Math 101.1 for Woodworkers

presented by
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Adapted from
Woodworkers' Essential
Facts, Formulas & Short-Cuts
by Ken Horner

Topics

- 1 - Measuring Wood
- 2 - Converting Numbers
- 3 - Proportions & the Golden Ratio
- ✔ marks a special hint!

Measuring Wood

- A Board Foot is the equivalent of a 1" thick x 12" x 12" block.
- ✔ If all dimensions are in inches, a BF has a product of 144. These are all 1 BF:
  - 1" thick x 6" x 24"
  - 1" thick x 8" x 18"
  - 2" thick x 6" x 12"
  - 3" thick x 4" x 12"

Measuring Wood

- ✔ If two dimensions are in inches and one in feet, the BF has a product of 12. These are all 1 BF.
  - 1" thick x 6" x 2'
  - 1" thick x 8" x 1.5'
  - 2" thick x 6" x 1'
  - 3" thick x 4" x 1'

Measuring Wood

- When the lumber yard sells dimensioned lumber, they still charge you for the parts they took off, so that 1" x 2" x 6' long, which is 1 BF, is now 3/4" x 1-1/2" x 6' long, and is still 1 BF.
- ✔ For dimensions 2" and bigger, figure 1/2" has been removed!

Converting Numbers

- Decimals to Fractions
- Fractions to Decimals
- Feet & Inches to Feet
- Feet & Inches to Inches
- Metric Equivalence

Converting Numbers

- Decimals to Fractions - multiply by the "fraction" you want it to be & round
  - example: .21 in 8ths, 16ths, 32nds :
    - .21 x 8 = 1.68, so .21 is about 2/8 (1/4)
    - .21 x 16 = 3.36, so .21 is about 3/16
    - .21 x 32 = 6.72, so .21 is about 7/32

Converting Numbers

- Decimals to Fractions - multiply by the "fraction" you want it to be & round
  - another example: .84 in 8ths,16ths, 32nds :
    - .84 x 8 = 6.72, so .84 is about 7/8
    - .84 x 16 =13.44, so .84 is about 13/16
    - .84 x 32 = 26.88, so .84 is about 27/32

Converting Numbers

- Fractions to Decimals - divide the top number by the bottom number
  - example: 7/8 = 7 ÷ 8 = 0.875

Converting Numbers

- Feet & Inches to Feet - convert each part and add
  - example: 12ft 7-3/8in is how many feet?
  - 3/8 = 3 ÷ 8 = 0.375; 0.375÷12 = 0.031ft
  - 7in = 7÷12 = 0.583ft
  - so, 12 ft 7-3/8 in = 12 + .583 +.031 = 12.614 ft
  - (To convert to inches 12.614x12 = 151.37in)

Converting Numbers

- Feet & Inches to Inches - convert each part and add
  - example: 6ft 3-3/16in is how many inches?
  - 3/16 = 3 ÷ 16 = 0.188in
  - 6 ft = 6x12 = 72in
  - So, 6ft 3-3/16in = 0.188 + 3 + 72 = 75.19in
  - (To convert to feet, 75.19÷12 = 6.27ft)

Converting Numbers

- Metric Equivalence
  - Inches to Metric: Inches x 2.54 for cm
  - Inches to Metric: Inches x 25.4 for mm
  - Metric to Inches: cm ÷ 2.54 for inches
  - Metric to Inches: mm ÷ 25.4 for inches

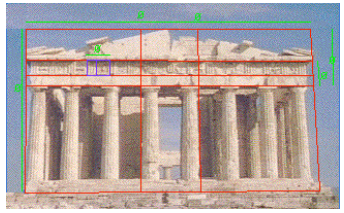
Proportions
& the Golden Ratio

- What is the Golden Ratio?
- Golden Ratio Numbers
- Golden Rectangular Solid
- How exact do I need to be?

Proportions
& the Golden Ratio

- Spirals
- Other Pleasing Proportions
- Drawer Proportioning

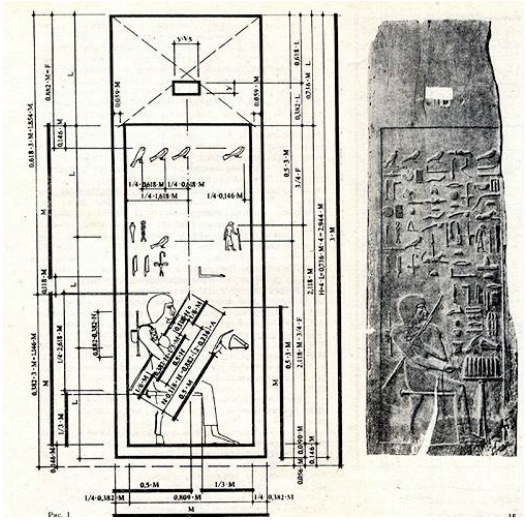
What is the Golden Ratio?



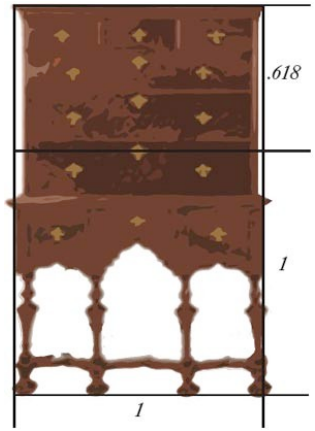
- The Greek architects used what they called the "classical proportion" or "golden rule" to determine the relationship between the dimensions of buildings, including the columns.

What is the Golden Ratio?

- The Egyptians used this same ratio to erect temples and tombs because they were pleasing to the eye; they called it the "sacred ratio."



What is the Golden Ratio?



- Furniture makers, including Thomas Chippendale, have long used similar proportions to make their work pleasing.
- The ratio does not have to be exact, but your work should be close.

What is the Golden Ratio?

- Simply stated, the Golden Ratio is: The smaller part is to the larger as the larger is to the whole.
- The "magic" multiplier is 1.618. smaller x 1.618 = larger & larger x 1.618 = whole
- There is an easier way!

Golden Ratio Numbers

- Look at these sets of numbers:
  - 1 - 1 - 2
  - 1 - 2 - 3
  - 2 - 3 - 5
  - 3 - 5 - 8
  - 5 - 8 - 13 (this is where the Golden Ratio really starts)
  - 8 - 13 - 21
  - 13 - 21 - 34
  - what's the next set?

Golden Ratio Numbers

- Now what do you do with them?
  - Think of a small box you would like to build - If it is 5" high and 8" wide, it should be 13" long.
  - ✔ You can also use "multiples" (10" x 16" x 26")

Golden Ratio Numbers

- If you are making a two dimensional object, like a picture frame, use the magic multiplier (1.618 or 1.62).
  - Example: A narrow frame is to be 24" high; Divide 24 by 1.618 and get 14.8", so it would be about 15" wide.

Golden Ratio Numbers

- Watch out for wide frames!
- Say the frame was going to be 3" wide; that would make the opening in your 24 x 15 frame be 18 x 9, which isn't close!
- Adjust the frame to be 24 x 17, then the inside will be 18 x 11, which is pretty close!
- ✔ Another way - start with the inside dimensions - they are more important!

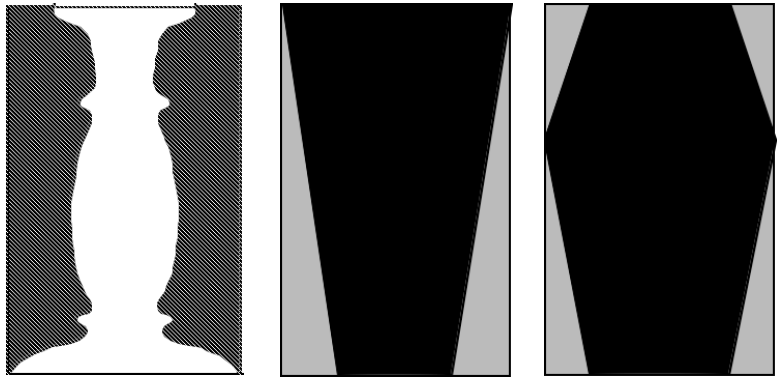
Golden Ratio Trick #1

- If you know just the "middle" number of the set, you can find the small and large numbers by multiplying or dividing the middle number by 1.62
- Example: The middle number is 8.
- 8 x 1.62 = 12.96 (about 13)
- 8 ÷ 1.62 = 4.93 (about 5) - producing 5 - 8 - 13!

Golden Ratio Trick #2

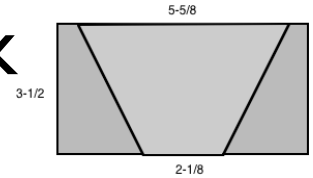
- The same can be done by multiplying and dividing the middle number by .6
- Example: The middle number is 8.
- 8 x .6 = 4.8 (about 5)
- 8 ÷ .6 = 13.33 (about 13) - producing 5 - 8 - 13!

Golden Ratio Numbers in Turnings



- The height of each is 10; the widest end is 6 1/4; the narrowest end is 3 3/4, following the golden ratio.

Golden Ratio Bowl Blank

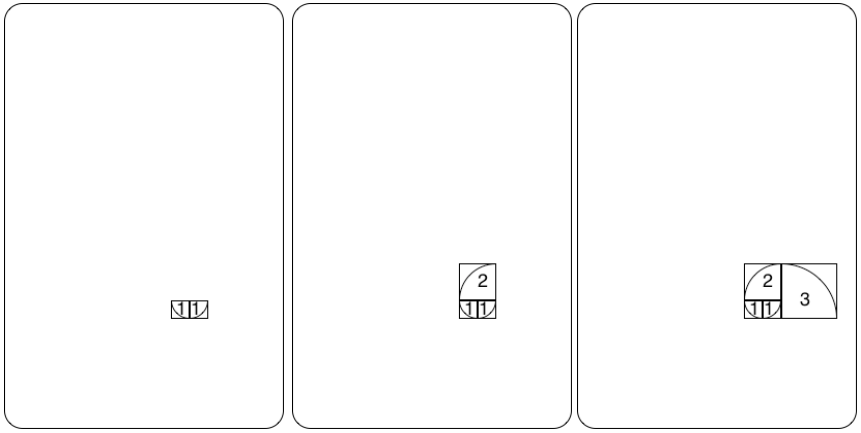


- If you have a 3 1/2" bowl blank, using the golden ratio to determine the top and bottom sizes:
- 3.5 x 1.62 = 5.67, about 5-5/8" (top)
- 3.5 ÷ 1.62 = 2.16, about 2-1/8" (bottom)

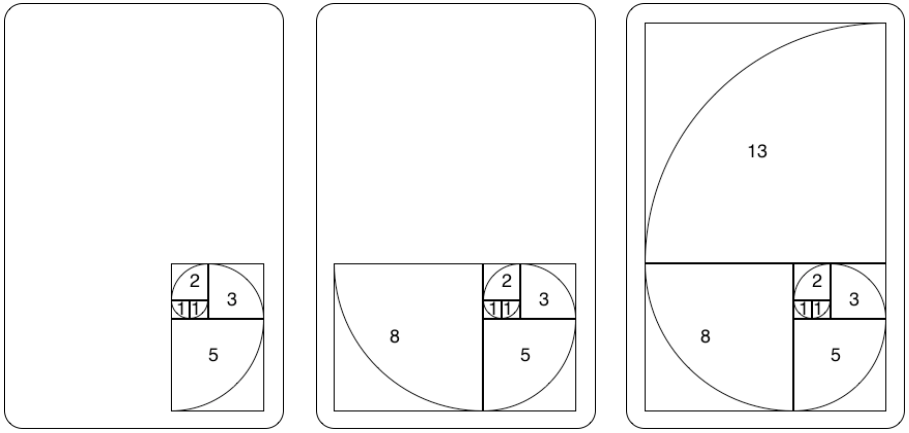
Spirals

- Remember the Golden Ratio sequence?
- 1-1-2-3-5-8-13-21-34...
- The Nautilus Spiral appears in nature in the snail or Nautilus shell. Architectural carvers use this method to lay out complex designs of various sizes.

Spirals



Spirals



The Golden Ratio

- In summary, there are many ways to work with the golden ratio
  - 1:1.618 can be simplified to 5:8
  - for the three part ratio, multiply and divide the middle by .6 or by 1.62
  - use the sequence: 1,1,2,3,5,8,13,21,34,...

Drawer Proportioning

- The Golden Ratio suggests that when designing a chest of drawers, a 60" high chest would be 37" wide (60 ÷ 1.62).
- Choosing the number and height of the drawers can be a challenge.
- Drawers of differing heights offer more visual interest.
- This method is from Richard Jones of *Woodwork Magazine*.

Drawer Proportioning

- Required information:
  - carcass opening height to hold all drawers (54”)
  - number of drawers desired (8)
  - height of top (smallest) drawer (5”)

Drawer Proportioning

- Multiply the number of drawers (8) by the height of the top drawer (5”) = 40”
- Subtract that from the carcass opening (54”) = 14”
- This is the amount to be distributed across the remaining drawers.

Drawer Proportioning

- 1st drawer = +0 x inc = 0 inc
- 2nd drawer = +1 x inc = 1 inc, so far, 1
- 3rd drawer = +2 x inc = 2 inc, so far, 3
- 4th drawer = +3 x inc = 3 inc, so far, 6
- 5th drawer = +4 x inc = 4 inc, so far, 10
- 6th drawer = +5 x inc = 5 inc, so far, 15
- 7th drawer = +6 x inc = 6 inc, so far, 21
- 8th drawer = +7 x inc = 7 inc, so far, 28
- Total = 28 inc

Drawer Proportioning

- Divide the amount to be proportioned (14”) by the number of increments (28) = .5
- So the drawers are: 5”, 5.5”, 6”, 6.5”, 7”, 7.5”, 8”, 8.5”

Drawer Proportioning

- Suppose in the same chest you only wanted 6 drawers, but still the top drawer would be 5”.
- Multiply the number of drawers (6) by the height of the top drawer (5”) = 30”
- Subtract that from the carcass opening (54”) = 24”
- This is the amount to be distributed across the remaining drawers.

Drawer Proportioning

- 1st drawer = +0 x inc = 0 inc
- 2nd drawer = +1 x inc = 1 inc, so far, 1
- 3rd drawer = +2 x inc = 2 inc, so far, 3
- 4th drawer = +3 x inc = 3 inc, so far, 6
- 5th drawer = +4 x inc = 4 inc, so far, 10
- 6th drawer = +5 x inc = 5 inc, so far, 15
- Total = 15 inc

Drawer Proportioning

- Divide the amount to be proportioned (24”) by the number of increments (15) = 1.6”
- So the drawers are: 5”, 6.6”, 8.2”, 9.8”, 11.4”, 13.0”.
- In fractions, we would use: 5”, 6-5/8”, 8-1/4”, 9-3/4”, 11 3/8”, 13”.

Drawer Proportioning

- If you don't want to stop and figure the number of increments each time, here's a chart (do you see the pattern?)

drawers	increments
2	1
3	3
4	6
5	10
6	15
7	21
8	28
9	36
10	45

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QUESTIONS

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ANSWERS