

## Northwest Woodworkers Association

# THE SAWDUST NEWS



August 2014

<http://www.nwwoodworkers.org>

An association for woodworkers of all skill levels to share their common interest

## The Next Meeting

**Date:** August 31, 2014

**Location:** Rockler Woodworking – Northgate  
832 NE Northgate Way  
Seattle, WA 98125

**Program Highlights:** 2014 – “2 X 4 Challenge”

Bring your projects made from a single construction grade softwood 8 foot long 2 x 4. Members will judge all contest entries and gift card prizes will be awarded. Great fun last year and we are expecting more of the same. Be sure to come and enjoy the fun and marvel at the members’ creativity.

## July 2014 Meeting Highlights

The **July 31, 2014 Northwest Woodworkers Association** meeting was held at **Woodcraft** in Seattle. There were 13 members and one guest in attendance. We thank **Ron and Michelle Hall** and their helpful staff for providing such a wonderful meeting place and helping us arrange the tables and chairs for our meeting.

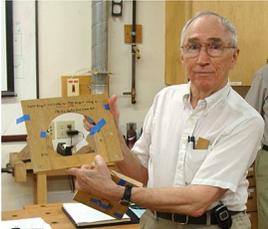


**Jan Erickson** showed us two boxes she has been working on and thanked **Herb Stoops** for teaching her how to construct wooden hinges and suitable legs for her box projects, and for being a wonderful inspiration to her.



**Bill Bond** reported on his ongoing dart-board cover project and welcomed member's ideas and thoughts on methods for constructing the split complex contoured lid.

## Show 'N' Tell



**Charlie Culler** explained that he does not own a biscuit joiner, so he showed us a unique jig he had made for use with his hand held router. He noted that the jig was designed to be used with a slot cutting bit suited to the particular biscuit size being used.



**Bob Craig** displayed an inlaid, engraved, turned pen he had made. He described the materials he used and how he accomplished the inlay and finishing. Truly a well done intricate project, **Bob!**



**Allen McCall** presented a slide show of an exquisite Padauk music stand he was recently commissioned to build for a client. The lovely piece was designed using a book-matched walnut crotch field surrounded with a gorgeous Padauk frame and stand. As usual, **Allen's** gallery quality craftsmanship was superb!





**Chris Green** presented another in his series of conical art pieces entitled, “**My Crown Jewel**”. In addition to displaying the piece and explaining its intricacies, he provided a slide show of the construction and the complex jiggling and clamping necessary to assemble the creation. In keeping with its name, **Chris** removed the crown shaped top of the piece to reveal a large cut glass jewel enclosed within – stunning to say the least!



## **Steering Committee Report**

**Chris Green** reported that he has been in contact with the staff at the **Wooden Boat Center** on Lake Union in an attempt to schedule an upcoming meeting there in the Fall. He will give us a further update on this issue in a subsequent meeting.

## **Program Presentation**

*(Please see the Photo Gallery on Page 10 for additional photos)*

## **Working with Fragile Woods**



**Herb Stoops**, NWWA Steering Committee Member and Head Raffle Guy, was our featured speaker for the evening. Ever the curious, creative woodworker, **Herb** decided he would investigate the pros and cons of using fragile woods and wood products to make woodworking projects. To this end, he treated us to a very interesting and informative presentation demonstrating the use of a variety of fragile wood materials and products including soft and springy pine, OSB composite sheet, Spalted Maple, end grain Douglas Fir, Baltic Birch plywood, and end grain Spalted

Apple Wood. He described many of the pitfalls encountered in working with these wildly different materials and wowed us with his creativity by producing a wide variety of unique project pieces.

### **Tension Joint Box**

Intrigued by a project he had seen in one of the woodworking magazines, **Herb** fabricated a unique box using some soft, clear, pine lumber from the local Lowes store, which he had resawed on his bandsaw and smoothed on his drum sander.

The box carcass consisted of flat, interlocking sides and bottom employing hook shaped tenons. The top also employed the same interlocking scheme. The secret to the assembly of the box was a series of lengthwise, open-ended slots routed through the panels, enabling the carcass panels to be compressed across their width to allow the hooks on the ends of the tenons to



engage slots in the end panels. Upon releasing the sideways compression, the tenons expanded locking the side panels to the end panels. The clear, light toned pine gave this unique box a very light and airy impression. Herb explained that such a design requires a flexible, springy wood like basswood or pine.

### Laminated OSB Composite Wood Boxes



**OSB (Oriented Strand Board)**, an engineered wood product, is a common construction material typically used for wall and roof sheathing in houses and similar structures. The material is made by bonding mats of thin, somewhat random size strips of wood

together under heat and pressure with resins to form rigid sheets. Typically, the face layers of strips are loosely oriented lengthwise of the sheets, with the internal layers oriented at roughly right angles to the face strips. Though as structurally strong as plywood, the layers of wood chips in **OSB** appear to be less tightly bonded to one another compared to the plies in plywood.



**Mat of Wood Chips Before Bonding**

So **Herb** wondered what kind of material would be formed if he laminated strips of **OSB** into a block and resawed the “end/edge grain” of the laminate into sheets, and could it be used to fabricate a simple box?

To answer the question, he showed us two pencil boxes he had made from his resawed laminated **OSB** material. Both were processed in a similar fashion as though they had been made from solid woods – i.e. they were of typical box construction with top and bottom panels having a routed profile, two different stains were used, and typical wood finish methods were applied.



However, **Herb** noted that the material was very difficult to work with due to the layers of strands not being securely bonded to one another. He found that the force of routing the profile in the panel edges actually pushed strands out the other side of the panel! He also noted that the router bit would sometimes gouge out sections of the profile for the same reason. Not surprisingly, **Herb** said the somewhat porous nature of the “end/edge grain” making up the panels really soaked up the stain and finish. So as a result of his experiment, **Herb** concluded that laminated **OSB** is not really a suitable woodworking material. However the good part is that now we don't have to lie awake at night and wonder..... :-) Thanks, **Herb**!!

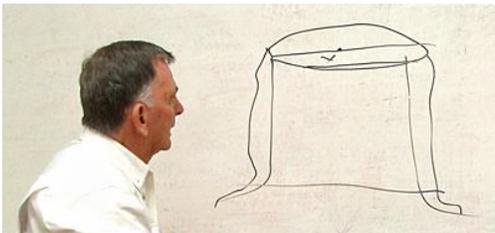
## Spalted Maple Boxes



**Herb** then showed us several boxes he had made using **Spalted Maple**. The spalting, which is a discoloration usually produced by fungi in the wood grain structure, typically produces very interesting patterns of dark lines, particularly in light woods like maple. **Herb** noted that sometimes the spalted areas can be soft and must be stabilized by using CA glue or epoxy to strengthen weak areas. He also noted that he had used “leadless cedar pencils” purchased from Lee Valley for his integral wooden hinges. This product is a hollow wooden dowel, which makes ideal hinge barrels. In addition, **Herb** also used hardwood

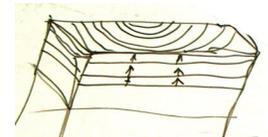
toothpicks as hinge pins. The wooden hinges blended in nicely with the overall box design. Finished natural, these boxes showed off their wild spalted patterns to perfection.

## End Grain Douglas Fir Projects



**Herb** then treated us to a series of projects he had made from a very unusual piece of a **Douglas Fir** tree stump. He diagrammed on the white board how the piece had been cut from the stump to make a slab roughly 6” thick x 24” wide x 20” long. He noted that if he resawed the slab lengthwise, the resulting material would be no more interesting than a typical 2 x 4. However, he reasoned,

because this slab exhibited spectacular end grain with very large growth rings, perhaps he could resaw **across** the grain to produce a series of end grain pieces to show off the spectacular grain pattern. So he again sketched his cutting method on the whiteboard showing the lateral cuts, illustrating how he had made a number pieces about  $\frac{3}{4}$ ” thick.



## Douglas Fir Stool

Using the boards cut crosswise from the slab discussed above, and smoothed on his drum sander, **Herb** was able to produce beautiful book-matched top and leg pieces for the stool. He pointed out that a large pitch pocket, prevalent in **Douglas Fir** and other conifers, had to be repaired with epoxy. **Herb** also noted that in spite of the thickness of the top pieces, he added two stringers under the top of the stool to support the somewhat fragile end grain. He also reported that he had to exercise care when routing the edges of the material as the soft areas between the growth rings tended to tear out – a more severe problem than usual due to the material being end grain. As shown in the photo, the end grain pattern in this material is nothing short of spectacular, with growth ring spacing as wide as  $\frac{1}{2}$ ”. A unique and beautiful piece, **Herb!**



## Douglas Fir Jewelry Box



Using additional material from the **Douglas Fir** slab, **Herb** designed a beautiful jewelry box to accentuate the unusual end grain pattern of the material. The book-matched top panels, oval top feature, molded filial and custom molded feet complemented the striking end grain pattern. The box also featured integral wooden dowel hinges, an oval mirror on the inside of the lid, and a magnetic catch. **Herb** cleverly used the mirror and the top feature to cover a pith void at the center of the material.

## Douglas Fir Tea Caddy

Lest such an unusual treasure be wasted, **Herb** wisely stretched his usage of that beautiful end grain **Douglas Fir** material by milling thin strips (~1/4" or so thick) by resawing and smoothing them on his drum sander to make a very unique **Tea Caddy**.

Since a plain ole box would never do, **Herb** designed his **Tea Caddy** to be in the shape of a **Dodecahedron**. For those of us who aren't mathematicians, he explained that a dodecahedron is a solid shape formed with 12 equal sided pentagons.

To make the pentagons, he made a template and cut the shapes out on his table saw. He used the template and a 60° router bit to bevel the edges of the pentagons, followed by sanding of the edges to reduce the bevel angle to the required 58°. Then he laid half of the pentagons out flat edge to edge and taped them together with painter's tape. After applying glue to the edges, he folded the pentagons up into half of the final shape, using the tape as his clamping method.



Wanting to seal the inside of the **Tea Caddy**, **Herb** applied adhesive backed aluminum duct tape over the joints and all inside surfaces of the glue up. He then used the same method to form and seal the matching half of the final shape. After gluing the two halves together, omitting one of the pentagons for access, and sealing the remaining joints, he made a matching pentagonal lid held in place with a small rare earth magnet. To set off the stunning end grain of the **Douglas Fir** pentagons, he used a stained round base with wooden balls for feet and knob (great craft store finds!). This was a very unusual project requiring excellent visualization and woodworking skills. Well done, **Herb**!

As a bonus, **Herb** gave us a real time applied geometry lesson on the white board, illustrating the process of drawing a pentagon with only a compass and a straight edge. He also distributed a handout of the procedure to the group.

[**Ed. Note:** Copies of Herb's informative handouts are attached to the end of the Newsletter.]

## Baltic Birch Plywood Boxes

**Baltic** (or **Russian**) **Birch** has long been prized by woodworkers for its uniform appearance, multiple thin plies, and virtually void free interiors. Frequently used as a material of choice for cabinet drawers, jigs, and many other uses in the shop, this wood product also exhibits a very interesting grain pattern when viewed from the edge of the sheet.

Fascinated with the edge grain of **Baltic Birch** plywood, **Herb** wondered what it would look like if he were to laminate strips of the material and resaw the laminated block into sheets that would show the edge grain. So he cut 8" wide strips of  $\frac{3}{4}$ " **Baltic Birch** plywood 18" long and laminated them face to face into a 6" thick slab. He then sliced the slab into boards across the grain such that the faces of the new boards were entirely edge grain material, showing the interesting pattern formed by the multiplicity of individual plies.



Using this material, **Herb** built a series of exceptional boxes.

One of the larger ones was especially unique in that all of its parts were fabricated from the laminated **Baltic Birch** material – including the external barrel hinges, the front hasp and engaging loop (staple), contoured handles on the ends of the box and custom molded feet! The ends and the front of the box were also contoured. **Herb** reported that the laminated material performed much like solid wood, no doubt due to its hardwood plies and consistent void free characteristics. **Herb** noted that he used hardwood toothpicks as mini-dowels in blind holes to locate and hold the handles while the glue dried – a technique he frequently finds very useful.

**Herb** then showed us a couple of other boxes using the laminated **Baltic Birch** material which were made in a very unique manner. As he was making some of his wooden barrel hinges with the router bits and techniques recommended for use with his **Inkra Hinge Master** tooling, it occurred to him that perhaps the hinge leaves could be used as the sides of small boxes with the barrels for corners. That led to further experimentation and the discovery that a completely different appearance would result from the hinges being turned inside out. As shown in the photo, the sides and corners of the two boxes are actually hinge leaves and barrels constructed using both configurations. He also noted that even more configurations are possible by mixing the two techniques. The lid hinges were also made from sections of wooden dowels. Craft store balls for feet and clear finish on the boxes accentuated the striated grain pattern of the laminated **Baltic Birch** material. Amazing creativity and craftsmanship, **Herb**!



As a side note, **Herb** also distributed a "Golden Ratio" table handout to the group to aid in selecting the dimensions for making boxes with pleasing proportions.

## Spalted Apple Wood Box

From an old Apple wood log, which was probably better suited for firewood, **Herb** sliced ½” thick pieces which he was able to mill and use to construct a beautiful box with compound angled sides and a four-piece book-matched lid showing a fantastic spalted grain pattern.



He said that the material was very difficult to work with due to the amount of decay and spalting present. To stabilize the material, he filled the decay voids with clear epoxy which solved the problem. However, some of the members suggested that in the future he tint the epoxy to better match or contrast with the other colors present. The **West System Three** epoxy system with compatible colorants, said to be available from such sources as **Rockler Woodworking**, was highly recommended.

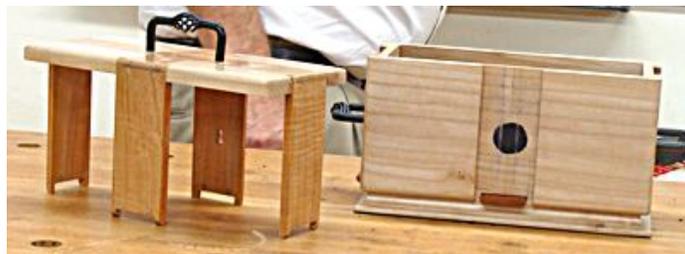
The shape of the box was unique in that the corners of the angled sides were coped off to produce four more short sides – actually turning the four sided box into an eight sided box. To fabricate the compound angled joints at the corners, **Herb** turned to his trusty **Wixey Angle Gage** to set both the table saw blade tilt angle and the miter gage setting. This technique enabled accurate setting of the partial angles frequently required by compound cutting. He noted that the parts fit together very accurately. Nice to have the right tool to do the job!

Piecing together scraps left over from making the box, **Herb** was able to create interesting feet for the box with molded contours. This project showed that seemingly nondescript or “unsuitable” wood can be put to good use to make a fantastic creation. Good show, **Herb!**

As a further learning aid, **Herb** passed out a handout with a table of values for the blade tilt angle and miter gage setting for various compound angle box joints. Thanks, **Herb!**

## Lunch Box

For his finale, **Herb** showed his clever, locking lunch box. Using Western Maple and Cherry materials and sliding dovetail joints, he designed a unique box with interlocking sides requiring a specific sequence of operations to open it.



Though an interesting design and certainly an exercise in making sliding dovetails, it doesn't look like something that will appear on your store shelves anytime soon.....! Since **Herb** called it a Lunch Box, the thought occurred to me that he might get pretty hungry if he forgets how to open the box..... :-) Fun project, tho, **Herb!**

# *Upcoming Events*

**August 2014 Meeting** – The 2014 “2 X 4 Challenge” will be held at **Rockler Woodworking – Northgate** on **Thursday, August 28, 2014**. This was a fun event last year and we had great participation with a diverse collection of inspiring member creations. As before, the entries will be judged by the members present and gift card prizes will be awarded. Bring one or more of your creations made from a construction grade softwood 8 ft. long 2 x 4. Look forward to seeing you there with your prize winning entry!

**September 2014 Meeting** – Meeting will be held on **Thursday, September 25, 2014** at **Woodcraft** in Seattle. **Bonnie Klein** will give a presentation about her First Prize winning stool entry in last year’s **2 x 4 Challenge**. Another of our “**Don’t Miss**” meetings. See you there.

## *A Special Notice from One of Our Sponsors*

### ***CLASSROOM COORDINATOR WANTED***

If you’re addicted to Woodworking, want to help spread the “woodworking gospel” and enjoy working in a well equipped shop, a position at **Woodcraft** beckons. You’ll be helping to create and maintain a great learning environment while working 15-25 hours a week scheduling classes, maintaining a clean and organized professional shop and working with instructors that need an extra “shophand” in their classes. Potential perks include free classes and shoptime. Position could be Full time if you also want to work on the sales floor.

Contact Eli or Eben at (206) 767-6394 or  
[Woodcraftsales@Woodcraftseattle.com](mailto:Woodcraftsales@Woodcraftseattle.com)

## *A Note from the Editor*



In today’s vernacular, **Herb Stoops’** excellent presentation at this **July 2014** meeting could have been titled “***Thinking Outside the Box to Make a Box***” !

Listening to **Herb’s** presentation, I was amazed at the resourcefulness and creativity he demonstrated in creating and exploring new forms and applications of existing materials, devising clever construction methods and techniques, and the plain old fun and enjoyment he shared with us as he explained his diverse projects!

Who’d a thunk he could slice a chunk from an old **Douglas Fir** stump to make spectacular end grain material and turn it into several amazing projects including thin sided boxes??

Who'd a thunk he could take **Baltic Birch** plywood and create a "new" decorative sheet material that could be used like solid wood but exhibiting wonderful striated edge grain patterns??

And who'd a thunk he could turn wooden hinges into box sides and a scroungy old apple stick into a beautiful box that looks like it was made from marble?

**Herb Stoops** is one of the many special, gifted woodworkers we are fortunate to have in our Association, folks! Thanks so much for sharing your knowledge, creativity and enthusiasm with us, **Herb!**

As a side note, in comparison with the wonderful earlier presentations he has made to our Association, graced with many beautiful projects, I was impressed with the marked increase in quality and creativity **Herb** demonstrated in the projects shown in this presentation. How wonderful it is to see our members increasing their skill levels and expertise and sharing their success with us. Great progress on your woodworking journey, **Herb!**

Wishing you happy and safe woodworking,

Paul

# *July 2014 Meeting Photo Gallery*

## *Newsletter Photos by Scott Wilson*



**"My Crown Jewel" by Chris Green**



**End Grain Douglas Fir Projects by Herb Stoops**



**Spalted Apple Wood Box by Herb Stoops**

# Northwest Woodworkers Association Sponsors

We appreciate the generous support provided by our NWWA sponsors, from providing member discounts on purchased items to providing state of the art venues for us to conduct our monthly meetings. Thank you, Sponsors!

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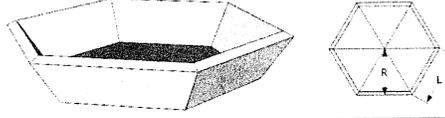
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We encourage our members to contact any of the above individuals with questions, comments, or items that may be of interest to the membership.

In addition, please visit our website and forum: <http://www.nwwoodworkers.org>

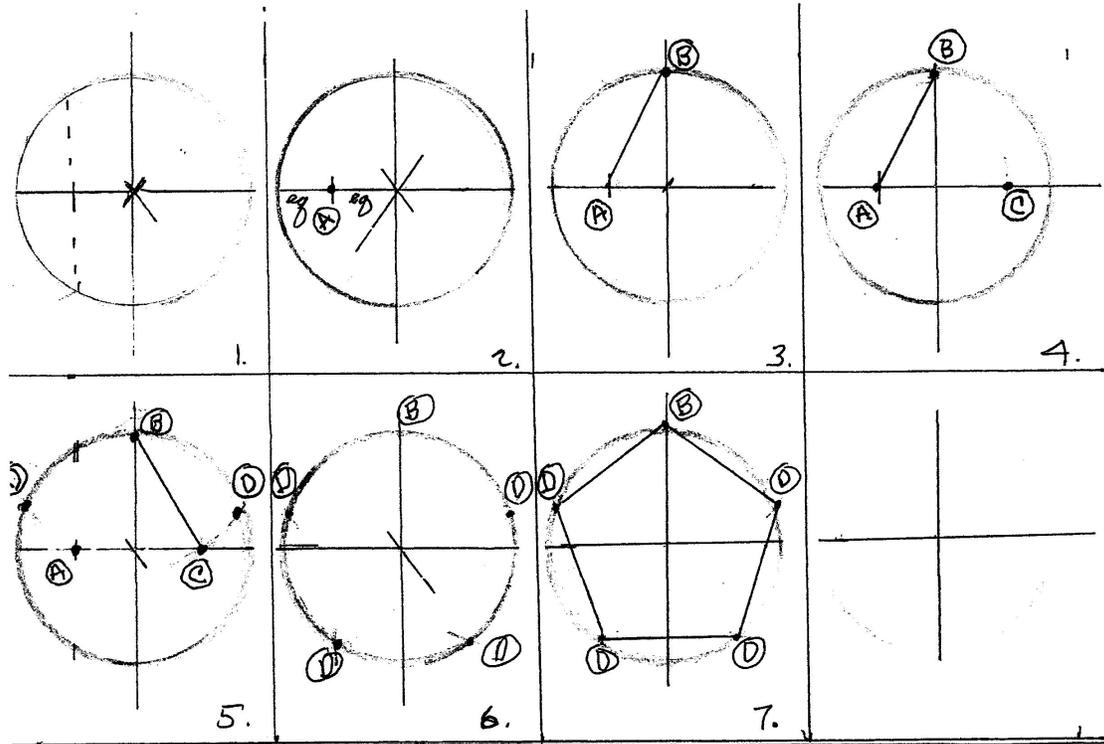
# Tapered polygon miter cut table

Use this table to determine the miter saw miter and tilt angle for making tapered regular polygons.  
For more, see <http://woodgears.ca/miter>



Number of sides → Flat miter angle	3 60 deg		4 45 deg		5 36 deg		6 30 deg		8 22.5 deg		10 18 deg		12 15 deg	
	L/R		2		1.45309		1.1547		0.82843		0.64984		0.5359	
Side outward tilt from vertical	Miter	Tilt	Miter	Tilt	Miter	Tilt	Miter	Tilt	Miter	Tilt	Miter	Tilt	Miter	Tilt
0	0.00	60.00	0.00	45.00	0.00	36.00	0.00	30.00	0.00	22.50	0.00	18.00	0.00	15.00
2	3.46	59.94	2.00	44.97	1.45	35.97	1.15	29.98	0.83	22.49	0.65	17.99	0.54	14.99
4	6.89	59.76	3.99	44.86	2.90	35.90	2.31	29.92	1.66	22.44	1.30	17.95	1.07	14.96
5	8.58	59.62	4.98	44.78	3.62	35.84	2.88	29.87	2.07	22.41	1.62	17.93	1.34	14.94
6	10.26	59.46	5.97	44.69	4.34	35.77	3.45	29.82	2.48	22.37	1.95	17.90	1.60	14.92
8	13.55	59.05	7.92	44.45	5.77	35.60	4.59	29.68	3.30	22.27	2.59	17.82	2.14	14.85
10	16.74	58.53	9.85	44.14	7.19	35.37	5.73	29.50	4.11	22.14	3.23	17.72	2.66	14.77
12	19.80	57.90	11.75	43.76	8.59	35.10	6.84	29.28	4.92	21.98	3.86	17.59	3.19	14.66
14	22.73	57.17	13.60	43.32	9.97	34.77	7.95	29.02	5.72	21.80	4.49	17.45	3.71	14.54
15	24.15	56.77	14.51	43.08	10.65	34.59	8.50	28.88	6.12	21.69	4.81	17.37	3.97	14.48
16	25.52	56.35	15.41	42.82	11.32	34.40	9.04	28.73	6.51	21.58	5.12	17.28	4.22	14.41
18	28.16	55.45	17.17	42.26	12.65	33.99	10.12	28.39	7.29	21.34	5.73	17.09	4.73	14.25
20	30.64	54.47	18.88	41.64	13.95	33.53	11.17	28.02	8.06	21.08	6.34	16.88	5.24	14.08
22	32.98	53.41	20.54	40.97	15.23	33.02	12.20	27.62	8.82	20.78	6.94	16.65	5.73	13.88
24	35.16	52.29	22.13	40.24	16.46	32.48	13.22	27.18	9.56	20.46	7.53	16.40	6.22	13.68
25	36.20	51.71	22.91	39.86	17.07	32.19	13.71	26.95	9.93	20.29	7.82	16.26	6.46	13.57
26	37.21	51.11	23.67	39.46	17.67	31.89	14.20	26.71	10.29	20.12	8.11	16.13	6.70	13.45
28	39.12	49.88	25.15	38.63	18.83	31.26	15.17	26.20	11.00	19.75	8.67	15.83	7.17	13.21
30	40.89	48.59	26.57	37.76	19.96	30.60	16.10	25.66	11.70	19.35	9.23	15.52	7.63	12.95
32	42.55	47.26	27.92	36.85	21.06	29.90	17.01	25.09	12.38	18.94	9.77	15.19	8.08	12.68
34	44.08	45.89	29.21	35.89	22.11	29.16	17.89	24.49	13.04	18.50	10.30	14.84	8.52	12.39
35	44.81	45.19	29.84	35.40	22.62	28.78	18.32	24.18	13.36	18.27	10.56	14.66	8.74	12.24
36	45.51	44.46	30.45	34.89	23.12	28.39	18.75	23.86	13.68	18.03	10.81	14.48	8.95	12.09
38	46.84	43.03	31.62	33.86	24.10	27.59	19.57	23.20	14.31	17.55	11.31	14.09	9.37	11.77
40	48.07	41.56	32.73	32.80	25.03	26.76	20.36	22.52	14.91	17.05	11.80	13.69	9.77	11.44
42	49.21	40.06	33.79	31.70	25.93	25.90	21.12	21.81	15.49	16.52	12.27	13.28	10.16	11.09
44	50.27	38.53	34.79	30.57	26.78	25.01	21.85	21.08	16.05	15.98	12.72	12.84	10.54	10.73
45	50.77	37.76	35.26	30.00	27.19	24.56	22.21	20.70	16.32	15.70	12.94	12.62	10.73	10.55
46	51.25	36.98	35.73	29.42	27.59	24.10	22.55	20.32	16.59	15.42	13.16	12.40	10.91	10.36
48	52.16	35.41	36.62	28.24	28.37	23.16	23.22	19.55	17.11	14.84	13.57	11.93	11.26	9.97
50	53.00	33.83	37.45	27.03	29.10	22.20	23.86	18.75	17.60	14.24	13.98	11.46	11.60	9.58
52	53.77	32.22	38.24	25.81	29.79	21.22	24.46	17.93	18.08	13.63	14.36	10.97	11.92	9.17
54	54.49	30.60	38.97	24.56	30.45	20.21	25.04	17.09	18.53	13.00	14.73	10.47	12.23	8.75
55	54.82	29.78	39.32	23.93	30.78	19.70	25.31	16.67	18.74	12.68	14.90	10.21	12.38	8.54
56	55.15	28.97	39.66	23.29	31.06	19.19	25.58	16.24	18.95	12.36	15.08	9.95	12.52	8.32
58	55.75	27.32	40.30	22.01	31.64	18.15	26.09	15.36	19.35	11.70	15.41	9.42	12.80	7.88
60	56.31	25.66	40.89	20.70	32.18	17.09	26.57	14.48	19.73	11.03	15.72	8.89	13.06	7.44
62	56.82	23.99	41.44	19.39	32.68	16.02	27.01	13.58	20.09	10.35	16.01	8.34	13.31	6.98
64	57.28	22.31	41.95	18.06	33.15	14.93	27.43	12.66	20.42	9.66	16.28	7.79	13.54	6.51
65	57.50	21.47	42.19	17.39	33.36	14.38	27.62	12.20	20.58	9.31	16.41	7.50	13.65	6.28
66	57.71	20.62	42.41	16.71	33.57	13.83	27.81	11.73	20.73	8.95	16.53	7.22	13.75	6.04
68	58.09	18.93	42.84	15.36	33.97	12.72	28.16	10.80	21.01	8.24	16.77	6.65	13.95	5.56
70	58.43	17.23	43.22	14.00	34.32	11.60	28.48	9.85	21.27	7.52	16.98	6.07	14.13	5.08
72	58.74	15.52	43.56	12.62	34.64	10.47	28.77	8.89	21.50	6.79	17.17	5.48	14.30	4.59
74	59.01	13.81	43.87	11.24	34.93	9.32	29.03	7.92	21.71	6.05	17.35	4.89	14.44	4.09
75	59.13	12.95	44.01	10.55	35.06	8.75	29.15	7.44	21.81	5.68	17.42	4.59	14.51	3.84
76	59.25	12.09	44.14	9.85	35.18	8.18	29.26	6.95	21.90	5.31	17.50	4.29	14.57	3.59
78	59.45	10.37	44.37	8.45	35.40	7.02	29.45	5.97	22.06	4.56	17.63	3.68	14.69	3.08
80	59.62	8.65	44.56	7.05	35.58	5.86	29.62	4.98	22.19	3.81	17.74	3.08	14.78	2.58
82	59.76	6.92	44.72	5.65	35.73	4.69	29.76	3.99	22.30	3.05	17.84	2.46	14.86	2.06
84	59.86	5.19	44.84	4.24	35.85	3.52	29.86	3.00	22.39	2.29	17.91	1.85	14.92	1.55
85	59.91	4.33	44.89	3.53	35.90	2.94	29.91	2.50	22.42	1.91	17.94	1.54	14.95	1.29
86	59.94	3.46	44.93	2.83	35.93	2.35	29.94	2.00	22.45	1.53	17.96	1.24	14.97	1.03
88	59.98	1.73	44.98	1.41	35.98	1.18	29.98	1.00	22.49	0.77	17.99	0.62	14.99	0.52
90	60.00	0.00	45.00	0.00	36.00	0.00	30.00	0.00	22.50	0.00	18.00	0.00	15.00	0.00

## HOW TO DRAW A PENTAGON



1. Draw 2 perpendicular lines. Draw a circle the desired size.
2. Find  $\frac{1}{2}$  the radius and mark the point on the horizontal axis, as point A.
3. Find the distance to where the vertical axis intersects the circumference of the circle. Mark this point B.
4. Draw a line from A to B, Swing an arc down to the horizontal axis, and mark the point C.
5. Draw a line from B to C, Swing this length arc to circumference of the circle and mark this point as D. Now swing the same distance to the other side of the circle and mark as D also.
6. Swing the distance B to D from both D points down and intersect the circle circumference.
7. Now connect from B to D to D to D back to B. You have formed a pentagon.

### Table of Golden Ratios

a	b	c	total inch	total feet
1	1.62	2.62	8.48	-
1.5	2.43	3	10.86	-
2	3.24	5.24	16.96	-
2.5	4.05	6.5	21.1	-
3	4.6	7.86	25.32	2.11
3.5	5.67	9.17	29.68	2.5
4	6.5	10.5	34	2.8
4.5	7.29	11.8	38.2	3.18
5	8	13	42	3.5
5.5	8.9	14.41	46.6	3.9
6	9.72	15.72	58.8	4.25
6.5	10.5	17	55	4.6
7	11.34	18.34	59.4	5
7.5	12.5	19.65	64.3	5.35