All About Barrels: Why and How They Enhance Wine
(Courtesy of Simi Winery, Healdsburg, California)

The origins of barrels for wine storage

Most of us are familiar with museum specimens and replicas of archeologically-recovered clay pots and amphorae from Greek and Roman sites: these clay-based vessels predate wooden containers for storage of wine and other liquid goods. But the existence of straight-sided, open wooden buckets, employing the craft of the cooper, is documented in Egypt as early as 2690 BCE (Before the Christian Era). Fully-closed barrels were first developed during the Iron Age (800-900 BCE), and by the first century BCE were widely in use for holding wine, beer, milk, olive oil, and water.

As trade and transportation developed, shippers discovered that sealed wooden containers were vastly superior to relatively fragile clay vessels, and the craft of cooperage -- barrel-making -- was launched, developing in direct proportion to the growth of trade. Wooden casks of barrels had largely replaced their clay counterparts by as early as the second century CE.

The most significant advantages of wooden barrels were, first, their strength: being made of wood and set round with hoops (first also made of wood, later of metal) that bound the joints of the barrels into a double arch; second, the barrels themselves were like wheels and could be easily rolled from one resting place to another; third, it became evident that certain goods - like wine - actually benefited from being stored in wood. This third advantage forms the basis for the entire modern cooperage industry, and in fact is the only real reason for its continued existence in a world where stainless steel and non-reactive synthetic materials outweigh all other advantages that barrels ever possessed.

Why do we still use barrels?

If the practice of using wooden barrels for wine storage had not been common throughout the long period of years when wooden barrels were the only practical containers for wine, it is highly unlikely that today's vintners would ever have thought of adding the dimensions of oak flavor to their wines. So we may say that it is a happy, historical coincidence that wine and wood marry together to form a richer, more complex flavor and texture than wine would have were it stored in a totally non-reactive container. Now, what does an oak (and oak is -- almost without exception -- the only kind of wood used for fine wine storage) barrel impart to wine that improves and enhances it? We'll look at two ways that wine benefits from its contact with oak.

First, for red wines, controlled oxidation takes place during barrel aging. This very gradual oxidation results in decreased astringency and increased color and stability. It also evolves the fruit aromas to more complex ones. Through a program of topping the wine (filling up the barrel) while it is in the barrel and

racking the wine from barrel to barrel to clarify it, just enough oxygen is introduced to the wine to have these beneficial effects over a period of many months.

Second, oak wood is composed of several classes of complex chemical compounds, each of which contributes its own flavor or textural note to both red and white wines. The most familiar of these are vanilla flavors, sweet and toasty aromas, notes of tea and tobacco and an overall structural complexity of tannin that mingles with the tannin from the fruit itself (in the case of red wines). The specific compounds creating these delightful nuances in the finished wine are: volatile phenols containing vanillin; carbohydrate degradation products containing furfural, a component yielding a sweet and toasty aroma; "oak" lactones imparting a woody aroma; terpenes to provide "tea" and "tobacco" notes, and hydrolysable tannins which are important to the relative astringency or "mouth feel" of the wine.

The chemistry of the oak barrel can impart differing amounts and qualities of flavor and texture depending upon the barrel manufacturing techniques and type of oak used. American oak (Quercus alba) versus French oak (Quercus robur), sawn versus hand-split, air-drying vs. kiln drying of the staves, and the use of boiling water, steam, natural gas, or wood fire to bend the staves are among the most important variables in the manufacturing process. As you can imagine, the barrel makers and wine makers all over the world hold widely differing opinions on the best way to make a barrel! One thing we can all agree on is that barrel making is an extremely complicated craft - there are no amateur barrel makers!

The Cooper's craft

The word "cooper" originates from the barrel makers of Illyria and Cisalpine in Gaul, where wine was stored in wooden vessels called "cupals," and the maker was a "cuparius." If your surname is "Cooper" or "Hooper" you can bet that some of your ancestors were employed in the time-honored craft of cooperage.

Organized coopers' guilds originated in Rome well before the Christian Era. They grew and flourished throughout medieval Europe and reached the apex of their membership in the late 19th century, before dwindling rapidly in the years following World War I, as other materials, first metals and then synthetics, replaced the wooden vessels formerly used throughout the household for washing, churning, eating, cooking, and storage.

To understand why this profession is so highly skilled and specialized -- with an apprenticeship even today of seven years' duration -- let's go through the steps required to make a wine barrel. Keep in mind that both the procedure and the tools have remained relatively unchanged for the past three thousand years.

How to make a wine barrel

First, get yourself a tree. Not just any tree of course. Cutting down that messy sycamore in the front lawn that has been plaguing you since you moved in won't work. You'll need a Quercus robur, one of the more than four hundred

species of oak trees that grow around the world. The Quercus robur can easily be found in central and eastern France, where they are grown in government-owned and managed forests, and where you can purchase one at a periodic auction. You will want a tree from a forest located in a cool climate, where the tree grows slowly, thus producing a wood with a tighter grain than those that grow more quickly in the region of Limousin. So you should do your shopping in the forests of Troncais, Allier, Nevers, or Vosges. There are other sources for good oak, such as Slavonia and even Russia, but the most prestigious barrels are made from French wood.

The forest should be planted with very close spacing, a condition that promotes tree growth with straight grain and no knots. These differences in tree structure produce noticeable differences in tastes imparted to the finished wine, and are an important part of how a winery achieves its ultimate style goals for each wine fermented and/or aged in barrels.

You'll want your tree to be at least 100 years old for your purpose, with a straight, unblemished trunk, about five feet in circumference. It doesn't really matter how tall the tree stands, because you'll be using only the part that extends from the ground to the first lateral branches, and if you do a good job, you should get at least 2 and at most 4 barrels from your tree.

Next, you'll need to measure the tree trunk into usable lengths for the barrel staves. Staves are the narrow strips of wood that are formed into the holding sides of the barrel. You have a choice of making either a Burgundian barrel (piéce) or a Bordeaux barrel (barrique). Both shapes of barrel will hold approximately 60 gallons of wine. The slight differences in shape and size between the Burgundian and the Bordeaux barrels don't seem to have any definitive reason except that of tradition.

It may be that because most Burgundian cellars are underground, the barrels work better if they are slightly rounder and therefore roll more easily and are shorter to fit better through inside doorways. Or it may be that white wines fermented in Burgundian barrels have more sediment collect in them from the lees (expended yeast cells) and that the bigger bulge in the barrel concentrates the sediments more effectively. But type of wood and method of making are the same for both piéce and barrique.

At Simi, Burgundian or Bordeaux-shaped barrels will be used at our Winemaker's discretion for Chardonnay, Cabernet Sauvignon, or Sauvignon Blanc. His/her choice is based on the particular style characteristics each cooperage imparts to its barrels. For instance, if a certain lot of grapes has good ripe fruit character but not much spiciness, he might use a François Fréres barrel (piéce) to add that dimension. For wine that lacks length of finish, he may use a Taransaud (barrique), and for wine that needs more weight on the palate to be well balanced, he might choose a Damy barrel (piéce). Each lot of wine, be it red or white, will be enhanced in balance and enriched in flavor and structure by the barrel in which it is fermented and/or aged. But a barrel that begins its life with white wine in it

always will be used for white wine, and the same for red wine barrels. Never the two shall mix!

You will have to hand split the logs into halves, then quarters, then eighths, and finally into the exact stave size. You could get twice as many useable staves if you were to saw the logs, but this tends to raise the tannin and astringency of the oak to an unacceptably high level.

You can take a break now, because you'll need to allow the hand-cut rough staves to dry for three to five years in the open air. Open-air drying (as compared to the more rapid kiln drying) decreases the possibility of barrel leakage, and leaches more tannins from the wood, resulting in a softer, finer finished wine. Although the wood must dry, it will be rotated on the stack of rough staves and periodically sprinkled with water so that the final level of humidity in the wood is about 15 per cent.

Now that you have good, air-dried rough staves, you can begin to form the finely finished staves. You'll cut them to a precise length and taper them at the ends, so that they fit together snugly when the barrel is curved into shape. Then you'll hollow out the inside flat part of the stave. To assemble the barrel itself, you'll fit the staves onto a frame, and then arrange the staves around an iron hoop. The barrel at this stage resembles a teepee, splaying out from the hoop at the top. In order to shape the barrel, you must bend the staves so that they can, in turn, be bound into another iron hoop at the bottom. Simi prefers that you use an open fire of oak wood chips rather than boiling water, steam or a gas fire. The wood chip fire helps provide a toasty flavor to the wine that will age in the barrel. You'll toast the barrel without a lid on it for about 40 minutes at 320 - 325 F. But these are just guidelines: Coopers toast barrels according to their own sense of what will be best, because each cooper has the expertise to extract the best possible characteristics.

You will custom make flat ends for your barrel and fit them into grooves at top and bottom of the side staves. Next, remove the temporary hoops, and set permanent ones into place. Then scrape and sand the barrel, so that the exterior is smooth. Now pour cold water into the barrel, and add air pressure to test for leaks. Finally, imprint the barrel proudly with your cooper's brand, and send us a bill for - depending upon the rate of exchange - 550 to 650 dollars.

When your barrel arrives at the winery

Your barrel's life has just begun when it arrives at the winery. It will probably be one of a ship's container load of 150 barrels, and will reach the winery between June and August. Your barrel has arrived with its bung hole (opening in the side for the wine to be moved in and out) sealed by a wooden bung and a piece of burlap. This prevents contamination from entering the barrel while allowing for enough air transfer to keep the inside of the barrel fresh and dry.

No matter how much care you've taken in making your barrel, we will still do a thorough inspection of each barrel that we receive. It is essential to make sure

that the barrel is sound - it should smell good and be clean inside. The wood inside, both for toast level and smoothness of finish must meet our expectations, and of course, it must be completely tight so that it will never leak.

All incoming barrels are subjected to two different kinds of inspection. The first is one in which our Cellarmaster tests the structural integrity of your barrel by checking the fit and finish, stave length and thickness, bung hole size and fit and by noting any external cracks or splinters.

Our Enologist then scrutinizes the inside of every barrel in the shipment, to make sure that you've toasted your barrel to the level that we've specified (light, medium, or heavy), to see if there are any blisters or char caused by overheating or excessive humidity during the toasting process, and to inspect the wood grain consistency and tightness of fit. He also checks to see if you have used any paste or reeds (the plant material used between the staves in the ends of the barrel) to repair small cracks or holes and to determine if the reeds are intact. Finally, he notes any uneven planning on the inside or any internal knots.

Your barrel has passed the test! Now we will mark the barrel to identify the varietal and the vineyard origin of the wine that will be stored in the barrel, as well as a complete history of any and all treatment given to the barrel during its life at Simi. Then we stencil the barrel with a cooperage designation and the year the barrel was delivered.

When the crush begins, and grapes come into the winery to be pressed and fermented (Chardonnay and Sauvignon Blanc) or fermented and then pressed (Cabernet Sauvignon), the cellar crew goes into action, rinsing the barrels and soaking the heads (end pieces). Then they pump five or six gallons of hot water into the barrel and seal it with a silicone bung. After rotating the barrel to each end for about twenty minutes, they pull the bung. If the barrel is completely liquid tight, a vacuum should have been created as the water cooled, and an audible rush of air will prove that your barrel is sound.

Your barrel is now filled with wine (Cabernet Sauvignon) or juice for fermentation (chardonnay or Sauvignon Blanc) and from this time on, will undergo a regular, rigorous program of monitoring by the Cellarmaster for the rest of its useful life. These programs of inspection and cleaning, both while the barrel contains wine and when it rests empty before another harvest, ensure that your barrel continues to enhance the wine and that it never develops any problem that could impair the quality of the wine.

But nothing lasts forever, not even a well-made barrel. At Simi, we use white wine barrels for six or seven years and red wine barrels for five years. After that time, the oak has little or no beneficial flavor components left to impart to the wine, and the barrel becomes essentially a neutral container. But it is still a sound container for wine, and we usually sell it to some other winery who wishes to use it for storage purposes. The final phase in your barrel's life is when your barrel is cut in half and sold for flower planters, at about ten dollars per planter.

But although your barrel is no more, the wine that was aged in it is still being enjoyed, and the connoisseur taster is exclaiming about its rich notes of toast, vanilla, almond, caramel, and clove. These are all nuances of complexity added to the wine from the barrel you made so many years before.

Oak - Chemical Structure and Its Effect on Flavor

[Many of the best wines are fermented and/or aged in oak barrels. The barrels can be large or small, old or new, or a combination of these factors. The smaller the barrel, the newer the barrel, and the more time spent in the barrel, the more oak flavors will be imparted into the wine. The source of the wood is also very important. Barrels are made by cutting wood into long, narrow pieces called staves. After seasoning, the staves must be heated so they can be bent to form the barrel. Steaming is the cheap method. The best method is to expose them to a flame. The longer the flame exposure, the more toasted or charred the wood becomes. This greatly affects the flavors imparted to the wine. The following information is from World Cooperage (www.worldcooperage.com), makers of oak barrels. Barrel production is science as well as art.]

Wine making has enough mysteries. That's why we've taken great steps to understand the various species of oak and the role they play in winemaking.

THE COMPOSITION OF OAK AND ITS FLAVOR CHEMISTRY

Tannin - [We tend to think of tannins in wine as coming from the skins, pits, and stems of the grapes, but in fact some comes from the oak barrels in which the wines are aged.] While tannins are approximately 1% of American oak and 8% of French oak mass, they play a vital role in [wine] aging. Hydrolysable, heat sensitive tannins stored in the tree's radial rays, are controlled by seasoning regimes, bending techniques, toasting times, and toasting temperatures. Today, precise oak tannin levels are achievable thanks to science.

Lignin --> Vanillin - A family of compounds, notably vanillin, is released during oak lignin breakdown. Slowly, nature's elements including precipitation, ultraviolet rays, and fungi, break down lignin. Toasting accelerates the degradation. Scientific understanding of these processes allows for more precise flavors.

Cellulose - The most abundant, natural polymer on Earth, cellulose is nearly 50% of white oak, but plays only a small part in aging wine. It is important because it holds the wood together.

Hemicellulose --> Wood Sugars/Body - Air seasoning initiates the polymer's breakdown into simple sugars. As oak climbs through 300 F during toasting, more simple sugars form. Caramelized sugars and sweet-associated aromas then develop. Toasty characters develop as the oak passes 420 F. Using this research, controlling temperatures allows definable, repeatable flavors.

THE STRUCTURE OF OAK AND ITS CONTRIBUTION TO FLAVOR

French Oak (the fragile sessile oak Quercus petrae Liebl.) - When examining French oak, we find the highest tannin of the oak types. Wine has easy access to an array of compounds in the more porous sessile oak, providing multiple extractives. An example is the popular spice notes that stem from extractives such as caryophyllene and copaene. Structurally, one finds less tyloses. Hand splitting following the grain is required. Logs sourced from the Office National des Forêts make for more expensive timber. This results in a more expensive barrel that is appreciated by winemakers for its flavor characteristics rather than its price.

American Oak (the strong Quercus alba) - Structural differences in American oak's hemicellulose and lignin result in more intense vanilla, wood sugars, and toastiness. Because stave timber is purchased from private landowners, log costs are lower. Its density, high tyloses, and straight grain means higher yields, machine cutting, and lower cost barrels with popular traits.

Eastern European (Slovenian & Hungarian) Oak (the slow growth Quercus petraea Liebl.)

- Under a microscope, this sessile oak is structurally similar to what is found in France, yet it has slightly different qualities including less tannin. These trees grow more slowly and are smaller, creating fine grain and extremely subtle extraction. Research shows that its hemicellulose breaks down more easily, forming a different spectrum of toasty aromas. Eastern European oak is purchased from both government controlled forests and private land. Although the logs are less expensive, lower yields produce barrels that are about average in cost.