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
- Quadruple Paper
- Straight Rule
- Curve Drawing Aids?
Refine, Select, Darken
Work period

- Take out piece of paper
- Draw a line down its 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
Put down the pencil for a minute!
Let’s discuss segments
Understanding Segments

Critical Parameters

Ca == Cut Angle  
SL == Segment Length
Number of Segments = 12

Angle Division = \( \frac{360}{12} \)

1/2 of Segment length

1/2 of SL = \( R \times \tan(Ca) \)
If \( \frac{1}{2} \text{SL} = R \tan \text{Ca} \)

Then

\[ \text{SL} = 2 \times R \times \tan \text{Ca} \]
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:
  \[ SL = \frac{6.28 \times \text{Radius}}{N} \]
  Hint: 6.28 x Radius ~ = Circumference

- For N less than 12 use:
  \[ SL = 2 \times R \times \tan(Ca) \]

- For all Spreadsheet use:
  \[ SL = 2 \times R \times \tan(Ca) \]
The not so critical parameters

$W == \text{Width}$

$T == \text{Thickness}$
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
<table>
<thead>
<tr>
<th>#</th>
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</tbody>
</table>

# 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
Put down the pencil for a minute!
R == Radius   W == Width   T == Thickness
N == Number of Segments   Ca == Cut Angle
SL == Segment Length
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 x R x Tan Ca

or

SL = 6.28 x 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)

\[ Ca = \frac{180}{16} = 11.25 \text{ Degrees} \]
\[ SL = 2 \times 3 \times \tan 11.25 = 1.193'' \]

< Or >
\[ SL = 6.28 \times \frac{R}{N} = 1.1775 \]

Put down the calculator. The Tangent of 11.25 is 0.1989
<table>
<thead>
<tr>
<th>Num Seg</th>
<th>CUT ANGLE</th>
<th>TANGENT</th>
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<td>4</td>
<td>45.00</td>
<td>1.0000</td>
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<td>0.7265</td>
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<td>0.5774</td>
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Example of Detail Sheet

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</tbody>
</table>
Work period

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

Do all you can in 10 minutes!
Put down the pencil for a minute!
Calculating Board Length

\[ X = W \tan(Ca) \]

A Segment

Another Segment

24 3/8"
Calculating Board Length

\[ BL = \text{Safety section} + N \times \left\{ (SL + \text{Blade width}) - W \times \tan(Ca) \right\} \]

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

BL = Safety section + N x (SL+BW+?)
# Typical Cut List

<table>
<thead>
<tr>
<th>Segment Cutting</th>
<th>Board Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring #</td>
<td>N of Seg</td>
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<tr>
<td>1</td>
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</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Segment Cutting</th>
<th>Standard Dimensions</th>
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</table>

Do as many as you can in 10 minutes
Cut list Calculations

\[ BL = \text{Safety section} + N \times \left\{ (SL + \text{Blade width}) - W \times \tan(\text{Ca}) \right\} \]

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</table>
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
- Precise Sled
Cutting Segments
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
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
Strike 4 Chords overlapping the Segments with the Tic Marks.
Draw lines at right angles through the intersections of your chords.
Chord method thanks to Karen Kerce Browning
The Feature Ring

– Usually at the Waist of the Vessel

– Sometimes Multiples

– Sometimes at the Top or Base

– Fancy
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
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)
The END

Basic Segmented Vessels
Alternative Method for SL

You could make a Segment the length of:

$$\text{SL} = 6.28 \times \frac{R}{N} \quad (1)$$

But your ring would be smaller.

On the other hand for higher \( N \) the \( \text{SL} \) 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