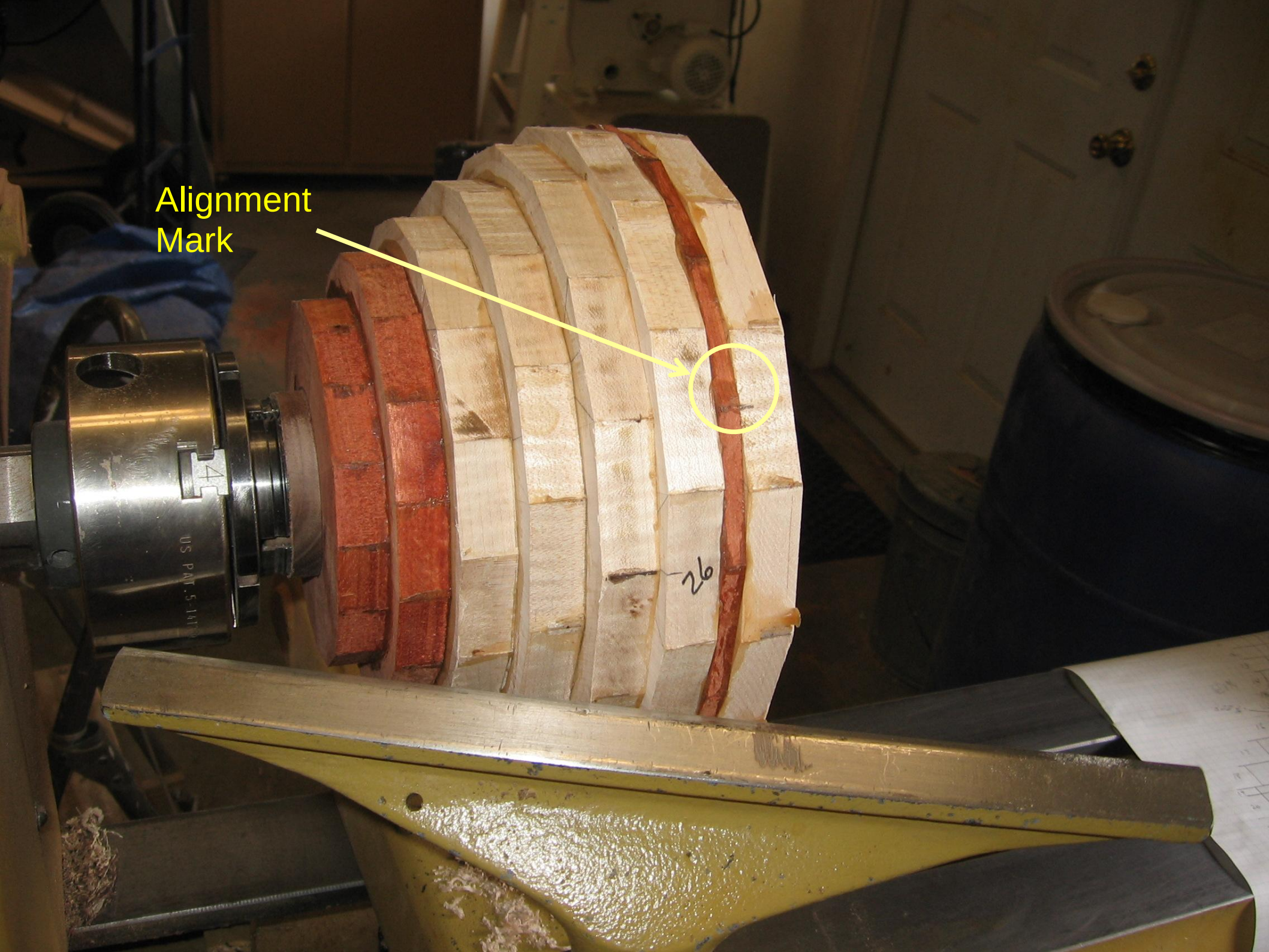

STAINLESS STEEL
WESTCOTT®


WESTCOTT
STAINLESS STEEL


WESTCOTT
STAINLESS STEEL
No. R590-12

Chord method thanks to Karen Kerce Browning


Alignment
Mark

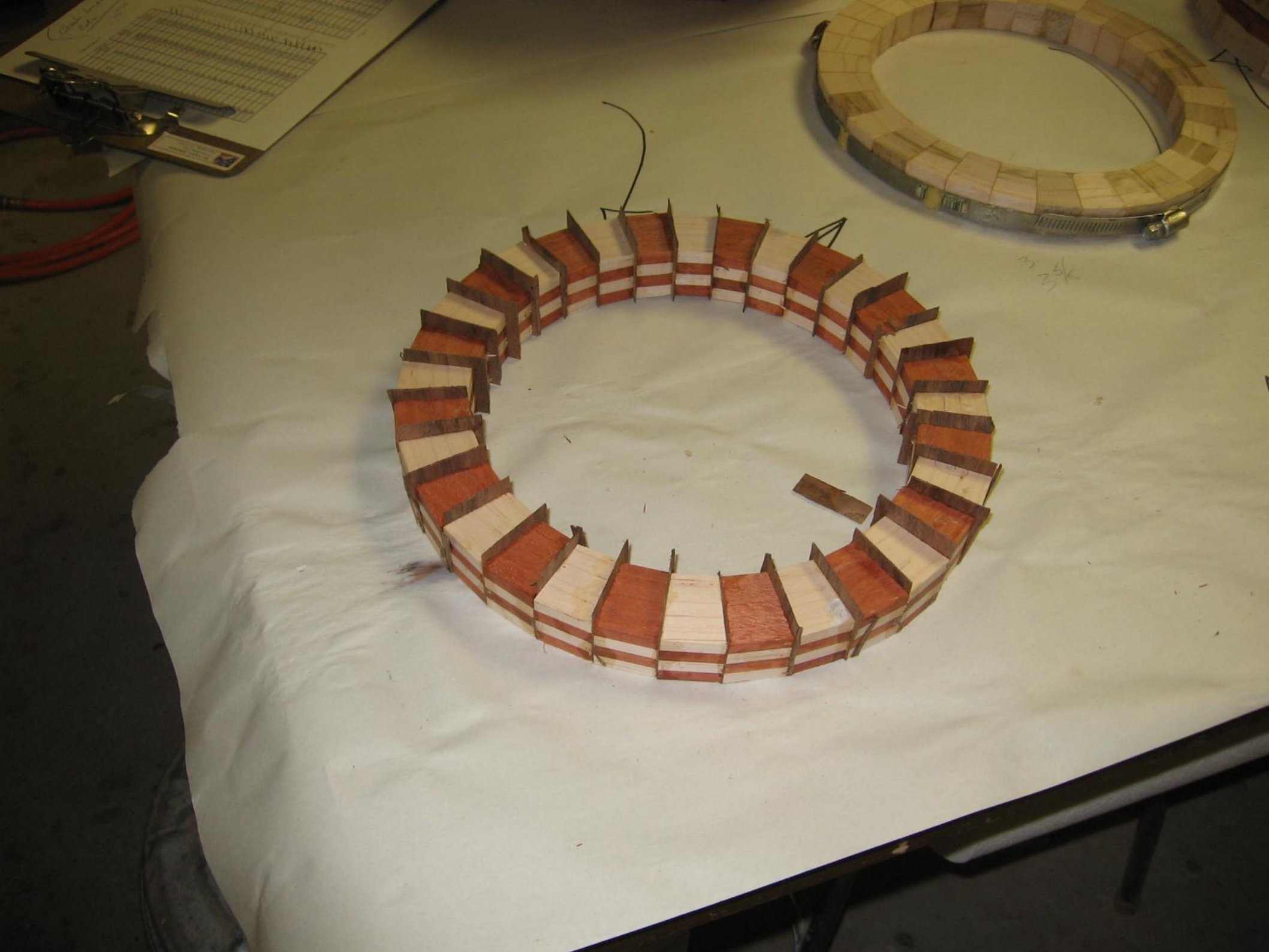

Alignment
Mark
26


22

The Feature Ring

- Usually at the Waist of the Vessel
- Sometimes Multiples
- Sometimes at the Top or Base
- Fancy


25
26
27
28
29
30
31



Where are We?

- We've Designed and Detailed our Piece
- The Lumber is Milled and Segments Cut
- We've Constructed and Sanded our Rings
- Then We Glued Some of the Rings Together
- And We've Worked on our Feature Ring(s)

Now What?

Turning at Last

We have Some Parts Assembled

But not the Whole Thing

Why?

Convenience in the Turning Sequence

Turning Sequence

In General:

- Rough Shape the Outside
- Rough out the Inside
- Finish (almost) the Outside Turning
- Finish (almost) the Inside Turning

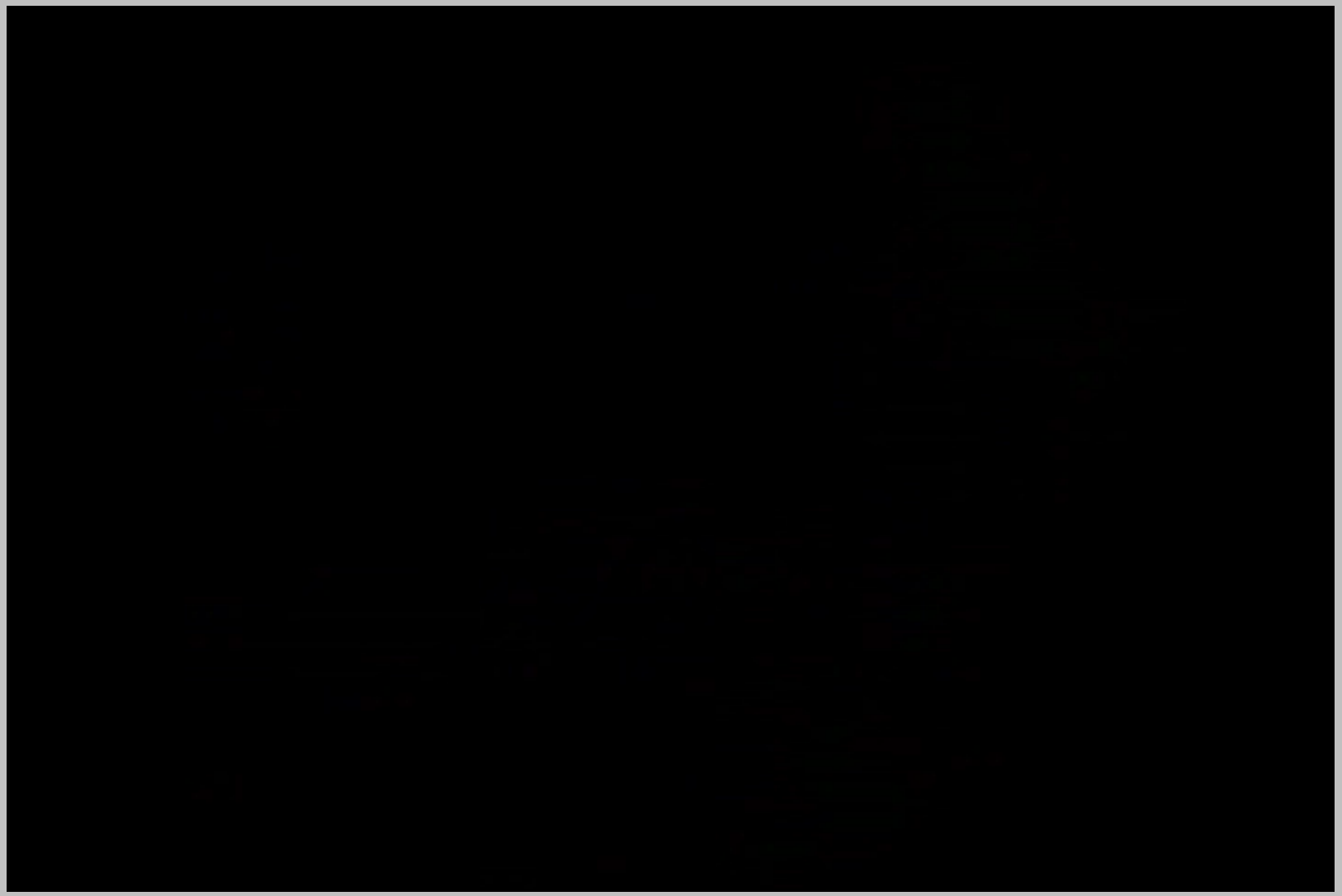
The Sequence Continued

In Particular:

- Do it to each piece first!
- Make sure to *Check the Fit!*
- Put them Together
- Finish turning the Exposed Surfaces

Turning Tools

Turning base




22

Turning added rings

Turning the Neck

Attaching Shoulder to Neck

Final Assembly

- Before turning the inside of top half
  - Establish outside curve
  - Make sure of fit
- Dry Fit top and bottom halves
  - Accurate measurement
  - Double stick tape

Final Assembly

Final Inside Turning

After Outside Shaping

Before Gluing Major Parts Together

Do the Final inside turning

Leave Ample Mating Surfaces on Joint

Complete Glue Coverage

Putting it all Together

All Together

Finishing Up !

Parting Off and Sanding the Connection

Done Between Centers

Leave the Nub to Remove with Chisel

Sand to same grit as other Surfaces

Finish with a Film (varnish, lacquer, shellac)

A FEW HINTS

- For alignment disks
  - Use melamine rather than MDF
  - Use faceplate mounting rather than live center
- Alignment maintenance
  - Pay close attention to sacrificial mountings
  - Use multiple chucks
    - Even cheap chucks help


• Live threaded /MT2 tailstock mounting
• Spindle adapters (ex: 1 ¼-8 to 1”-8)

http://www.pennstateind.com/store/LTCA18.html

http://www.pennstateind.com/store/CMG3C.html

The END
Basic Segmented Vessels

Alternative Method for SL

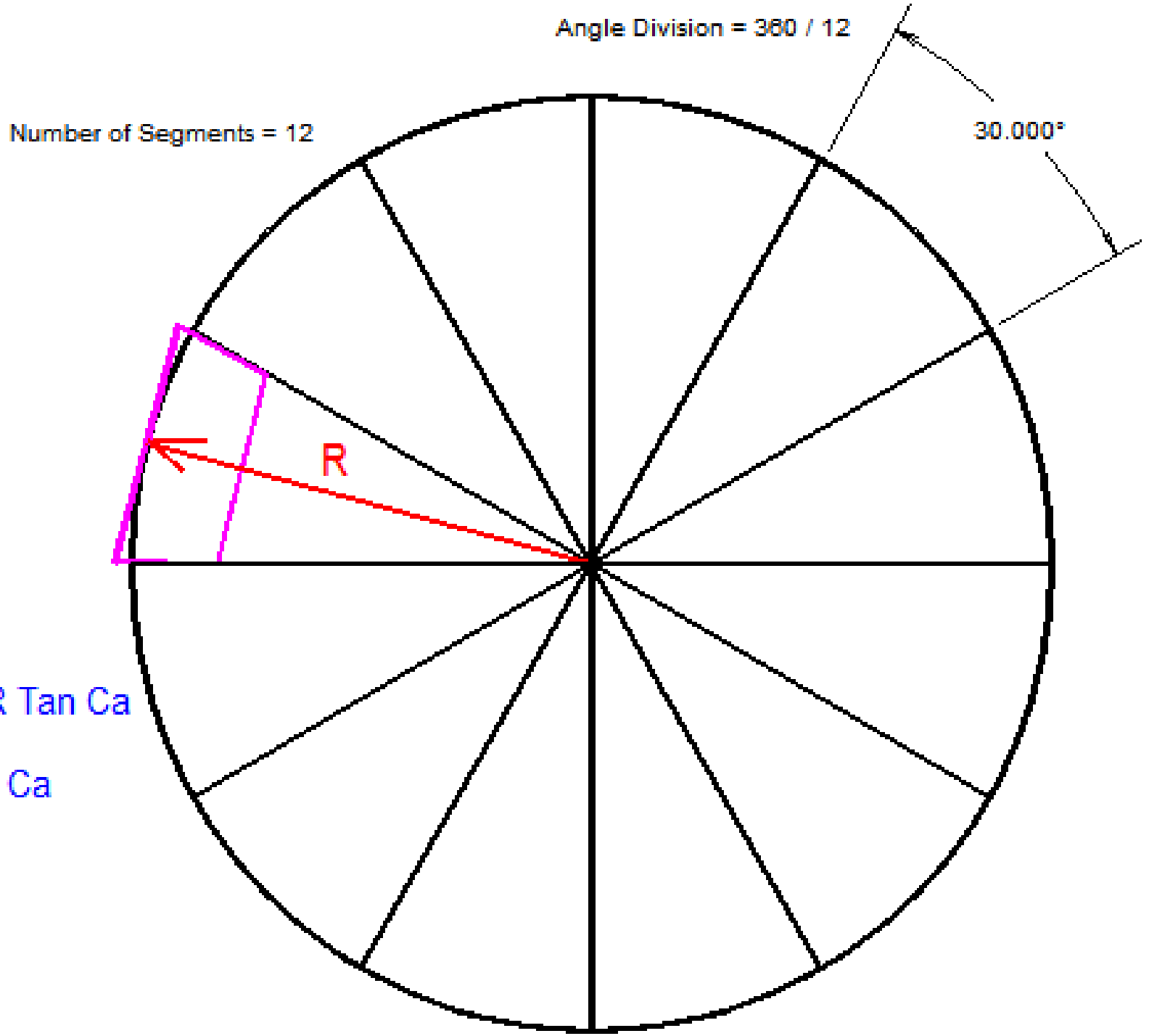
You could make a Segment the length of:

$$SL = 6.28 * R / N \ ^{(1)}$$

But your ring would be smaller.

On the other hand for higher N the SL gets closer to the ideal.

(1) You're just dividing the circumference by the number of segments.



If 1/2 SL == R Tan Ca
Then
SL = 2 R Tan Ca