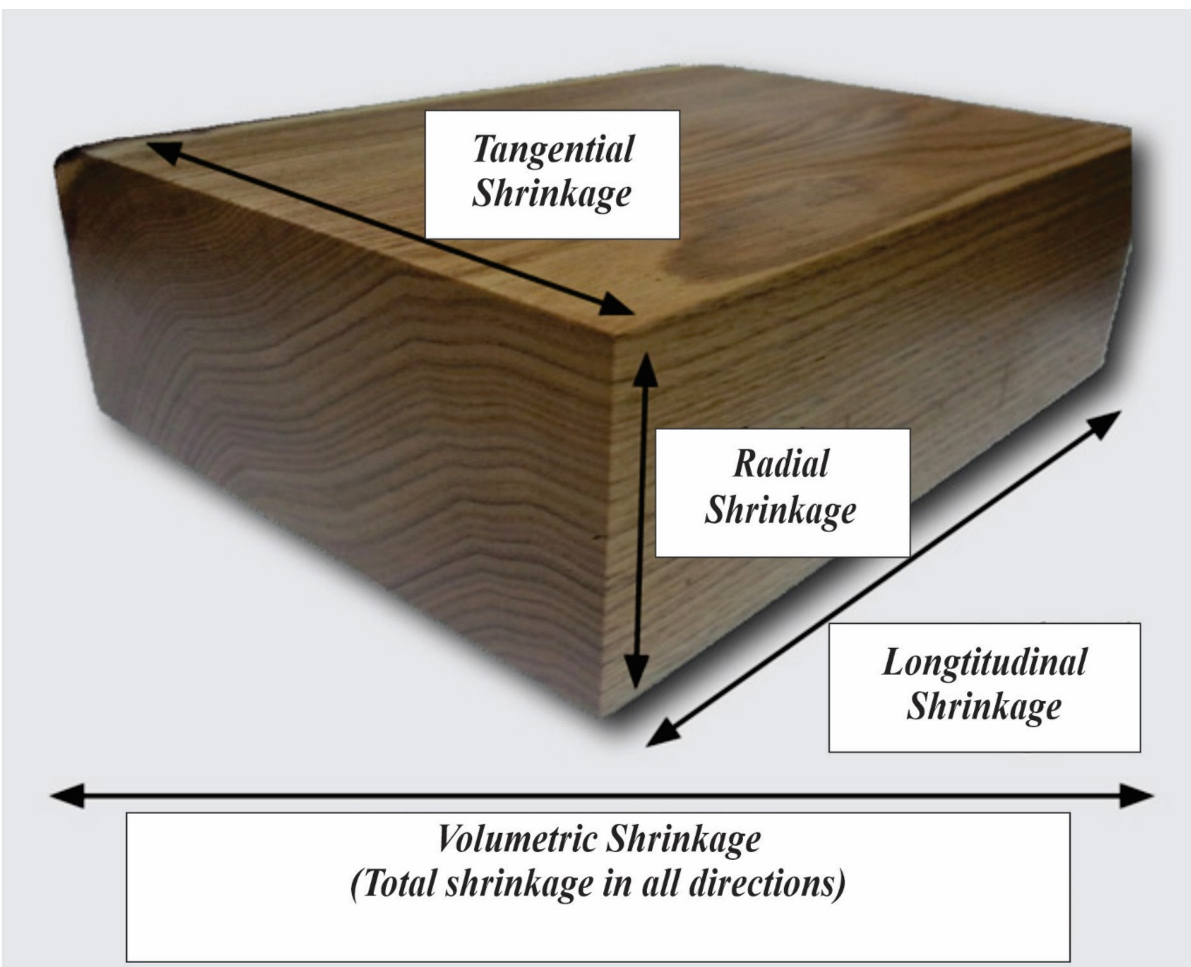
Wood shrinkage:

Wood has a "**hygroscopic"** property (it expands or contracts depending on the ambient humidity). Wood is also "**anisotropic"** (hygroscopic movement determined by the direction of the grain). This property is most clearly demonstrated in **"dimensional shrinkage"** (length, width and thickness lost due to drying).

Unlike "***isotropic*** " materials (where shrinkage is equal in all directions, such as a sponge) anisotropic wood does not shrink uniformly; understanding this will avoid many problems related to the shrinkage of wood that can occur months (or even years) after finishing the project.

The basic measure of shrinkage (expressed as a percentage) is the extent to which wood shrinks from its "**green**" state (freshly cut) to the "**anhydrous"** state **(**completely dry). In other words, since green wood is at its largest size and the complete drying of wood represents its smallest volume, the measure of green to anhydrous wood is the measure of the maximum possible percentage of shrinkage (the volume of dry wood ÷ volume of green wood). This is the "**volumetric shrinkage"** of wood.



Volumetric shrinkage:

Volumetric shrinkage indicates *how* much a piece of a species of wood will shrink in total, but it does not indicate the *directions* of shrinkage. The radial (thickness) and tangential (width) surfaces are the two primary axes (wood surfaces) where shrinkage takes place and therefore correspond to the "radial shrinkage" and "tangential **shrinkage**" of the piece of wood. The total of these two values should roughly correspond to the volumetric shrinkage (expressed as a percentage). Volumetric shrinkage is generally between 9% and 15% for most wood species.

Longitudinal shrinkage:

The extent of shrinkage of a piece of wood lengthwise, called **"longitudinal shrinkage",** is usually so small, (by about 0. 1% to 0. 2 %) that it is generally inconsequential for volumetric shrinkage.

It should be noted that plywood benefits greatly from the low longitudinal shrinkage of the wood because the layers of veneer are glued so that the direction of the wood grain of each layer is oriented perpendicular to the adjacent layer, which has the effect of minimizing radial or tangential shrinkage in the veneer layers. The shrinkage rates for the width and length of a plywood board are generally less than 1% (although the changes in thickness remain the same as those of the solid wood species used in its manufacture).

Radial shrinkage:

The radial shrinkage of solid wood can vary from less than 2% for some of the most stable wood species, to about 8% for the least stable species; most woods are in the range of about 3% to 5% radial shrinkage.

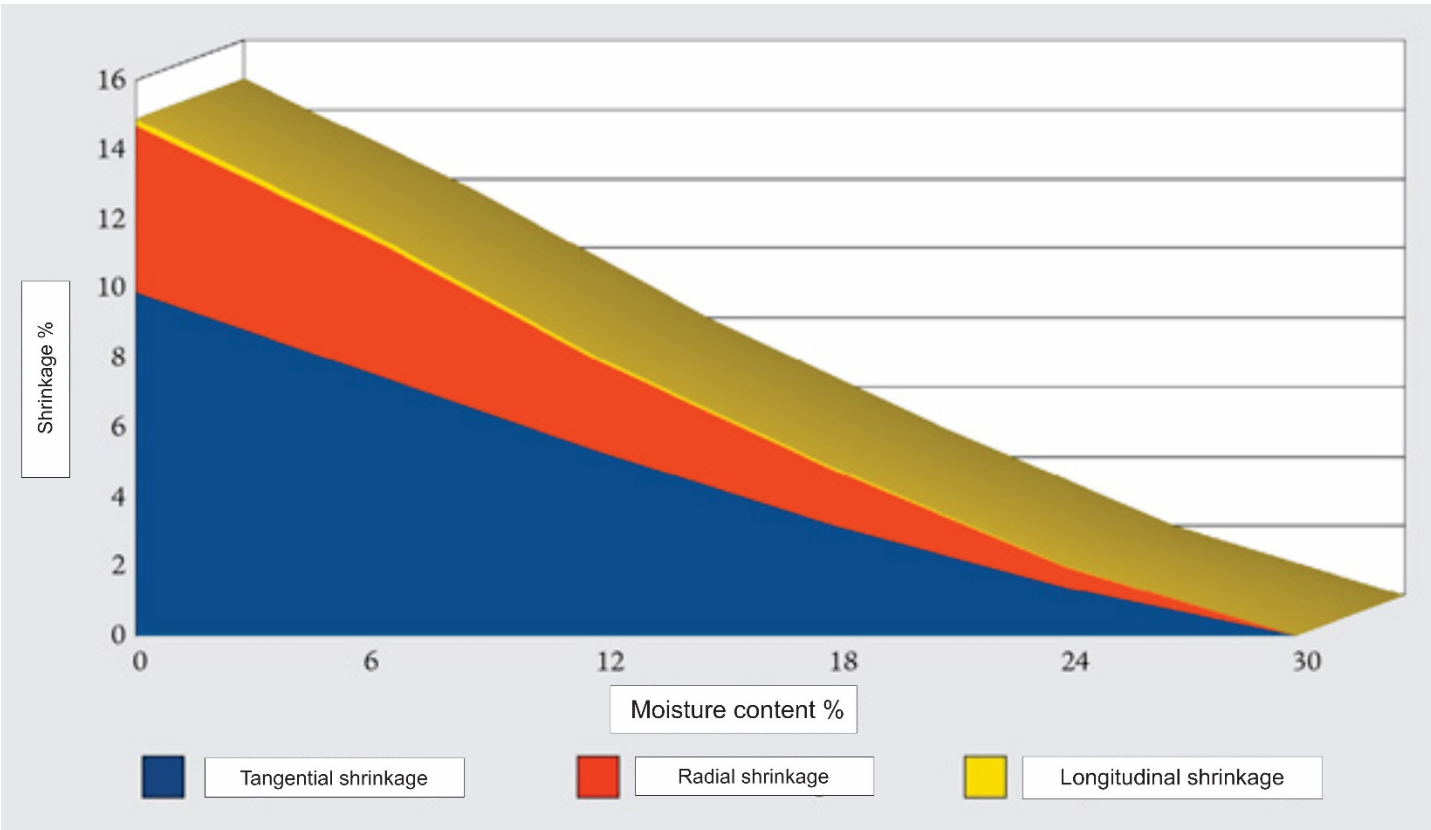
Tangential shrinkage:

Tangential shrinkage can range from about 3% to about 12%; most woods are in the range of about 6% to 10% tangential shrinkage.

The tangential / radial contribution:

The relationship between these two shrinkage values is expressed as a tangential/radial shrinkage ratio, or simply **T/R ratio**. In addition to volumetric shrinkage (which measures the extent of the shrinkage), the T/R ratio is used to measure the uniformity of shrinkage and is another good indicator of a wood's stability. Ideally, a wood species with good stability would have both low volumetric shrinkage and a low T/R ratio (these values should be as close as possible to "1").

A hypothetical shrinkage curve:



A hypothetical shrinkage curve: Although shrinkage rates can vary considerably between species (and even within the same species), this graph helps illustrate shrinkage rates and their average proportions relative to each other. The data was mapped from the values of sugar maple (*Acer saccharum*), which has a T/R ratio of 2:1. The volumetric shrinkage (not shown) is generally close to the sum of the three shrinkage percentages shown above. Tangential narrowing accounts for most of the overall shrinkage (about two-thirds), radial narrowing accounts for most of the remaining third, and longitudinal narrowing accounts for virtually nothing.

It should be noted that just because a particular species of wood experiences a high initial shrinkage during drying does not mean that this has always correlated with equal swelling after drying. For example, Basswood has fairly high initial shrinkage percentages, tangential: 9.3%, radial: 6.6% and volumetric: 15.8%, but its overall movement is relatively small.

Using shrinkage and T/R ratio data simply offers carpenters and craftsmen the best way to make an "educated guess".

In various wood species, the T/R ratio can vary from just over 1 to nearly 3. At a T/R ratio of "1", shrinkage would occur in a perfectly uniform manner over the entire width and thickness of the board. At a T/R ratio of "3", the flat sawn (tangential) area would shrink or inflate three times faster than the quartersawn (radial) area.

For most wood species, tangential shrinkage is about double that of radial shrinkage, resulting in an average T/R ratio of about 2. This explains why quartersawn boards (where a quarter log is cut perpendicular to the growth rings) are considered more stable than flatsawn boards (tangential surface); when the wood is quarter sawn, the majority of shrinkage or swelling occurs on the thickness of the board, and, as a result, the face, (or width) of the board has a minimal change, an important feature when looking for boards for floor coverings or workbench tops.