

Adventures in Open Segmenting

Tom Kenyon



Each Rotation Raffle Prizes

- One Small Open Segmented Bowl
- 2 Chances to Unwrap End-of-Process Bowls

After Second Rotation Prize

- In-process Small Open Bowl – you finish it!



Pickup raffle ticket !



Road Map



Bowl with different thickness layers



Sacrificial Segment Technique
Evolution



Bowl Design & Construction



Then the Fun - Raffle !
Unwrapping bowls
8" first unwrapping



About Me

- Grew up on Chicago's Southside
- California Polytechnic College & USC
- Worked on ground and airborne government system
- Winding woodworking path to open segmenting



My Shop



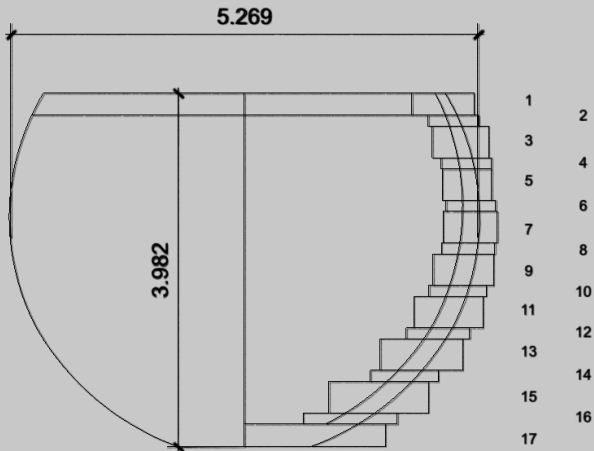


Small Bowl

- It just feels right
- Go to bowl for gifts, donations, and exchanges
 - Project description on forum



Design

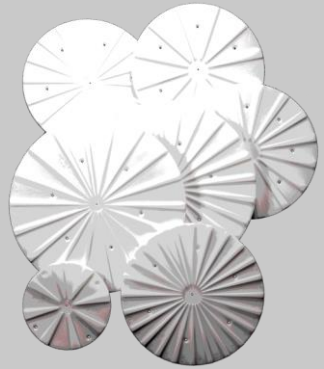


VectorWorks

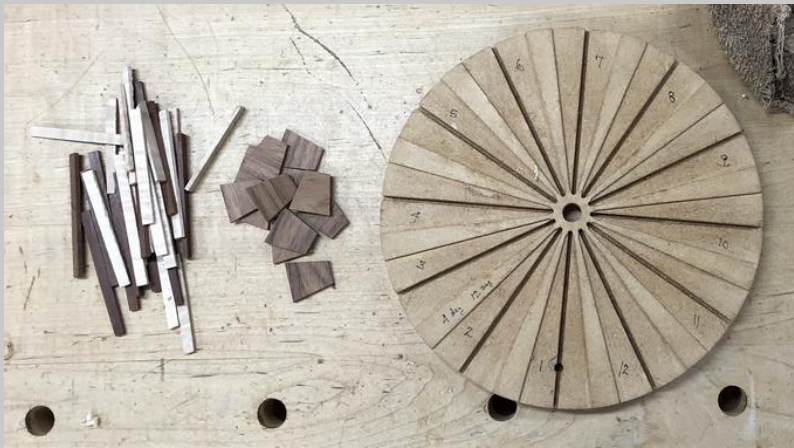
Layer	# of Pieces	Open Seg	Material	Thickness	Radius	Diameter	Length	Width	Len Req'd	Dividers - Koa	Seg-Maple
1	12		Maple	0.250	2.589	5.178	1.387	0.698	18.1		
2	12	x	Koa	0.125	2.641	5.282	1.027	0.567	13.8	13.82	
3	12	x	Maple	0.354	2.756	5.512	1.071	0.639	14.4		14.36
4	12	x	Koa	0.125	2.789	5.578	1.084	0.570	14.5	14.51	
5	12	x	Maple	0.354	2.789	5.578	1.084	0.553	14.5		14.51
6	12	x	Koa	0.125	2.834	5.668	1.102	0.561	14.7	14.72	
7	12	x	Maple	0.354	2.854	5.708	1.110	0.610	14.8		14.81
8	12	x	Koa	0.125	2.825	5.65	1.098	0.603	14.7	14.68	
9	12	x	Maple	0.354	2.811	5.622	1.093	0.684	14.6		14.61
10	12	x	Koa	0.125	2.729	5.458	1.061	0.649	14.2	14.23	
11	12	x	Maple	0.354	2.694	5.388	1.047	0.781	14.1		14.07
12	12	x	Koa	0.125	2.541	5.082	0.988	0.715	13.4	13.35	
13	12	x	Maple	0.354	2.465	4.93	0.958	0.934	13.0		13.00
14	12	x	Koa	0.125	2.187	4.374	0.850	0.765	11.7	11.70	
15	12	x	Maple	0.354	2.078	4.156	0.808	1.125	11.2		11.19
16	12	x	Koa	0.125	1.726	3.452	0.671	1.061	9.6	9.55	
17	1		Maple		1.591	3.182					
									Total	106.57	96.56
					Kerf		0.125				
					Open Seg Deg		4.000				
					Wood 1		Koa				
					Wood 2		Maple				
					Wood 3		Walnut/Maple				
					Jig_Used		n	y/n			

Parameters transferred manually

Segment Plates



Plates hold segments in alignment
Patterned after Jerry Bennett's Seg-Eas Plates
Two plate set



Thin layer, 1/8", Plate



Thick Layer

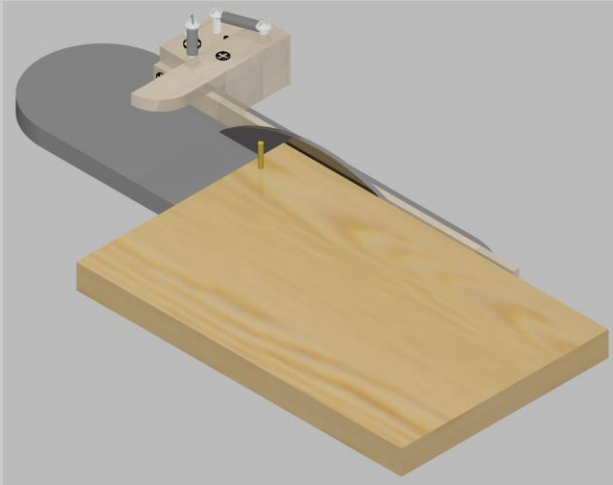
Cutting the Segments

Segment Flipper



Segment Flipper

Flipper Trigger Pin
(jig)



Flipper Pivot Point
(thru to throat plate)

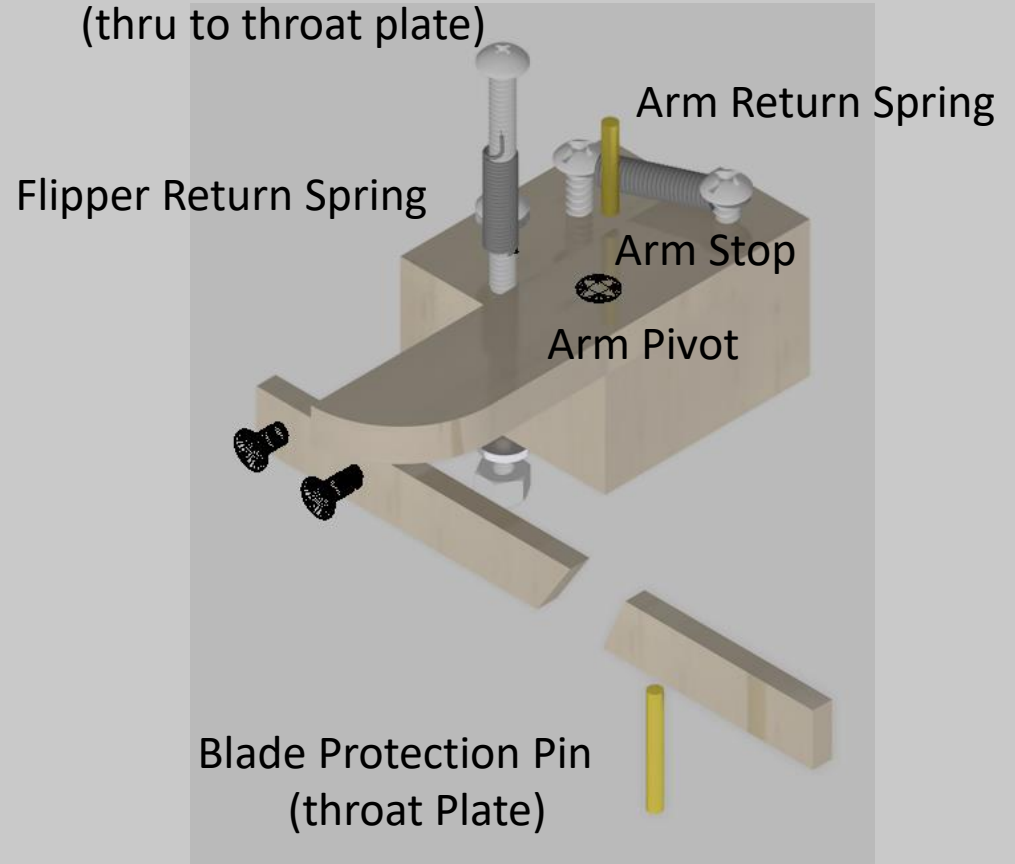
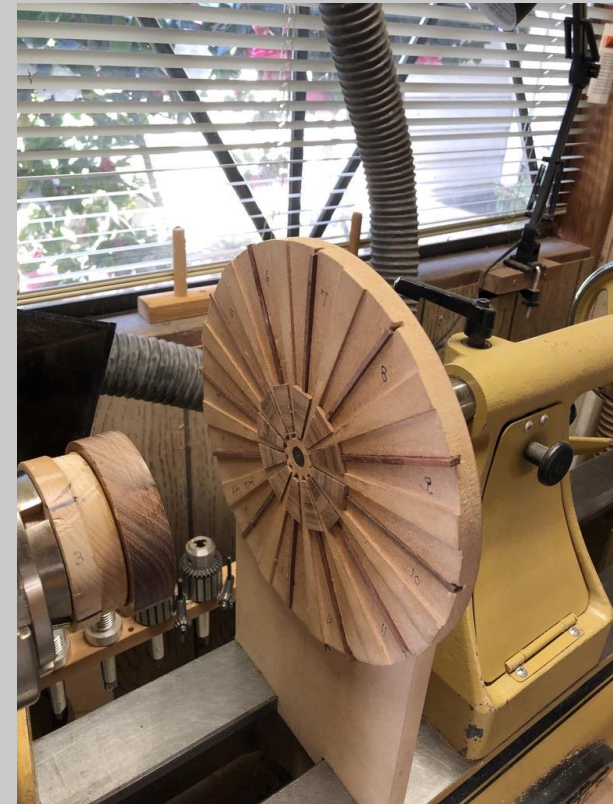
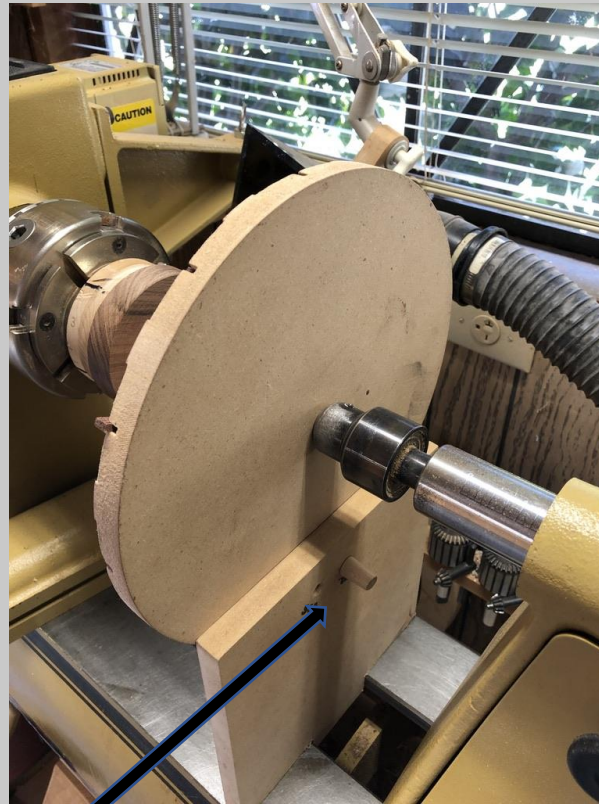


Plate Alignment

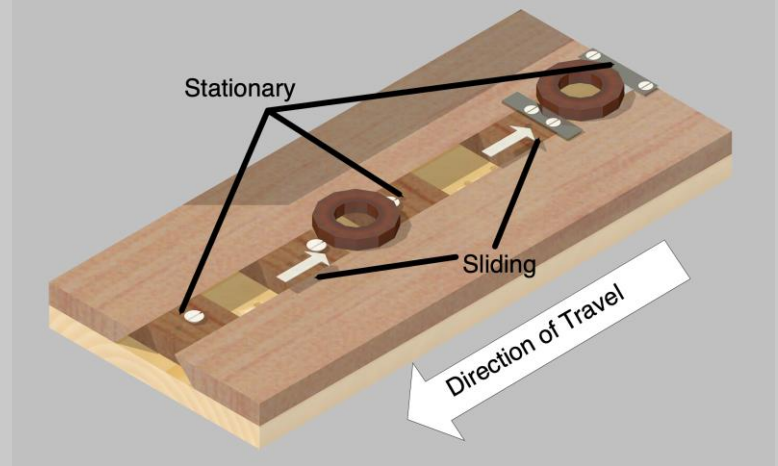
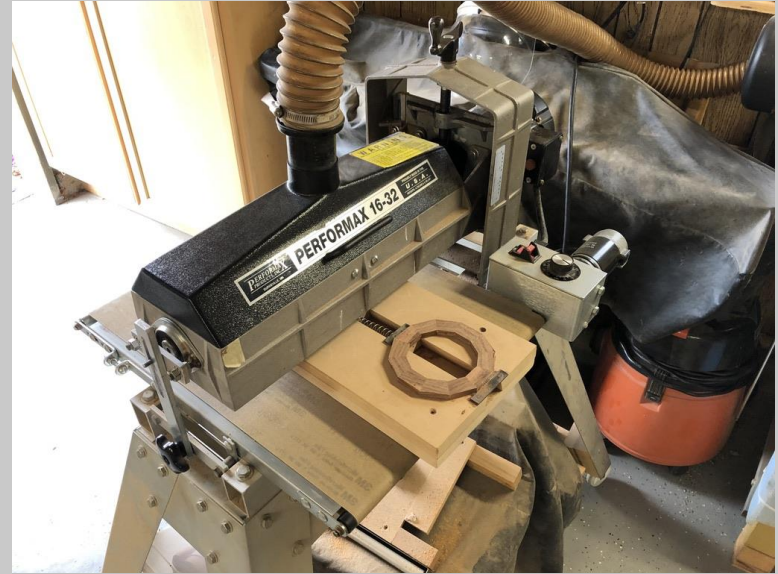


Alignment Holes

Top Ring

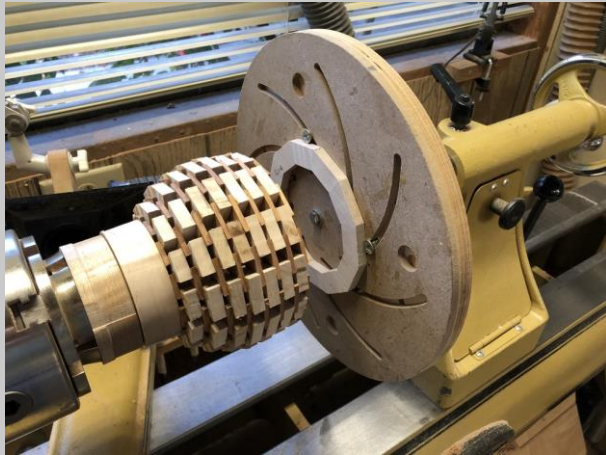


Segments Clamped Together for Gluing



Described on Forum

Bowl Completion



Sacrificial (Missing) Segment Technique Evolution

David Vanneir's Journey to 2012 AAW Symposium Rotations



Bud Latven
2003 AAW

How did he
do that ?



2008
3x3 First
Test



2008
First Generation



2010
Second generation
Multiple turnings
Missing segment
exterior
Segmented
interior

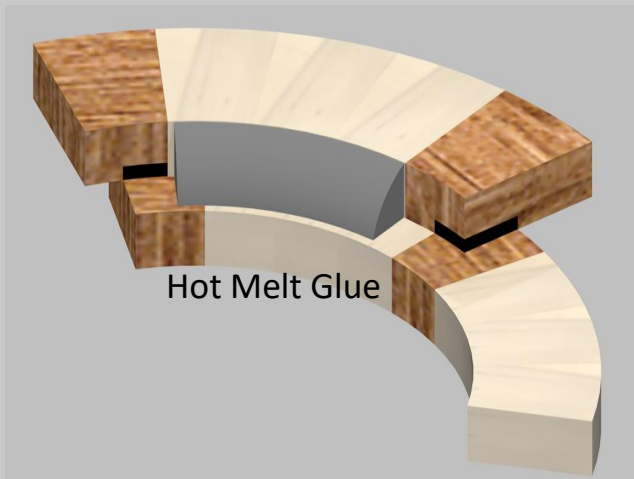


2011
Fourth generation
All pieces are
angled segments
4 different cutting
angles

2012 AAW Rotation

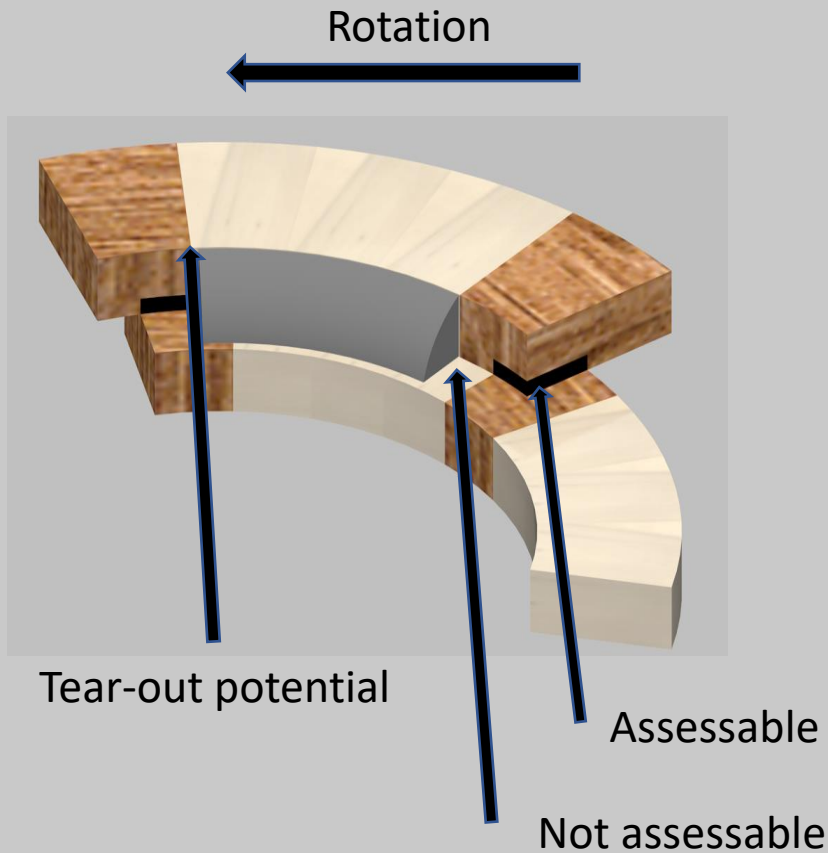
Technique Concept

Project Segments Sacrificial Segments



- Project & sacrificial segments
- Project segments glued in
- Sacrificial segments hot melt glued in
- Outside is turned & taped
- Inside turned
- Separated from hub and base finished
- Tape is removed – sacrificial segments fall out - maybe

Always - Buts



- Some glue squeeze out not assessable
- Project segments tear-out
Trailing edge needs support

My Journey



Lots of open segment projects using other techniques

Decided to explore “sacrificial segment” application to Bowl from Board (BFB) process.



Process - Design

- Shape



- Bugle
- 8" Round

- Style



- Stepped
- Carved

- Methodology



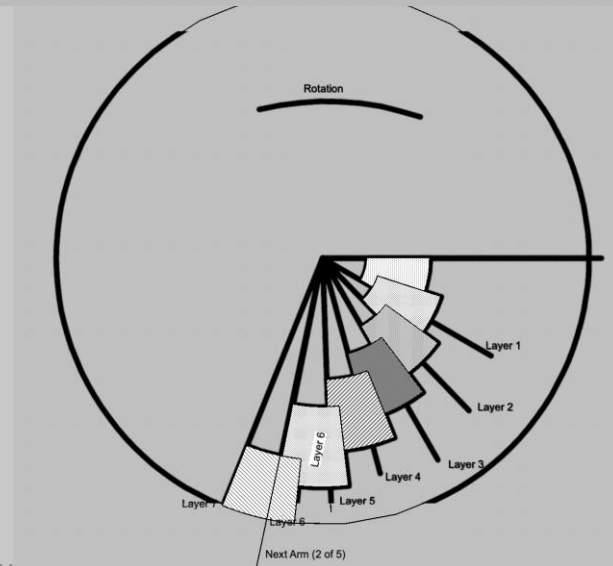
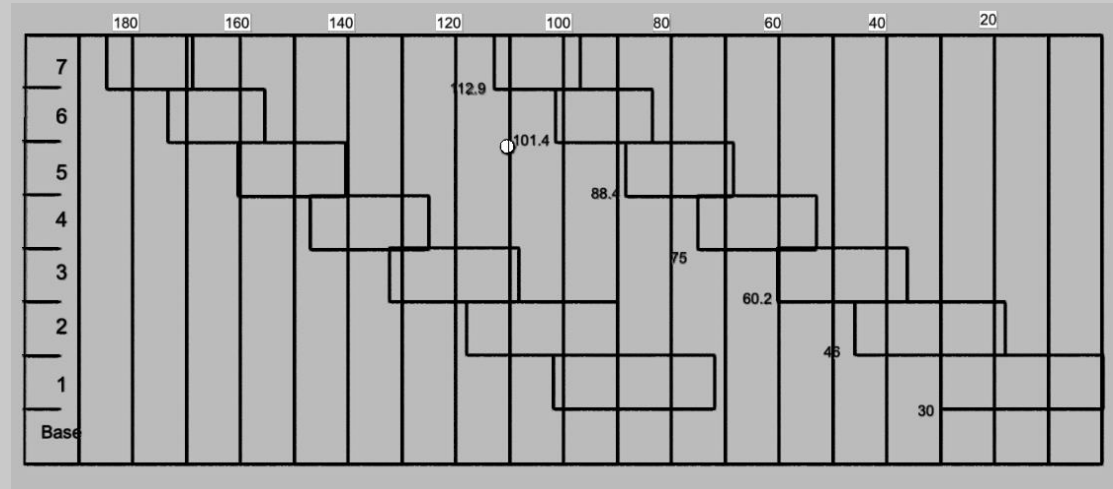
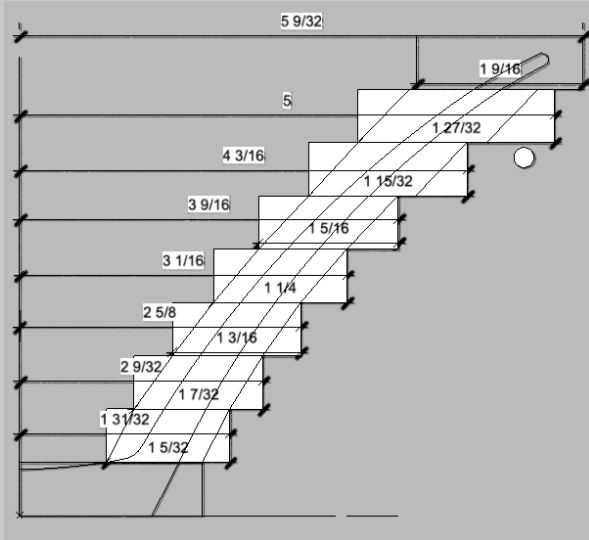
- BFB
- Normal segmentation

- Constraints

- # of arms
- Sweep
- # of layers
- % of overlap



Design Material



More Design Material



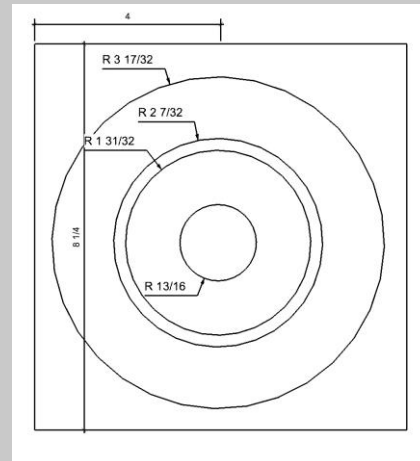
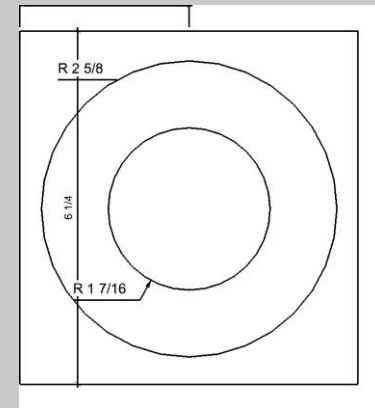
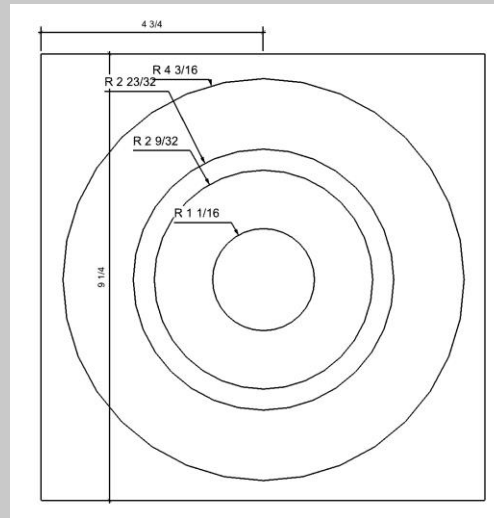
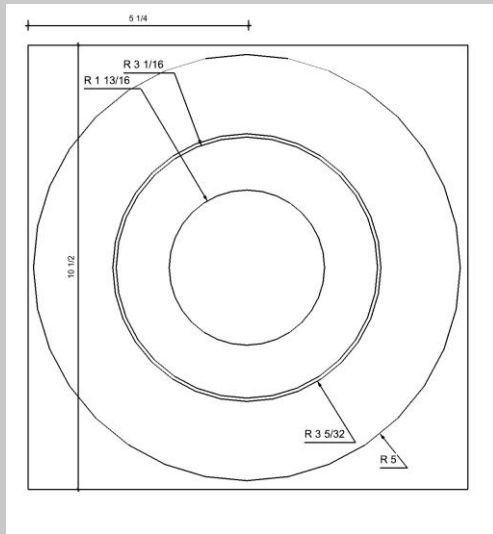
Material and jig parameters

Layer #	Height-Top	Start Pos (deg)	Jig Position (deg)	Offset	Radius	Adjusted Rad	Length	Width	Arm Material	FillerMaterial	
1	0.375	0	30	333	2.401	1.401	0.751	1.166	3.75	5.26	
2	0.75		37.5	83	2.536	1.536	0.823	1.166	4.12	5.76	
3	1.125		45	167	2.677	1.677	0.899	1.166	4.49	6.29	
4	1.5		52.5	250	2.853	1.853	0.993	1.166	4.97	6.95	
5	1.875		60	333	3.006	2.006	1.075	1.166	5.38	7.53	
6	2.25		67.5	417	3.188	2.188	1.173	1.166	5.86	8.21	
7	2.625		75	500	3.372	2.372	1.271	1.166	6.36	8.90	
8	3		82.5	583	3.597	2.597	1.392	1.166	6.96	9.74	
9			90	667	3.813	2.813	1.507	1.166	7.54	10.55	
10			97.5	750	4.058	3.058	1.639	1.166	8.19	11.47	
11			105	833	4.304	3.304	1.771	1.166	8.85	12.39	
12			112.5	917	4.573	3.573	1.915	1.166	9.57	13.40	
13			120	1000	4.853	3.853	2.065	1.166	10.32	14.45	
14			127.5	1083	5.195	4.195	2.248	1.274	11.24	15.74	
15			135	1167	5.55	4.55	2.438	1.375	12.19	17.07	
16			142.5	1250	5.949	4.949	2.652	1.378	13.26	18.57	
addition to move to first									1.166 width	86.36	120.91
									other width	36.69	51.37
									top ring	????	
Parameters											
Base_Rad			Jig Parameters								
First_Layer_Length			steps_per_deg		11.1111						
First_Layer_Deg			deg_per_step		0.090						
Layer_Width_Adj_Per_Layer			move to first		333.00						
Target_Rad			5.25		input						
Last_Layer_Target_Length			2.543		input						
Last_Layer_Target_Deg			30		input						
Per_Cent_Overlap			75%		input						
Over_Lap_Deg			22.5								
Rotation_Per_Layer			7.50								
Layer_Thickness			0.375		input						
Target_Layer_Height			3.125		input						
radius_adj			-1								
number of arms			5								

Layer	# of pieces	Thickness	Outer Radius	Width	Inter Radius	Sweep-Deg	Dia_inch	Sweep-Steps	Arm Position-Deg	Arm Position - Steps	Layer Offset - Steps
Top	15	0.5	5.281	1.625	length 2.187						
7	5	0.5	3.141	1.659	3.141	9	0.5	100.00	112.95	1255.00	85
6	5	0.5	4.187	1.468	2.719	13.5	0.7	150.00	108.00	1200.00	80
5	5	0.5	3.532	1.312	2.22	18	0.9	200.00	99.90	1110.00	710
4	5	0.5	3.062	1.25	1.812	22.5	1.1	250.00	88.65	985.00	585
3	5	0.5	2.625	1.187	1.438	27	1.4	300.00	74.25	825.00	425
2	5	0.5	2.281	1.218	1.063	31.5	1.6	350.00	56.70	630.00	230
1	5	0.5	1.968	1.156	0.812	36	1.8	400.00	36.00	400.00	0
base	1	0.5	1.712	1.712						move to first segment	
Height			4.5		Target Cord = 0.75						
seg Position											
start #			end		overlap %		overlap #		Cord		Fill Seg for Insert Cord Length
7	102.95	9	112.95	-30%	-4.05	0.785	0.353			29.35	
6	94.5	13.5	108	-30%	-5.4	0.587	0.395			26.68	
5	81.9	18	99.9	-30%	-6.75	1.110	0.416			23.96	
4	66.15	22.5	88.65	-30%	-8.1	1.202	0.433			21.24	
3	47.25	27	74.25	-30%	-9.45	1.237	0.433			18.41	
2	25.2	31.5	56.7	-30%	-10.8	1.254	0.430			15.54	
1	0	36	36			1.237				12.54	
base											
Parameters											
Steps_Revolution			4000								
Steps_Deg			11.11								
Deg_Steps			0.09								
Deg_Revolution			360								
Move_to_First_Seg			400								
Move_Between_Seg			800.0								
Number_of_Arms			5								
Diagram_Deg_Inch			20								
Turning_Radius_Reduction			0.187								
Change_in_Width			-4.5								
Insert_Cord_Length			0.375								

Segment Sizing - # of arms, segment sweep, overlap

Material Layout



Layer Preparation



Double Sided Tape

1/4" base cut for each layer provides center for cutting segments

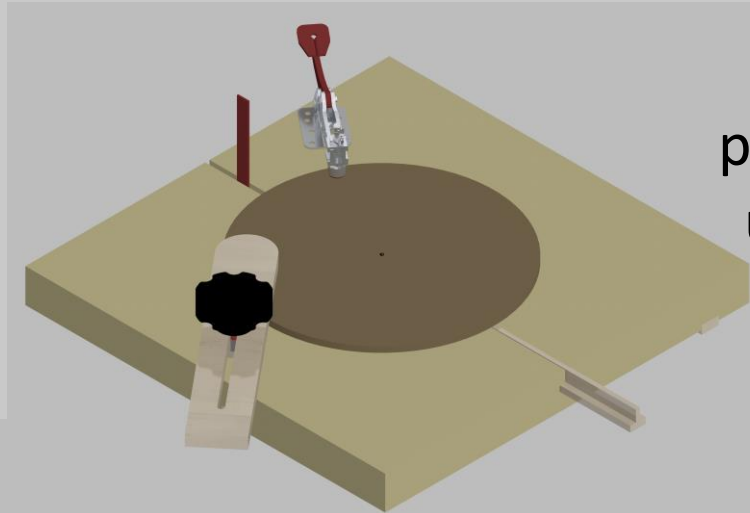


Cutting Segments

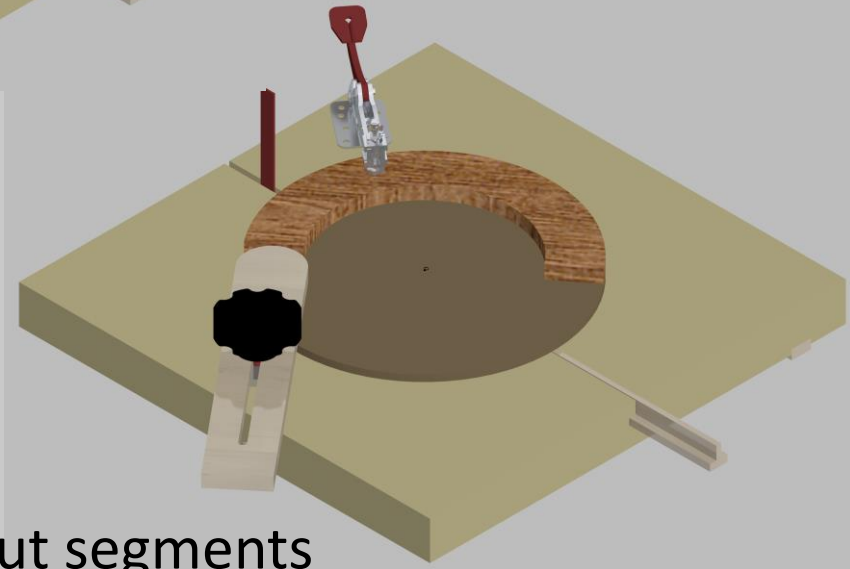
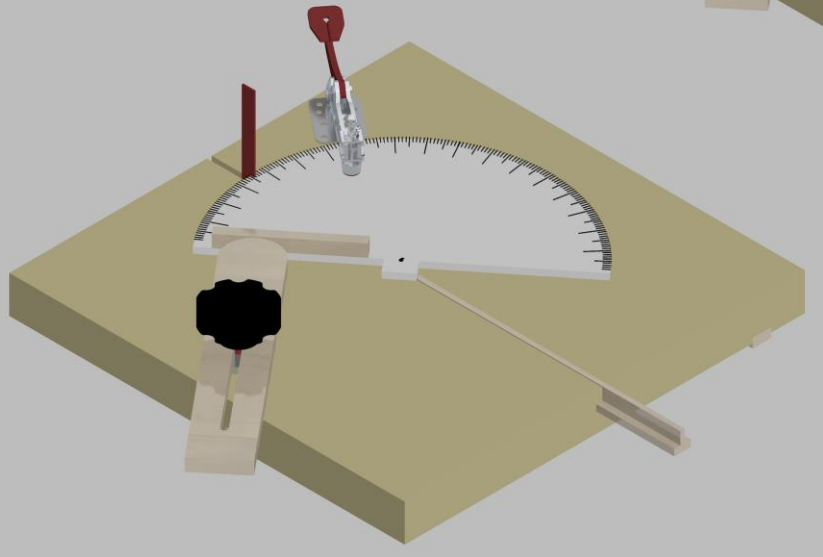


Segment Cutting Jig

Set stop for
segment
sweep

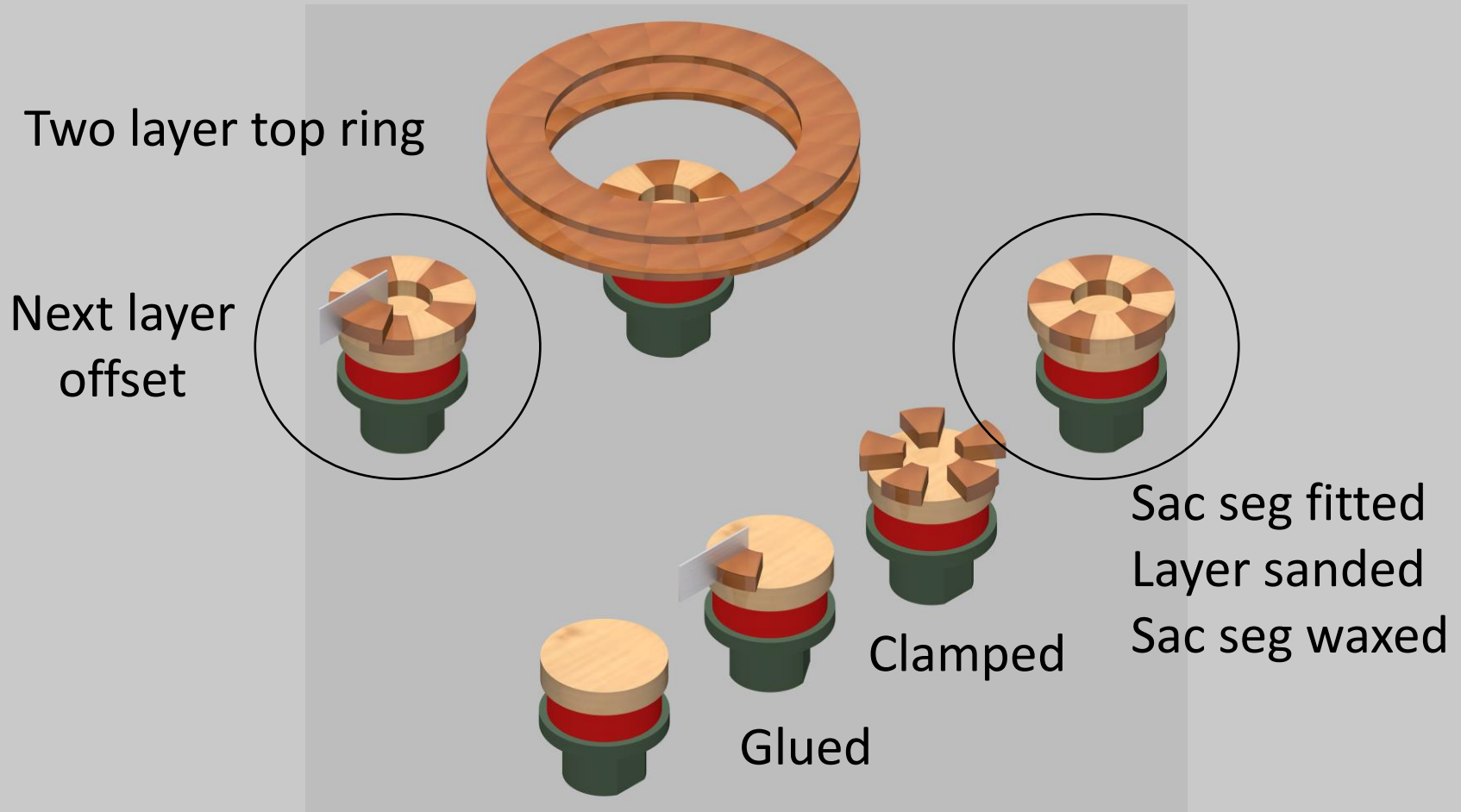


Set center
point so ring is
under clamp



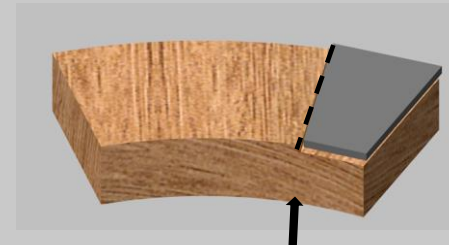
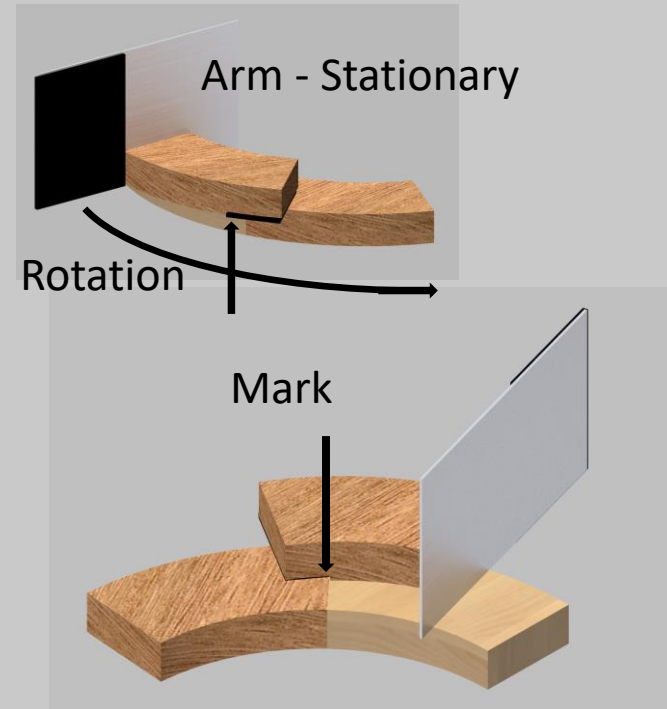
Cut segments

Stack Assembly

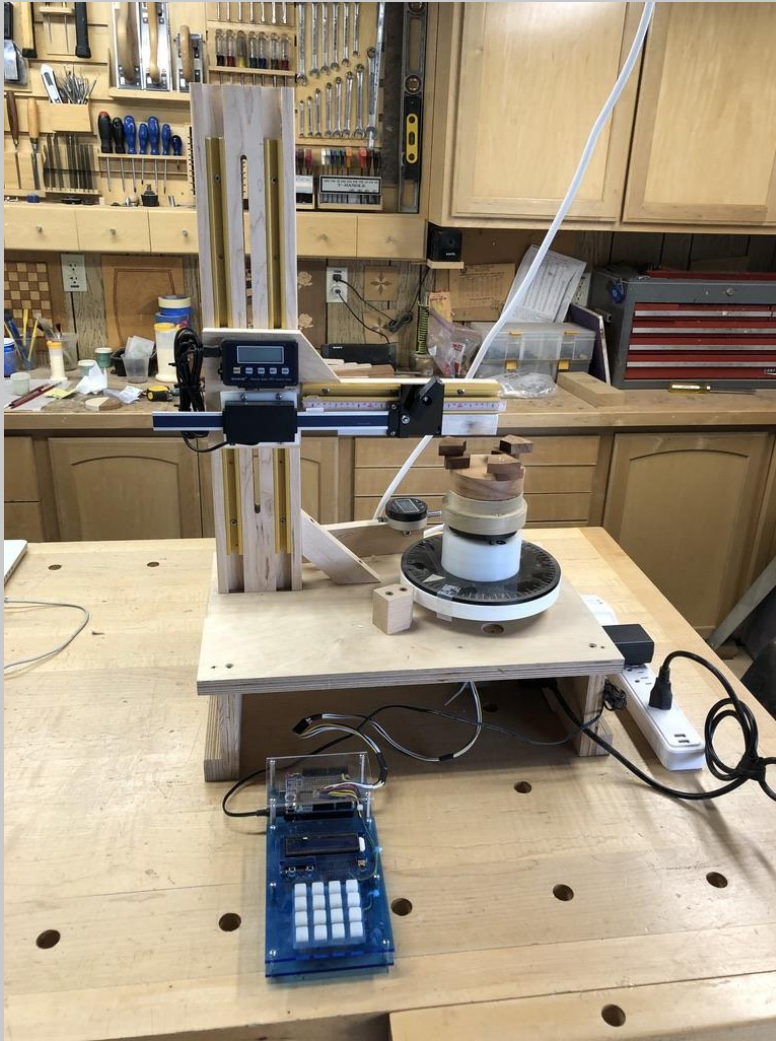


Assembly Steps Expanded

Sacrificial Segment Evolution



Open Segment Jig



Third Generation

Arduino controller

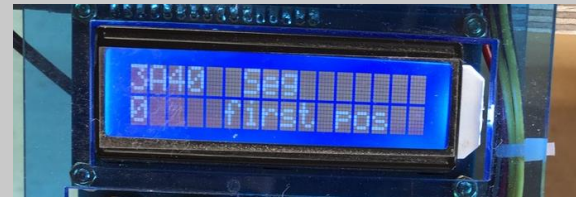
Direct drive stepper motor

Powermatic 3520 hub

Keyboard & 2 x 16 LCD

Parameter tables

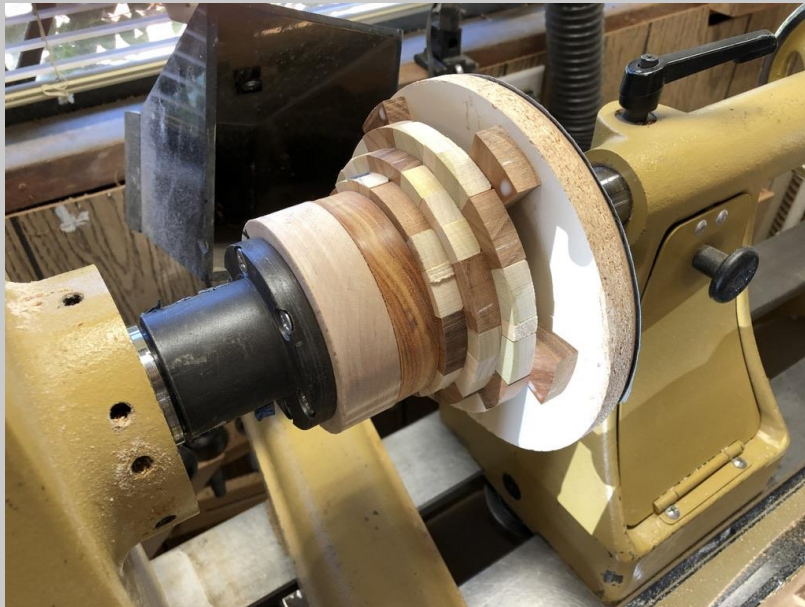
Typical Layer Actions



Open Segmenting Jig in Operation



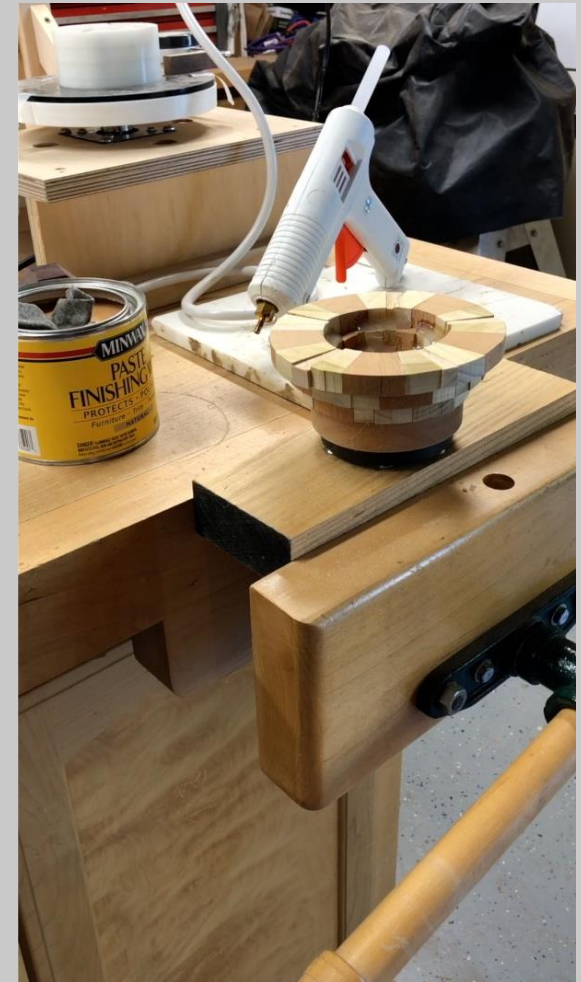
Project Segment Clamping



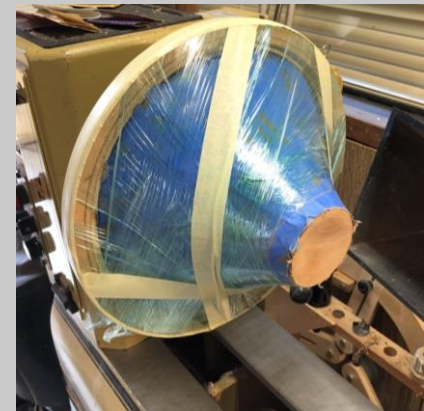
Fitting Sacrificial Segments



Layer Completion



Turning & Taping



Unwrapping



- Gentle !
- Reverse order of taping

Finishing Tools & Material



- Grex Air Brush - Cross between airbrush and touchup spray gun
- Target Coating water based lacquer – Great Stuff!

Finishing Approach

- General Sequence
 - Sand to 320 prior to first coat
 - Segment sides still rough
 - Sand between coats
 - Backup in grits as required – often
 - 320 again, 400, 600 or 800
 - Final 1000 after a couple of days
- Stepped more difficult
 - More arms – less space to access
 - More surfaces to coat and sand

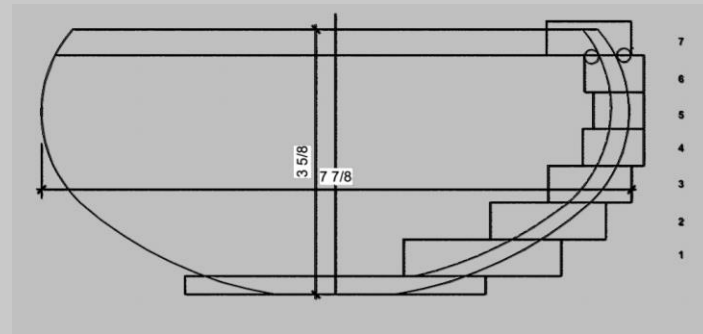
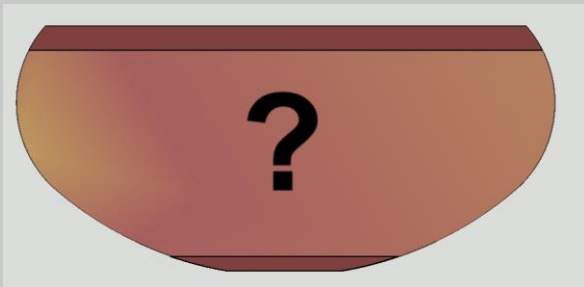
Alternative Style – Bugle Bowl

- Carved Arms
 - Requires significant overlap between layers
 - Same build methods
 - Carving skills – in short supply



Alternative Shape & Methodology

- 8" Bowl
 - Uses “traditional” methodology utilizing sacrificial segments



- Careful selection of parameters significantly reduces build time
 - Segment group – 3 sacrificial & 1 project segment evenly divisible into 360
 - Sacrificial segments slightly longer to account for kerf

Now for the Fun

Failure not uncommon

- Get a ticket if you want to participate
- Raffle prizes – each rotation
 - Completed small bowl
 - Chance to unwrap bugle bow – keep it if you want
 - Chance to unwrap 8” bowl - keep it if you want
- After the second rotation
 - In process small bowl



Thank You For Coming !