How to Determine Your TARGET SIZE for Sawing Lumber

by Brian Bond

I'd like to thank reader Paul Garrity for sending me an e-mail about something I should have discussed in my last article on quartersawing—and that is target sizes. So, let's discuss what target sizes are and how they are calculated before explaining their importance in quartersawing.

When cutting lumber to various thicknesses, we typically rely on an inch scale (Figure 1) or lumber scale (Figure 2) on the machine to help us saw lumber to specific thicknesses. The inch scale tells you how high the saw blade is from the deck of the machine, allowing you to lower the blade to get the desired thickness out of each board as it is cut from the log. A lumber scale is set up so each mark on the scale is the location for cutting a board at a particular thickness as you progress into the log and will have several desired thicknesses on the scale (4/4, 6/4, 8/7, etc.). What exactly are the distances between the scale marks and how were they determined? Let's dive into determining the target size of lumber to find out.

Fig. 1. Inch scale.

Fig. 2. Lumber scale.

STANDARDS FOR LUMBER THICKNESS

What are the standards for lumber sizes and where do they come from? Let's separate the discussion into hardwoods and softwoods. The target size for commercially produced hardwood lumber is set by the National Hardwood Lumber Association. You can locate the standard sizes in the "Rules for the Measurement and Inspection of Hardwood and Cypress," National Hardwood Lumber Association, Memphis, Tennessee. www.nhla.com. Here's what it says for sizes: "One inch and thicker may also be expressed in quarter inches as follows: 4/4, 5/4, 6/4, 7/4, 8/4,10/4, 12/4, 14/4, 16/4, 18/4, 20/4, 22/4 and 24/4." For standard thickness it states, "Standard thicknesses for surfaced lumber are calculated by subtracting 3/16 inch from standard rough thickness for lumber 1-1/2 inches thick or less and by

subtracting 1/4 inch for lumber between 1-3/4 inch and 4 inches thick as follows, where S2S is surfaced two sides (after drying):

Notice, these standards do not actually tell us what the target size for green lumber should be, but only the dimension that green board should surface out to when it is dried and planed. The standards allow us some freedom in choosing our actual target size.

3/8 inch S2S to 3/16 inch
1/2 inch S2S to 5/16 inch
5/8 inch S2S to 7/16 inch
3/4 inch S2S to 9/16 inch
1 inch S2S to 13/16 inch
1-1/4 inch S2S to 1-1/16 inch
1-1/2 inch S2S to 1-5/16 inch
1-3/4 inch S2S to 1-1/2 inch
2 inch S2S to 1-3/4 inch
2-1/2 inch S2S to 2-1/4 inch
3 inch S2S to 2-3/4 inch
3-1/2 inch S2S to 3-1/4 inch
4 inch S2S to 3-3/4 inch

For softwood dimension lumber, the final lumber sizes are given by the American Softwood Lumber Committee, American Softwood Lumber Voluntary Product Standard PS 20-20. http://www.alsc.org/. See Table 1 for nominal and minimum-dressed thickness for dimension. Note that for softwoods, dressed boards means dried to the appropriate moisture content and then surfaced on all four sides. Again, note that no green target size is specified, only the finished, dried, and planed dimensions. So, what should they be?

Dimension	Thickness	
	Nominal Inch	Minimum Dressed Dry (inch)
	2	1-1/2
	2-1/2	2
	3	2-1/2
	3-1/2	3
	4	3-1/2
	4-1/2	4

Table 1. Minimal nominal and minimum-dressed sizes of boards

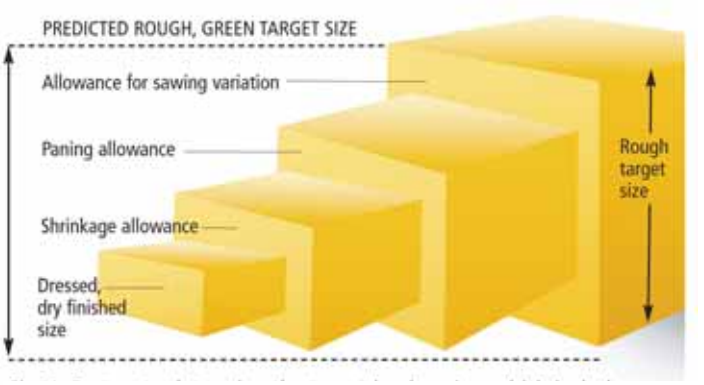

Fig. 3. Factors to determine target lumber size which includes sawing variation.

FINAL FINISHED LUMBER SIZE

Let's use hardwood lumber for the examples in the rest of the article. The industry standards, set by the NHLA, state that a 4/4-inch board must surface out to 13/16 inches when dried and surfaced. What should my target be? We have to think about what needs to be added (taken away as we process the green board into a dried and planed board for use) to get back to the green, un-planed state (Figure 3). We know that wood shrinks as it dries, so we have to account for how much the wood will shrink over some moisture loss (green to dry). We also have to deal with the loss of thickness from wood shavings that come from the surface planer to produce a smooth surface on the top and bottom of the board. That sounds fairly easy! I can look up shrinkage values, and I know the average of how much I like to remove with a planer. However, our mill set up, which includes sharpness of blades, type of wood, how fast we saw, our setworks, etc., can influence our ability to produce a uniform thickness within a board and between boards produced on the sawmill. This variability is called sawing variation. I have seen sawing variation on portable sawmills to be lower than 1/8 inch on a well-tuned mill with sharp blades to over 1/2 inch with a poorly set-up mill with dull blades. I'll provide some values for our example calculations and revisit how to determine your sawing variation in a future article.

$$T = \frac{F + P}{\left(1 - \frac{Sh}{100}\right)} + (Z \times S_t)$$

Figure 4. Calculation for green target size.

CALCULATE YOUR TARGET SIZE

The formula to help you figure out your target size is shown in Figure 4. Notice you can calculate the target size depending on the species,

your desired planer allowance, your sawing variation, and what percentage of boards you will allow to be undersized (thinner than desired). Determining these variables makes it more complicated but allows you to maximize your lumber volume production over time—assuming that is what you want to do! Let's look at some examples to help understand how this is done, referring to Figure 4, where

F = Final size
P = Planer allowance
Sh = Percent shrinkage
Z = Percent undersized allowed
St = Sawing variation

A customer tells us he wants his southern red oak lumber to be 1 inch thick. We check with him to see if he really wants his *green lumber* or his *dried, planed, and ready-to-use lumber 1 inch thick*——big difference. We find out he actually wants lumber in its dried and planed state to be 3/4 inch thickness. So, let's plug in the numbers to calculate our target size.

To determine our target size for the tabletop boards, we would plug the following numbers into our target size calculation.

F = Final size = 3/4 inch (It's what our customer said he wants)
P = Planer allowance = 1/8 inch (It is what our customer usually removes, see text)
Sh = Percent shrinkage = 4.3 % (Looked up in Wood Handbook)
Z = Percent undersized allowed = 0.01 % (1% undersized allowed)
St = Sawing variation = 0.25 inch (I'm providing this number)

Where do these numbers come from? The final size is what we want when our lumber is dried and planed, ready for use. The planer allowance is how much you need to get an acceptable surface using your planer. I usually take off at least 1/16 on each side, a minimum of two passes of 1/32-inch cuts, so two sides, 1/16 + 1/16 = 1/8 inch. I will be sawing the southern red oak to produce plainsawn boards, or the width of the board is the tangential plane of reference and the thickness is the radial plane of reference. So, we will use the radial shrinkage value for red oak, which you can get from the Wood Handbook, NHLA, or other

online resources—4.3%. Since I'm a small outfit and want every board to meet target, I'm only allowing for a 1% under allowance and that means only 1% of my boards sawn should be undersize or 99% of my boards should meet target size. Finally, I've measured my sawing variation over time and know that my machine has a total sawing variation of 0.25 inch. Knowing what this value is for your sawing equipment is very important, and I will discuss in detail how to measure and calculate this value in my next article.

So, we get:

$$T = \frac{0.75 + 0.125}{\left(1 - \frac{4.3}{100}\right)} + (0.01 \times 0.25)$$

The ideal target size for southern red oak boards will be 0.917 inch. Wow, that is an odd size to measure while I'm looking at a scale rule fixed to my mill! So, I go with 1 inch thick, knowing that I'm sawing a little oversize and each cut depth is easier to quickly identify.

EXAMPLE #2

If my customer had actually wanted 1 inch dried and finished boards, what would my target be? For the boards that need to be 1 inch thick when dried and planed, I would substitute:

F = 1 inch
P = 1/8 inch
Sh = 4.3
Z = 0.01
St = 0.25

$$T = \frac{1 + 0.125}{\left(1 - \frac{4.3}{100}\right)} + (0.01 \times 0.25)$$

My green target size would now be 1.178 inches. I'd likely move it up to 1-3/16 to get an easier size to cut using my scale. Actually, with my eyesight, this would be really difficult. I think I would have to get a digital setworks to make this work for me (Figure 5). Many digital setworks will allow you to set your targets and automatically move your mill down to the next size.

Figure 5. Digital setworks.

QUICK SUMMARY

To accurately determine your target size, you need to know the size of the lumber the customer wants when dried and planed (often set as a standard), the shrinkage value for the species being sawn, the amount that should be allowed to be removed with a planer (when dried), the sawing variation for your mill, and the amount of lumber you are willing to be undersized. That seems rather complicated to do for every size and species!

Can I avoid all this by using a lumber scale? Yes, well, sort of. Most lumber scales are set up to saw approximately 1/8 inch over the nominal for 4/4–6/4 lumber and slightly larger for larger sizes of material. So, a 4/4 board when green, for all species, is sawn at 1-1/8 inches. There should be plenty of room for your sawing variation, shrinkage value for most species, and a hefty planer allowance. Let's do another example using the NHLA thickness standard to see how much material is in the board to give us some "flexibility." We'll increase the number of undersized boards allowed to 5%.

F = 13/16 =0.8125 inch
P = 3/16 = 0.1873 inch
Sh = 4.3
Z = 5% = 0.05
St = 0.25

$$T = \frac{0.8125 + 0.1873}{\left(1 - \frac{4.3}{100}\right)} + (0.05 \times 0.25)$$

My calculated target using these values would be 1.057 inches, so I have 1.125 - 1.057 = 0.068 inches of flexibility, or you could say, I'm giving away 0.068 inches of wood in thickness for each board produced. Doesn't seem like much—especially when I can easily see the lumber scale on my mill and make my cuts more quickly.

QUARTERSAWING EXAMPLE

Let's now look at my quartersawing example. We'll use the same values as above, except now my lumber thickness will be plainsawn or the tangential plane of reference and the width of the board radial. For southern red oak, that means my shrinkage value will now be 11.3%!

F = 13/16 =0.8125 inch
P = 3/16 = 0.1873 inch
Sh = 11.3%
Z = 5% = 0.05
St = 0.25

$$T = \frac{0.8125 + 0.1873}{\left(1 - \frac{11.3}{100}\right)} + (0.05 \times 0.25)$$

The target size now would be 1.140 inches. If I produce lumber using the 1/4-inch scale on my machine, the board will be 1.125 inches thick when sawn. I will produce my lumber too thin to produce a dried and planed board! Note that the probability of sawing too thin for quartersawn using a 1/4-inch lumber scale is limited to species with high tangential shrinkage values, like southern red oak, beech, white oak, etc.

PUTTING IT ALL TOGETHER

If you calculate the exact target size for each thickness and species, you will maximize your lumber recovery. Every bit of wood you put into the next cut allows you to potentially gain lumber grade and volume. Given the low production of most portable sawmills, these gains are likely not worth the effort. To be effective, you would need a digital setworks that allows for custom target values. Also, customers are used to uniform thickness of 1/8 inch over the nominal and may not be happy with thinner boards, even though the boards will ultimately meet the standards for dried and finished lumber.

Calculating your target size will likely impact you if you quartersaw species with large tangential shrinkage values; you will need to increase your target to assure the correct thickness of finished. Also, learning the sawing variation of your machine could assist you in improving your lumber quality as customers typically like boards with little thickness variation. I will follow up next issue with how to determine your sawing variation. ■

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