BARREL AGING

In all the world, and across all centuries, the consistent defining element of all great spirits is barrel aging.

There are those who do drink clear spirits, and of course there are those who drink dirty pond water.

This book is not for them.

For those who savor and enjoy the very best of the alembic arts, all great spirit is brown. It is brown not by desire or design, and indeed the color itself doesn't matter. It is brown because that's the color the barrel gives to it – over time.

Indeed, what you have learned in this book unto this page matters not without what follows. Sparkling clear "white" spirit from the still is but raw material for the creation of great spirit – which in all cases happens in an oaken barrel.

No matter what magic water you use, what fermentable manna you employ, how well trained your phalanx of able yeastie beasties may be, how clean your apparatus and how cunningly ingenious its design, you have yet to make whiskey.

The defining moment is when it goes into the barrel. From that instant of birth, it is something different, something wonderful, and a thing of awe and majesty. This moment should be celebrated with each and every circuit of the planet around the sun.

And it is very much alive. It breathes, it sleeps, it wakes, it throws tantrums. And from this infant beginning, over the years it matures and eventually grows old. Old is good.

The view of those intimately familiar with the finest

spirits the world has produced is utterly unanimous. Older, oak barrel aged spirit is better. It tastes better. It feels better. And it is indeed better.

How did this view become so unanimous? By the trial and error efforts not of hundreds, nor indeed thousands, but undoubtedly millions of people who have made it, and additional millions who have tasted it, across the past six hundred years.

And therein lies the chief knowledge problem of barrel aging. Experimentation requires time. Some fine alembic Cognacs are routinely aged 60 years. The most esteemed Scottish whiskys typically 30 years. And that is such a large fraction of a human lifetime, that even with careful record keeping, what precisely went into the barrel, how it was treated over such a span of time, and relating that to what comes out at the end, is essentially impossible. If you make a change to your barrel aging routine, it could easily be your grandchildren who observe the results.

A barrel of whiskey sitting still in the warehouse is a brutalizing reminder of our own mortality. And the "scientific method" staggers in the face of such a span of time.

Add to that an awe inspiring amount of misinformation, disinformation, and myth from those who are trying to sell it, and it becomes nearly indecipherable – essentially nonsense.

In preparing this chapter, we have visibly angered everyone we have discussed it with. Almost all the experts and consultants on the topic rely on barrel aging as the ultimate "magic waters" element in their repertoire of mystery and the gross impossibility of some of the conflicting claims made in the process are rarely a welcome bit of additional information. And so we expect it to be the most controversial element of the book.

But as distill is what we do best, we will attempt to distill the common parts into something rational that you can both read and act on. We will attempt to list and rationalize the variables you can control and imply the effects these variables appear to have on outcome. And despite the romantic esteem we hold for this mysterious miracle, in the end it is a controllable process.

Most new distillers quail at the thought of barrel aging for cost and time reasons and indeed most licensed distillers start out with some form of immediately salable white spirit. Almost all eventually gravitate toward aged spirits and those who don't generally harbor secret dreams of one day having the resources to do so.

There IS good news. It isn't as hard as you've been led to believe. It isn't as expensive as you've been led to believe. And by carefully observing a few basics, you can make really excellent whiskey in a surprisingly brief period of time.

If our glowing introduction to the miracle of time and oak barrel aging implied otherwise, apologies all around. You can easily do this, and you can easily gain an EXCELLENT outcome from it. We promise you “very good” spirits in MONTHS, not years. Better, you can then improve upon it for the rest of your life.

HISTORY

All whiskey books need history. And if they've not ready access to it, it is easy enough to make it up entirely.

We've studied several dozen accounts arguing who first discovered that barrel aging improved spirits. Most of the stories are indeed engaging and ultimately believable. But it is a logical certainty that they can't all be true. And it is quite likely that none of them are particularly true – at least as far as being “the first.”

For example, if indeed the Chevalier de la Croix Marron really invented the concept in France in a dream in the late 1500's, it is hard to credit Elijah Craig with the same discovery some 300 years later.

But beyond conflict, the problem with all the historical accounts is that they fly in the face of the history of other things – most notably the wooden barrel.

The wooden barrel, made of a variety of woods, predates the distillation of alcohol by at least a millennia and depending on what is counted, quite possibly three milllennia.

It becomes obvious that whiskey was first contained in wooden barrels because that was what was already available to contain almost everything else, including whale oil, water, fish, flour, and indeed anything that needed to be "contained" while it was transported or stored.

And very early in the use of wooden barrels to contain things, it was further learned that wherever they put the barrel, they had to move it again later.

Constructed as a simple cylinder, they were hard to move around. They rolled poorly and in various directions. By bowing the staves used to create the barrel, they essentially changed the cylinder into a wheel – the widest point in the barrel forming a narrow wheel which could easily allow large weights to be rolled and directed with dispatch.

In this shape, a single man could move a very impressive weight of flour, sugar, or whatever because he was essentially pushing it along on a narrow wheel. This bowed shape then was the defining innovation in barrel manufacture. It made them portable. And barrels are commonly and clearly depicted in this bowed shape many centuries before the distillation of alcohol.

To bow and taper the staves was a fantastic innovation. But cutting them in that shape, while also beveling them to

fit, was a bit of work to get the ends to meet. The solution was to simply bend them into shape and allow the natural flex of the wood to line them up inside a containing ring or hoop of wood, vine, rope, or metal.

To do this most effectively required heat. Wood is quite stiff dry and at room temperature. If you steam heat it, it becomes limber - for awhile.

Today we would naturally steam heat wood to make barrels, and indeed many historical accounts of large cooperage operations show just that. But most small operators did not. They simply “shook” the staves into a circle, threw a ring around the top or bottom, and started a fire in the center. After the wood had heated, they then winched a rope around the wide end, and drew it closed, adding a second ring of wood or metal to hold that end.

And so the vast majority of barrels, typically built by village coopers, and quite predating distillation, were toasted or “charred” on the inside anyway – from the fire used to bend them at manufacture. It had little effect on containing almost anything. And it was simpler and required less equipment than steaming the wood.

Barrels were valuable. They were quite costly in the living of the times. As a result, they were used over and over until they literally fell apart. And at that point, they were returned to the cooper who simply rebuilt them.

There were various methods of cleaning the barrels of their previous contents. It was quite common to “scald” the barrels with boiling water and this certainly had a good effect. But wooden barrels are porous, and if they developed a bacterial infection or for example, stored fish, it was quite difficult to get the “sour” out of one. The common remedy was to pile it loosely with clean straw and light it on fire – again charring the interior, as well as burning off fish bits and of course sterilizing it.

Barrels were certainly used to contain water for early sailing vessels. And the water notoriously developed green growth within a few weeks. Burning them out was routine prior to refilling them. It was the easiest way to clean them out. You burned a little straw or moss in them and perhaps scraped them a bit with a blade. Good to go again.

So the interior charring or toasting of the barrel undoubtedly had nothing to do with whiskey. Indeed, it was endemic to barrel manufacture and maintenance.

There WAS no magic discovery of barrel aging for whiskey. They already had barrels. They already knew how to clean the barrels. They put the whiskey in the barrel. It was better later.

In Europe prior to the mid 18th century, glass bottles were very expensive. A family of property and substance might have ONE. The whiskey was kept in a barrel in the basement. The bottle was filled from the barrel, usually daily. In England, the servant who did this came to be termed the “bottler” or more colloquially, the “butler.”

And the family “barrel” might go on for generations. Each year they would buy their favorite whiskey, and add it to the barrel. It was never allowed to be empty. Over time it aged, and it was essentially a blend of all the whiskies they had ever purchased. As such, each family's whiskey was unique.

Why oak? Actually barrels were made of a variety of woods and typically whatever was indigenous to the area of manufacture. Pine wood gave the contents a pitch flavor. Most softwoods didn't last very long. Oak was very durable, relatively easy to work, so common it was rarely expensive, and relatively inert. Over time, it simply became the material of choice – if you had a choice. But barrels of chestnut or cedar or even palm have been available and indeed used over the centuries. Oak simply emerged as the winner over time.

And so the question of who “discovered” that whiskey took on a brown color and a better flavor after being stored in barrels is a bit of a misfire. Most likely, everyone did, whenever they stored whiskey in barrels, which was pretty much everyone involved in whiskey – from the beginning.

In more recent years, as technology improved, hundreds of innovations in various lighter, less expensive containers made from a variety of materials have been invented, deployed, and used. None has displaced or even favorably compared with storage in oak barrels. Today virtually ALL premium spirits and wines are oak barrel aged.

THE PROCESS OF MATURING WHISKEY IN BARRELS

Ethanol out of the still is slightly sweet, mild in flavor, and of course, causes a euphoric effect. It is variously referred to as raw spirit, new make, white lightning, or white dog. We tend to taste quite a bit right out of the parrot spout and it is certainly of interest. But it is pretty simple. There is no lingering aftertaste. There is very little floral scent. And it often contains harsh flavors from the higher order alcohols produced.

The distillation process, as described earlier in the book, basically takes the difference in evaporative temperatures of ethanol and water to concentrate the ethanol. But the typical mash actually contains a huge number of other compounds, in lesser quantities, that evaporate at temperatures both lower and higher than ethanol. The result is that often these are concentrated as well.

But they do have a couple of handy characteristics we will generalize generously here. First, they tend to be not very good for you. Picture butane among them. Methanol.

Hydrazines. Acetates. Acetaldehydes. They usually taste bad and although rarely really dangerous in the amounts encountered, are poisonous. Worse, they contribute to the infamous hangover. Acetaldehydes in small amounts actually have a bit of narcotic effect. Large doses cause respiratory failure and death.

So the use of the satanic Anneas Coffey Patent Still would seem to be in order to remove all those elements and produce a light, pure ethanol.

Fortunately, there are also a wide variety of congeners, a broad term covering a multitude of sins involving a very complex mix of minute ingredients that define much of the taste obtained from the original source material. This is what makes rhum agricole taste differently from grape brandy or barley whiskey. It is where the heart of true spirit production lies. The actual flavor components are commonly termed fusel oil, and often characterized as an undesirable impurity. In fact, while a bit of an oversimplification, many of the positive flavor characteristics of spirits are contained in this material. And it is what keeps the Alembic process alive in the face of the “efficiencies” of more modern devices.

The pure ethanol purists belie their existence by almost always flavoring their product with real whiskey, distilled in Alembic stills and matured in real oak barrels.

Fortunately, many of the higher order alcohols are not terribly stable, while the congeners tend to be more so. Over time, the obnoxious elements tend to break down into simpler and generally less noxious compounds.

These harsh flavor agents tend to mask the subtler but more stable “good” flavors lying beneath. So as we gradually break down the harsh elements, the underlying good flavors of the spirit are increasingly revealed with time.

Oxygen is one of the most reactive agents on the planet.

It is generally responsible for all rust and corrosion you see about you. Some 21% of our atmosphere is composed of it. And of course we breath it. It aids us in breaking down these complex molecules, but in doing so also affects our ethanol. And so, it works best to expose our distillate to very minute amounts of oxygen slowly.

The oak barrel does this brilliantly. It is porous enough to allow a slow exchange of gases while being solid enough to contain liquids. Over time, a transpiration of gases occurs where much of the more complex compounds, including unfortunately, quite a bit of ethanol, evaporate out of the barrel. Oxygen slowly migrates into the barrel.

This form of respiration is exacerbated by temperature changes. During the day, as the liquid contents heat, it tends to migrate gases out of the barrel and the liquid expands deep into the pores of the wood. At night, as the contents cool, they contract creating a bit of a vacuum which allows more external gases to be absorbed by the oak through the exterior walls.

In this way, our barrel breathes. Seasonal changes affect this heavy breathing as well. Often, barrels are stored in high humidity areas with stable temperatures such as caves or cellars. This slows the process. At the other extreme, they may be stored in tropical warehouses, which tends to increase the activity.

The very air around the barrel storage ultimately effects the flavor of the product. Many Scottish whisky makers located on the shore tout the sea-salt air as a significant flavor component. This may overstate the case, but indeed the air is part of the native terroire of the whisky and is one of many variables making one whisky different from another.

The degree of “char” or “toast” to the barrel has a profound influence on the flavors imparted to the whiskey.

Wine makers are more intimately familiar with this. You can typically order barrels with light, medium, medium plus, or heavy “toast” to get just the effect you want on your wine or spirits.

Lighter toasts tend to be sweeter, heavier toasts impart a more roasted or smoky flavor. American and now Scottish whisky is traditionally stored in “charred” oak barrels. Picture burnt to a cinder. To our tastes, the same spirits could be dramatically improved in a medium toast.

Indeed, we've not been a fan of Bourbon generally, but we have found corn whiskey aged in a medium toast American wine barrel strikingly superior to most any Bourbon available on the market.

Oak trees, like any plant to a greater or lesser degree, contain sugar. Actually, what is termed hemi-cellulose contains a conglomerate of eight sugars: xylose, galactose, glucos, mannose, N-acetylgucasamine, N-acetlygalactosamine, fucos and sialic acide. In charring or toasting the inside of the barrel, these sugars are caramelized.

Oak wood also contains lignin. Lignin, when burned, forms methoxyphenols. Oak also contains tannins, vannillins, and a host of other elements.

Basically, this is where the brown color of aged rums, Cognac, and whiskey comes from. It also sweetens the taste and indeed adds an incredibly complex array of subtle flavors. The specific type of oak, how it is dried, how it is shaped, and of course the degree of toast or char, all affect the eventual flavor.

As oak trees are a living plant, the degree and makeup of sugars and lignins and tannins is ultimately the result of the specific micro-environment where it was grown and the time period it grew in. So to some degree, the very oak we store our spirits in has its own “terroire” to contribute to the

ultimate product. This is of course further modulated by the infinite variables introduced by the specific techniques used by the cooper who crafts the barrel.

The ability to take on color and flavor from the oak varies with alcohol content. While wine gains immeasurably in flavor from oak aging, it obtains color to a lesser degree. And the solvent power of higher alcohol levels dramatically enhances this extraction from the oak. It is very common for Irish or Scotch whisk(e)ys to be aged in used wine barrels and they do benefit dramatically from this. The higher alcohol level of whiskey extracts many attractive elements the lower solvent power of wine could not touch.

Let us speak of angels. In addition to obnoxious compounds, a good part of our product is going to evaporate through the barrel walls as well. You can easily lose 3-5% of the contents of a barrel per year and more in smaller barrel sizes. This loss can variously be water, ethanol, or a combination of the two, depending on the barrel environment. In Catholic France, this was termed the “Part de Anges” or “Angels Share”.

Revel in it. Not only does it make your barrel and your barrel room aroma delightful, but this reduction acts to concentrate the flavors carried over from the original mash into the distillate, as well as the flavors picked up from the oak.

In summary, barrel aging comprises:

1. Slow oxygenation and breakdown of long-chain molecule obnoxious compounds.
2. Flavoring and coloring from the toasted oak itself by extraction.
3. Concentration of native flavors of the spirit due to

evaporative loss and exposure of those flavors as the harsher elements break down into more stable compounds.

It is a magical combination that turns plain clear ethanol into a marvelously flavored elixer.

BARREL AGING VARIABLES

While we have learned broadly what happens to alcoholic spirits and beverages during barrel aging, do understand that this is mostly derived from observation and anecdotal evidence gleaned over time. Truly scientific examination of the process is devilishly difficult and simply hooking up a gas chromatograph has limited utility. Most people assume a science here that simply does not exist.

Indeed, there remains more that we don't know than what we do. And people who speak with authority and apparent expertise on this topic should be looked askance.

For example, we have observed that the aging of spirits in an oak barrel is much more variable than normally presented. You will find that your spirit improves dramatically not in decades, but in DAYS. While that is indeed great news for the instant gratification crowd, we fear further depressing news. Your spirit will also regress in the barrel, sometimes dramatically.

We've sampled barrels that had a truly marvelous flavor two weeks earlier, that suddenly exhibited bland, almost tasteless qualities. We have even had barrels of alcohol suddenly exhibit awful flavors. We had a barrel named “vomitus distillaire” for awhile. Fortunately, it is tasting enormously better today, and the frustrated crayon scrawl on the barrel is now ironic. The point is, your spirits will most likely mature marvelously awhile, then retreat for awhile, and then again improve numerous times over the

years.

Distilled spirits are often aged for years or even decades. Gradually, over time, the gyrations seem to dampen, until at some point somebody bottles it. Because this development is often generational in human lifespan terms, all theories as to the perfect time to age spirits are suspect. These theories are like mothers, everybody has one.

Everyone in the spirits industry readily knows that while spirits age in the barrel, once the spirit is bottled that aging ceases immediately and completely. ???? After 53 years of careful observation of life, God, and the universe, I can without knowledge or experiment assert with all confidence that NOTHING works like THAT. It is not so much that it is not so, it is more that it cannot be so in a rational universe.

The point here is that while we can define some of the things that occur during barrel aging, the knowledge base is much more limited than it is normally presented by the experts. We do know that all spirits gain immeasurably by barrel aging, and that time is one of the major variables.

There are others that we have some anecdotal information on. The focus in this chapter is what variables are available **that you can control** to affect the eventual outcome of your Alembic spirit. We'll list them, and then go into some detail on each.

1. Time
2. Barrel size.
3. Degree of barrel wall carmelization (toast)
4. Barrel size
5. Storage Humidity
6. Storage Temperature
7. Cask strength of Distillate

8. Motion

TIME

Time would appear to be the simplest of the barrel aging variables. As we said, put it in the barrel and wait. How long? Longer is better.

Oddly, we found time to be the MOST surprising element of barrel aging. It should be an absolute constant. It is actually THE most variable element. This is because it is interactive with all other variables. And quite likely, there are a multitude of maturation processes at work, each with a different exponential curve.

But broadly, spirit maturation occurs on an exponential decay rate curve. Exponential decay rates occur quite commonly in nature. For example, the decay of radioactive waste occurs at an exponential rate and the time it takes to decrease to half it's original level is said to be its' “half-life”.

Similarly, atmospheric pressure decreases with altititude at an exponential rate. For each 1000 feet you go up in altitude, the pressure decreases by 12%. So while at sea level, the pressure is 14.7 lb per square foot, at 1000 feet it would be 12.936 pounds decreasing by 1.764. But during the next 1000 feet, it would decrease, again by 12%, but of the 12.936. And so it would decrease an additional 1.552 lbs per foot to 11.384 lbs per square inch at 2000 feet. At 3000 feet it would decrease another 1.42 lbs. So we can see that it declines with each additional thousand feet, but by a decreasing amount.

And so our atmosphere extends thousands of miles into space at some density, but above about 14,000 feet, we can no longer breath it sufficiently to avoid hypoxia.

This is a pretty good analogy in that while the decay

proceeds essentially forever, it doesn't do us much good after 14,000 feet or so.

Precisely what the exponential decay rate of ethanol maturation in the barrel is would be rather hard to calculate. It is in any event variable. We know that it ages faster at a higher temperature for example. And we know that it ages faster in a smaller barrel over a larger.

Worse, there may be several exponential curves at play. One might be for the observable ontake of color. Another for the absorbtion of certain sugars from the oak wall, while another for the decay of methanol into lower order alcohols. In reality, there are undoubtedly hundreds of separate changes, each with their own varying exponential decay rates in play.

We can know that it is exponential without knowing what the precise exponent is.

Let's assume that 30 years is the useful life of whiskey maturation and nothing particularly noticeable is going to happen after that. It's a dubious assumption mathematically but a pretty acceptable one to those who have tasted whiskey.

By law in most countries, at least two years of maturation of spirit is required before it can be advertised as aged. Why two years? Again, a highly subjective number, but one that has been arrived at in different places by different groups at different times. So it qualifies as better than no assumption at all. And we can certainly derive that the product will be sufficiently different after two years to warrant, in most people's minds, a change in labeling.

A linear decay rate would imply that $1/30^{th}$ of the benefit of the aging process is obtained in the first year. And $1/30^{th}$ of the benefit is obtained in the second year, and so forth in, well, linear fashion.

To our experience, this is not the case. An exponential

rate of aging is implied from 2 years to 30 years. Clearly anyone with a mouth connected to a brain stem can taste the difference between raw dog out of the still, and two year old whiskey. A cat would prefer the latter. Indeed, if you are new to distilling, you will be shocked by the degree of change in the spirit in the barrel in 3 months.

Similarly, I would utterly defy anyone on the planet, no matter what a whiskey connoisseur they imagined themselves, to really be able to tell, even 51% of the time, the difference between a glass of whiskey 28 years old and one from the same barrel two years later at 30 years old. It just isn't there.

We have noticed a profound change in spirits with as little as two weeks in a barrel. It is of course more profound after a year.

And so it is clear that whiskey aging is at an exponential decay rate. The actual rate is hard to pin down.

But in nature, certain numbers pop up repeatedly, and with no known reason. In electronics, the pre-eminent waveform is the sine wave. It is known to actually be a composite representation of an amazing array of frequencies and components, but it can be readily represented by a sine wave.

The average value of a sine wave increasing from zero to a certain positive point, and decreasing through zero to a negative point of the same value is of course zero. But if we take just the positive half, or just the negative half, and average it, the value will always be 0.707. Peak values will conversely always be 1.414 of the average – the same function in reverse.

This applies to bells ringing, heat energy, RF frequencies, and light. It has nothing to do with whiskey, but its a number that comes up a lot in nature and the universe. It's handy, and we're familiar with it.

Let's apply it to 30 years of whiskey aging and see what we get.

To come out to just under 100% at 30 years, using a maturing exponent of 0.707, we wind up with 29.3% of the effect occurring within the first year.

By the end of the second year, we have accomplished almost half the value we can derive from aging at all.

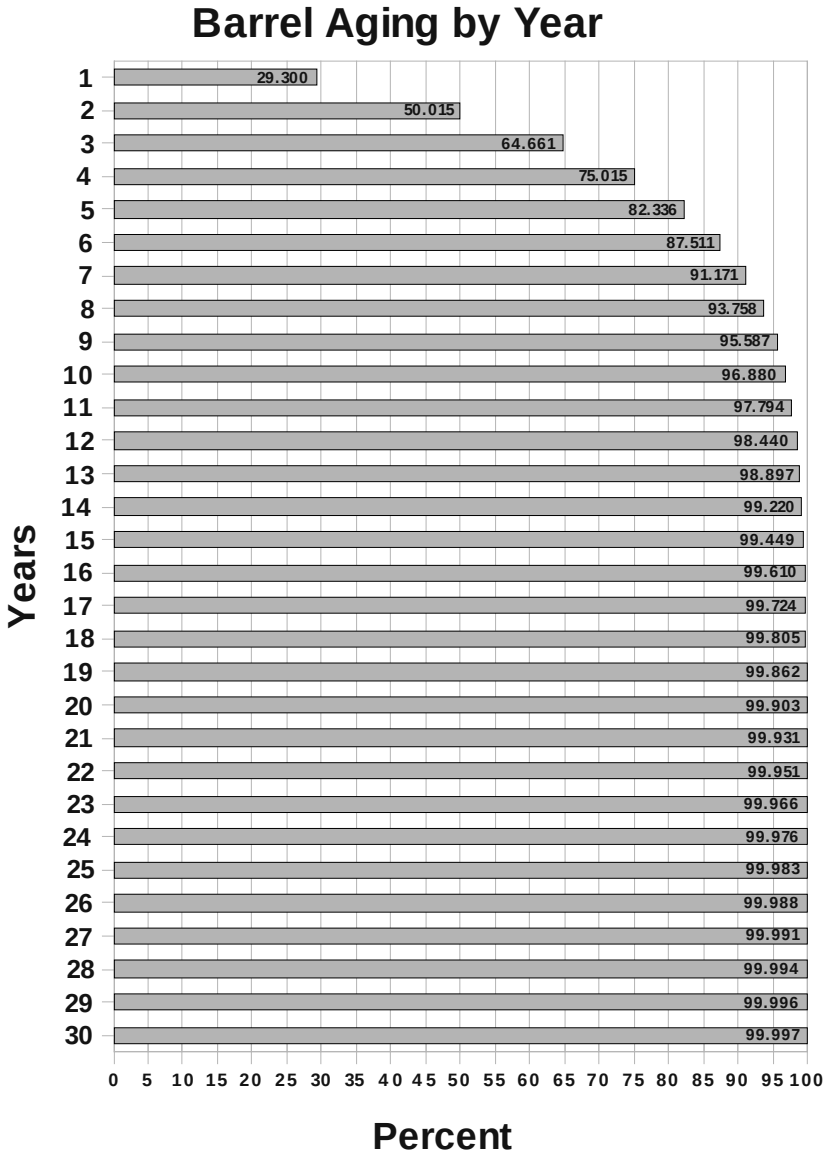
The reason I like this curve is that most Bourbon makers insist 8 years is the magic number. At 8 years, with our .707 curve, some 93% of the effect of barrel aging has been accomplished.

Scottish Whiskey makers fall in at 12 and 15 years most commonly. Of course, they almost universally employ USED oak barrels which with regards to barrel extraction, would appear to be slower anyway.

More likely, by using used oak barrels, they are eschewing some of the short exponent curve values such as color and sweetness, to enhance some of the long exponential curve values – theorizing the breakdown of higher order long chain molecules. That would make their whiskey taste

YEAR	TOTAL	PERCENT
1	29.300	29.300
2	50.015	20.715
3	64.661	14.646
4	75.015	10.354
5	82.336	7.321
6	87.511	5.176
7	91.171	3.659
8	93.758	2.587
9	95.587	1.829
10	96.880	1.293
11	97.794	0.914
12	98.440	0.646
13	98.897	0.457
14	99.220	0.323
15	99.449	0.228
16	99.610	0.161
17	99.724	0.114
18	99.805	0.081
19	99.862	0.057
20	99.903	0.040
21	99.931	0.029
22	99.951	0.020
23	99.966	0.014
24	99.976	0.010
25	99.983	0.007
26	99.988	0.005
27	99.991	0.004
28	99.994	0.003
29	99.996	0.002
30	99.997	0.001

differently from Bourbon and indeed it does.



But our entirely made up theoretical curve oversimplification fits nicely. At 12 years, 98.44% of the effects of aging have occurred and at 15 years, 99.449% have

been accomplished. And we see that after that, not much is happening. From age 15 to 30 we pick up another 0.5%. Is there a noticeable taste difference between 15 and 30 years. Some would say so. Most would be challenged to detect it in a blind taste test, all other things being equal.

The curve pretty much matches industry practice for the aging of spirits in approximately 50-60 gallon oak barrels. We believe if you averaged the number of bottles actually aged of all spirits worldwide, you would see a distribution curve really quite similar to this. That is half the aged spirits sold worldwide are aged 2 years or less. Some 93% are aged 8 years or less, and so on.

Understand that the curve is entirely made up. We've picked the start and end points of 2 and 30 years out of thin air. And we've actually grabbed a number, that though common in nature, has nothing to do with whiskey that we know of to establish a rate of decay.

But the more we look at it, the better we like it anyway. It matches our subjective view of spirit taste testing closely enough to illustrate the principle.

And what about the 60 year old Cognac of unquestioned quality? Hard to say. We didn't taste it at 30. And we didn't taste it at 15 because we weren't of drinking age yet. But we would wager that we would not have spit it out at 8 years.

Further, recall that we said this exponential curve is essentially a large number summary of many many exponential curves representing various things that occur in the aging process.

Indeed, you will see that almost all other variables in barrel aging have an effect on the curve. The point we illustrate is that it is an exponential curve and not a linear process.

BARREL SIZE

Small craft distillers actually have an enormous advantage in barrel maturation. You can routinely enjoy aged spirits with 3 months of aging and we've made some strikingly good spirit in three years.

There are a couple of reasons for this – some geometric and most economic. First, is what they didn't tell you about the 50 year-old Cognac. It IS truly 50 years old. But you assumed that they distill it, place it in a new oak barrel, and revisit the issue a half century later.

Not precisely true. What they actually do is distill it, and place it in a relatively small new oak barrel for six months or a year, or two. About 50% of the aging is accomplished there.

They then transfer the contents to a used oak barrel, in most cases which does little for taste and color thereafter. And the changes from that point are very slow and often quite subtle.

Further, while they may have done the initial charge in a 225 liter barrel, in general the longer storage barrels are much LARGER – typically 400 or 500 liters.

In the barrel business, a barrel twice the size is NOT twice the cost. Buying larger barrels just makes more sense economically than smaller barrels when you are producing thousands of gallons of product.

Irish Whiskey is almost always aged in very used Pipes (477.3 liters) or tuns (954.7 liters – about 252 gallons). These are usually port or sherry barrels and the whiskey does gain some from the flavors of the wine residual contained in the wood, as well as from the wood itself, but the aging process is dramatically slowed, not only by the

spent qualities of the barrels inner surface, but by the size of the barrel.

To see why this is so, we need to look at the mathematical relationship between the surface area of the inside of a cylinder, and the unit volume of liquid it can contain. We're going to use a representative straight cylinder rather than the actual tapered nature and actual sizes of the barrels because the math gets pretty obnoxious just to account for the taper, which doesn't fundamentally change the equation.

A 60 gallon barrel would contain 60 x 231 cubic inches of liquid or 13860 cubic inches. This corresponds to a cylinder slightly larger than 19 inches in diameter and 48 inches long. The surface area of each end would be approximately 288 square inches. The surface area of the inner wall of the barrel would be about 2901 square inches. Total inner surface area would then be about 3476 square inches or 1 square inch of surface area for each 4 cubic inches of distillate (3.987: 1 actually).

A 252 gallon tun, by contrast, would contain some 58, 212 cubic inches of distillate. This corresponds to a cyclinder roughly 35 inches in diameter and 60 inches long. This renders a wall size of 6597 square inches. The area of each end would then be about 962 inches for a total inner surface of 8521 square inches. The ratio in this case would be about 1 square inch of surface to each 6.83 cubic inches of distillate.

In your distillation, if you can achieve an alcohol level of 13% in your wine, a 30 gallon fermenter would then theoretically contain 3.9 gallons of pure ethanol. If you could distill this to 100 proof or 50%, that would be about 7.8 gallons of spirit. This is more the size of a 30 liter barrel.

A 30 liter barrel is roughly 8 gallons or 1848 cubic inches of distillate. A cylinder of 20 inches length averaging 10.8

inches in diameter will contain that amount. The interior wall surface would be about 678 square inches with the ends of 91.6 inches for a total surface area of approximately 861 square inches. This represents a ratio of 2.14:1.

The result is that just on surface area contact and extraction, your whiskey will age 3 times faster in the 8 gallon barrel than it will in the 252 gallon barrel and roughly twice as fast in an 8 gallon barrel as in a 60 gallon barrel.

The downside of tall this geometry is evaporation. You will lose correspondingly more product to evaporation from small barrels than the larger. With 8 gallon barrels, it seems the “Angels” are getting more than their fair share.

Economically, we can obtain excellent quality 8 gallon barrels at this time for about $215 ($26.87/gallon). We can also purchase quite good 59 gallon new wine barrels for about $650 ($11/gallon). So you can readily see why larger barrels are popular for larger operations. For most whiskey makers, barrels above 59 gallon are simply difficult to handle physically.

But you are not bound by the economics of producing 200,000 gallons a year. The bottom line is that as a small craft distiller, you have an enormous advantage when it comes to aging your spirits. By using smaller and newer barrels, and ignoring the economics, you can age whiskey in just a few years equivalent to the oldest, most expensive spirits commercially available in the world.

Economics? Let's spend a ridiculous $215 on a new French Oak Barrel of 30 liters. And let's assume that 1.5 gallons of our whiskey actually evaporate away as the angels share leaving us 6.5 gallons of spirit. This would be approximately 32 750 ml bottles of whiskey. Barrel costs are $6.72 a bottle. And you could easily cut this in half using American Oak, which increasingly approximates the French

Oak in quality.

It's entirely about how much you're going to make. But we like 50 liter barrels. Not so coincidentally, Laphroaig has introduced a new QUARTER CASK label purportedly aged in 15 gallon barrels. We've tasted it. And we like it a great deal better than their 15 year old standard.

NEW VERSUS USED OAK BARRELS

The debate over the use of new versus used oak barrels appears to be related to our timeline in a very interesting fashion.

The American Bourbon industry actually got legislation passed mandating the use of NEW, charred oak barrels and any whiskey not made in new charred oak barrels could not be called Bourbon. This continues today. As Kentucky produced Bourbon thoroughly dominated the American whiskey industry and culture, it became the norm.

This was a tremendous boon to the Canadian Whiskey industry. There was essentially no market in the United States for used whiskey barrels. And so Canadians, unhampered by the concept of using NEW barrels, were able to purchase used ones from Kentucky for as little as $2 per barrel in the earlier days. Today, we suspect there may be a better market globally for used Bourbon barrels than there is for the Bourbon made in them as Mexico, the Carribean, and of course the Scotch, have all been bidding on the use of these used barrels.

We have a bit of a bias against Canadian whiskey because of their propensity to blend a little bit of whiskey in a carload of mass-produced grain spirits and call it whiskey. But they didn't precisely originate the concept and Canadian Whiskey has certainly been popular. Crown Royal is probably the single largest selling brand in the United States.

American Bourbon producers not only insist that only new oak barrels will do, but that they do not need to age their whiskey more than seven or eight years and that in fact, if you aged it longer, you would “over-oak” the whiskey.

We view brown spirits with “too much oak” in the same category as having “too much money” or a wife “too pretty” or a horse “too fast.” But all things are a matter of taste.

Whiskey certainly absorbs elements from the oak barrel over time. And the barrel only has so much to give. After 8 years in the barrel, the whiskey has absorbed most of what's there, and we can't picture the additional elements it would extract over additional time harming the whiskey in any way. But the additional time might allow other non-extractive processes to develop more fully.

The American claim that storage in oak beyond 7 years is most likely an economically driven one. It should naturally improve in the eighth, ninth, and tenth years as well, but with an exponentially diminishing change in each successive year. Indeed, in recent years Bourbon producers HAVE been introducing premiums of more advanced age, and of course, to excellent effect

Scottish Whisky has been made in whatever oak barrels were available. Used French or Spanish oak barrels that had held wine, typically sherry but sometimes port, were strongly favored by Scottish Whisky makers a century ago, and by a very few today. Laphroaig actually pioneered the use of used American Oak whiskey barrels. Yes, there is a little bit of Makers Mark in every bottle of Laphroaig.

Today this is very much the common mode in Scotland with virtually every single malt distiller now using used American Oak barrels.

Scottish whisky makers insist that their whisky is too delicate for new oak barrels, and that only long slow aging

in used barrels will do. At the same time, if you actually talk to a Scottish barrel manager, they all yearn for the sherry wood days, and they constantly campaign/argue with their managers for better wood.

In Cognac too, the claim is that Cognac only shows its true character and greatest flavor after 40 years. They use huge 400 liter barrels and they reuse them over and over.

Is this another example of “magic waters?.” Hmmm. Perhaps. But it is more likely just another variable, and probably a very legitimate one.

We believe that broadly new oak barrels do provide much better, faster, and in all ways more excellent barrel maturation than used oak barrels. And we believe it will do so for three years, seven years, 10 years, 20 years, 50 years, and 100 years. Actually, we're guessing a little at 100 and beyond.

In the wine industry, both in France and in the United States, it is absolutely accepted that wine matured in new oak barrels is superior in every way to wine matured in used oak barrels. It is further absolutely accepted that wine stored in used oak barrels is superior in every way to wine that isn't matured in oak barrels at all. Because of the daunting economics of this, experiments continue with oak chips, micro-oxygenation, and other techniques. But no one seriously proposes that anything is actually superior to new oak barrels.

By lumping apples, oranges, grapes and grain all into the same barrel, are we attempting to read messages from God in cloud formations?

Perhaps, but each of the spirits discussed has a strategy and a following. What emerges is part of the art.

In all cases, the old barrel crowd uses longer slower aging processes and the new barrel advocates age for shorter periods of time. And their products, all good, are indeed

remarkably different. No one would confuse a Cognac with a Scotch or a Bourbon.

Most likely this variable is one of fine balance. If you wanted more of the flavor of the original grain or fruit product to emerge at the expense of the oak flavor, you would age your spirits longer and slower in used barrels. You would achieve a perhaps lighter, more fragrant fruit or grain flavor.

In other words, by using either or both of larger barrels or older “spent” barrels, you can flatten the timeline curve to accentuate other flavors.

If you prefer the flavors imparted by the barrel and the barrel aging process itself, you would use newer oak barrels and perhaps shorter maturation times for a heavier, sweeter, and more fully flavored oak taste.

BARREL TOAST

In America, there is no shortage of stories as to how the tradition of charring the inside of the barrel came about. One tale revolves around an early Kentuckian reusing barrels that had contained fish. Elijah Craig has been the apocryphal story most popularly passed – revolving around a cooperage fire and an attempt to use burned staves.

We can't find any historical merit in most of these stories. In any event, the concept did not originate here.

But since apocryphal stories are popular, here's one of our favorites. By the late 1500's, according to legend, the Chevalier de la Croix Marron had a dream in which a voice instructed him to distill his wine twice to improve the quality of the distillate. He sent two oak barrels of this twice-distilled wine to the monks at Renorville.

The first barrel was drunk immediately and apparently to great applause. The second was saved for a “special” event.

The visit of the Bishop of Saintes 15 years later was deemed sufficiently “special.” But the monks discovered that a significant portion had evaporated, and that the eaux de vie had changed color, acquired a new taste, and was absolutely delightful. Thereafter, double distillation and oak barrel aging became the norm in the Cognac region.

New distillers and wine makers look at the toasted interior of a barrel and immediately think “charcoal filtering.” Charcoal is indeed used to filter any number of things and quite effectively. In fact, it is not unheard of to “polish” brown spirits by charcoal filtering before bottling to improve clarity.

And indeed, Jack Daniels whiskey, for example, actually runs their whiskey through a bed of sugar maple charcoal immediately out of the still.

The action of storing spirits in an oak barrel with 1/8 inch of char on it is unlikely to filter anything. In the first place, the whiskey doesn't really flow through the charcoal, although there is some saturation and penetration increases during heating phases and retreats during cooling phases.

The toast or char on the barrel is more akin to the concept of caramel. If you take sugar, and cook it over a low flame, it will gradually thicken and turn brown. This dramatically alters the flavor of the sugar – in a very positive way to our taste. As it continues to brown, this effect increases.

Of course, if you burn it black until smoke is pouring out of the kitchen, it won't really be improved in flavor. It will become horribly bitter with a lot of offending flavors.

Our approach to toast is the same. Lighter toasts provide sweeter lighter flavors. Medium toasts provide more color and some perhaps more interesting flavors. Heavy toast provides even more color, and some very “smoky” flavors. The heavy charr concept used in American Bourbon really

isn't that appealing. Lots of color, but not particularly appealing flavors.

As part of our chapter on Bourbon, we made quite a bit of it. We aged it for about a year in a small new American Oak wine barrel with a MEDIUM toast as opposed to the traditional char. It has reawakened our interest in corn whiskey. Utterly delightful and quite superior to any store bought “Bourbon” we've had.

In any event, the degree of toast is actually a pretty dramatic variable in spirit aging. Feel free to experiment. You can make good spirit with any of them.

STORAGE HUMIDITY

One of the often overlooked areas of spirit maturation has to do with relative humidity in the air where it is stored. This is largely because there is little you can do about it directly without going to some expense beyond its' likely good effect.

But you should understand it because there are things you can do in other areas that will take it into account.

Part of the maturation process is the expense of disappearing product. Usually termed “The Angels Share”, a good bit of your hard won spirit simply disappears out of the barrel over time because of evaporation. But angels in different relative humidities apparently have different tastes in whiskey.

If the relative humidity is 60% or above, more of the evaporative loss will consist of ethanol than water. Not only will the liquid level in the barrel fall, but the proof of the liquid will fall as well. The ethanol concentration remaining in the liquid decreases with time.

If the relative humidity is below 60% normally, more water will be lost than ethanol. The ethanol concentration,

and so the proof, increases over time.

This is a very interesting variable. Water is a solvent, and extracts certain compounds from the toasted barrel wall.

Alcohol is similarly a solvent, but with a higher vapor pressure and it extracts very different compounds from the toasted barrel wall.

Water extracts more sweet compounds, sugars, and color. Alcohol tends to extract more lignins and vanillins – as well as tannins.

As the evaporation continues, the proof in the barrel changes and so the solvent extractive nature changes as well.

This isn't magic waters. It is true magic – a very good thing. Very slowly, your spirit is deriving new and different flavors from the barrel over time by changing itself to either a higher or lower cask strength.

Rather than try to control the humidity, it is usually better to work with it. If you are going to store your barrels in a high humidity area, an underground cave, for example, or the tropics, you would probably want to fill them at a higher cask strength than you normally would, because over time the level of alcohol will diminish to a lower proof.

If you are located in Arizona or the high Rocky Mountains and the relative humidity is always low, you would fill the barrel initially with a somewhat lower cask strength, with the expectation that as water evaporated, the proof in the cask would rise.

In the midwest, we have very high humidity in the summer and relatively low humidity in the winter. So it moves in BOTH directions seasonally and averaging about a draw. What is important is that it is changing. This is part of why we say a barrel “breathes.”

TEMPERATURE

Another way a barrel breathes is by temperature. Virtually all chemical processes in the universe are slowed by diminishing temperature and accelerated by increasing temperature.

It would appear so in spirits as well.

Rums and Tequilas in tropical areas are only rarely aged longer than three years.

Scottish and Irish Whiskys made in the cooler northern lattitudes are considered more noble at around 15 years.

Temperature is certainly one of the factors. And you can increase temperature and generally speed aging. That may or may not be a good thing.

In addition to the rate of chemical process, temperature has another effect. It changes the density, and volume of a liquid.

As temperature increases, both the liquid and the gas held in an oak barrel expands and pressure increases. This drives the liquid, and the gas, deeper into the wood and causes the barrel to out-gas to the surrounding environment. We rather like to join the angels in the barrel room just for the aroma.

As temperature decreases, both liquid and gas contract, lowering the pressure in the barrel and even creating a slight pressure differential with the surrounding environment, causing in-gassing into the barrel.

In unconditioned environments, this cycles from the heat of the day to the cool of the night, as well as across the seasonal changes in temperature. All of these changes are largely positive. The change itself causes greater extraction of the barrel components.

In recent years, some producers have tried to slow the

process by using modern heating/air conditioning in barrel storage warehouses. We don't quite get the point.

More ironically, some of them have not only turned to controlling it, but are now starting to cycle it. Now we're back to where we were.

We would advise you to avoid extremes in temperature. Gentle cycling is magic. Extremes are PROBABLY not good.

However, Madeira was actually developed after they noticed that the extreme tropical heat encountered during early shipboard transits caramelized the sugars in their wines and the English buyers actually developed a taste for this. Today, they actually heat their wines during maturation to accomplish this caramelization.

It is certainly a variable.

CASK STRENGTH

The distilled spirit you place in an oak barrel will be a combination of ethanol and water. The “proof” or percent alcohol by volume at which you store this is a very interesting area.

First, the art of distillation is quite like the art of editing, it's all about what you leave in, except for where it's about what you leave out.

In making your cuts at the still head, it would be highly unlikely that you would wind up with a bottle strength distillate.

As described in earlier chapters, most Alembic distillers make their head cut at about 80% abv and collect the hearts down to anywhere from 45-65% abv depending on the product fermented and the flavors sought. The %abv will fall gradually on a wash run with a flatter profile on the second distillation. Anything below the “cutoff” gets cycled to the next distillation as “tails”.

Generally, the result of whats kept will average much higher strength than you would ever want to drink. In Alembic distillation, we generally wind up with a spirit of about 135 proof on average.

Bourbon, by law must be distilled at less than 160 proof.

It unlikely that you could regularly drink any brown spirit at 135 proof and enjoy it for any length of time. When you bottle your spirit there are a couple of popular levels, but 135 proof isn't one of them. And your liver would probably want a vote on this as well.

Actually 86 proof is. Spirits bottled below about 40% tend to have some clarity and haze issues – stability. It's purely a cosmetic issue and does not harm the spirit at all but commercially, clear stable fluids are more salable. And so 43% ABV or 86 proof has over the years become a kind of magic number for spirits sold by the bottle. It's magic is that it is just safely above the 40% level.

In previous centuries, the very concept of “proof” was 100 proof or “fully proved” which corresponds, in the United States at least, to 50% alcohol by volume.

In America in the last century, the concept of “bottled in bond” was developed almost as a ploy to get the government to assure consumers that they were getting full strength whiskey which hadn't been watered down by intermediaries. Barrel whiskey was almost universally watered down by merchants to increase profits. By bottling at 100 proof in a bonded government warehouse and putting a seal on the bottle, distillers could assure quality and strength all the way to the consumer.

Drinking 100 proof is generally considered a pretty stiff drink. And 86-90 proof is generally most comfortable for most drinkers.

To bridge between distillation strength – 130-150 proof and drinking strength, 86-100 proof, you must dilute the

distillate with clear, pure water.

The question is when.

The commercial spirit industry is almost suspiciously unanimous on the level of ethanol to be placed in the barrel. This figure varies in minor ways from Cognac to Islay to Louiseville, but 63.5% ABV or 127 proof is the universal figure. They dilute the distillate to this level with distilled water usually.

Then they dilute it a second time when they blend various barrels to get a flavor profile, and add distilled water to get bottling strength.

We have heard numerous theories as to why 63.5% abv is the magic number. They vary so widely, and even conflict so often, we have come to the conclusion that either we do not understand what they are saying, or they don't understand what they are saying.

Either way, after some examination, we think it's the wrong figure - all things ultimately a matter of taste.

Our reasoning goes like this.

Water is a solvent.

Ethanol is a solvent.

They are different solvents.

They each extract different components from the barrel wall.

Generally, water extracts heavier, sweeter elements and more color.

Ethanol extracts a lighter color and more tannic/vanilla flavors.

If you want to save on the cost of the barrels, you want more ethanol.

We think the last has been overriding – and for very good

reason. Let's take 100,000 gallons of ethanol at 135 proof and dilute it to 127 proof.

The formula for calculating how much water must be added to dilute to a specific target proof is:

quantity (starting proof/target proof) – quantity = water quantity.

100,000 (135/127) - 100,000 = 6299

We'll need to add 6299 gallons of water and we'll wind up with 106,299 gallons of product.

Let's assume we are using 59 gallon barrels.

106,299 gallons / 59 = 1802 barrels

1802 barrels @ $350 = $630,700

Yes, you do get a little price break in quantities of 1800. Lets do it again diluting to 105 proof.

100,000 (135/105) - 100,000 = 28,571

100,000 + 28,571 = 128,571

128,571 gallons / 59 = 2179 barrels.

2179 barrels @ $350 = $762,650

There is a $131,950 disparity in our books here. This is strong motivation for 127 proof to be the magic number instead of 105 proof. In fact 135 proof starts to look pretty good in the barrel.

If you are doing 1000 gallons instead of 100,000, the savings comes down to $1319. If you are doing 100 gallons instead of 1000, it drops to $132.

But wait, there is more!

We've spent a very long time in the barrel trying to mature this whiskey. We hopefully have broken down some obnoxious compounds revealing the marvelous flavors of the grape or the grain. And we have, it is true, extracted flavor and color from the barrel.

But we have also paid a heavy price. Through evaporation we have lost a good bit of our product. And this has served to further concentrate those flavors, of the original product, and of the extraction, by evaporating water, ethanol, or both.

NOW after all these years we are going to DILUTE those flavors with water?

Well, actually yes. It's a necessary evil. We don't want to serve it with that high an ethanol content.

Let's do our calculations again, but this time from barrel strength to bottle strength at the END of the maturation.

With the magic 63.5% number – looking for 86 proof.

100,000 (127/86) - 100,000 = 47,674

100,000 @ 127p + 47,674 water = 147,674 @ 86p

We've just diluted our FLAVORS by 48%.

Let's do it again from 105 proof:

100,000 (105/86) - 100,000 = 22,093

100,000 @ 105p + 22,093 water = 122,093 @ 86p

We've diluted our flavors by 22%. Cruelly unfortunate, but much better than 48%

To quote Ron Popeil, inventor of the Popeil Pocket Fisherman: But wait, there's more!

At the end, we have 147,674 gallons of 86 proof if we start at 127 proof. This is 745,372 bottles of 750ml each. At $25 per bottle that's $18,634,300.

If we do the same magic at 105 proof, we have 122,093 gallons for 616,230 bottles at $25 or $15,405,750. That is a difference of $3,228,550 in end product from the same 100,000 gallons of made whiskey in the barrel.

So at the 100,000 gallon range, it's true we save $131,950 in barrels, but we make $3,228,550 more at the bottling

end.

How can such magic be? Well another way to look at it might be that 129,142 bottles were really **distilled water**. We are selling water. Distilled water. At $25 per bottle. As if it had been lovingly crafted by master distillers and aged 12 years in oak barrels.

We LOVE it! What a country! This is better than selling air. We can sell WATER at the price of the finest aged whiskey.

The bottom line is that there is a HUGE financial pressure for 63.5% to be a magic number, especially if you are going to sell magic water.

But it dilutes 7 years, or 12 years, or 20 years of hard work and time by 48% instead of by 22%.

It rather depends on whether you are drinking it, buying it, or selling it.

So why don't we dilute it all to 86 proof in the beginning?

Actually, we've tried it. It works well enough. And in just a few months makes excellent spirit. But it's not very practical. This is because the evaporation causes either proof loss or gain, or both at various times and we can't practically maintain it at 86 proof. We can easily dilute down to 86 proof. But there really isn't a handy way to dilute UP or concentrate it. By starting at a higher proof than we are shooting for, we can generally be assured that we can hit our bottle strength by simple dilution. And we can dilute to either 100 proof or 86 proof from the same barrel.

More locally, we have tasted so much whiskey while making it, aging it, and thinking about it, that we may have developed a taste for cask strength goods. We actually don't dilute ours at all for bottling, and indeed rarely bottle it.

The bottom line is that with lower barrel proofs, we will

alter our extraction from the wood in a very minor way toward a heavier, darker, and sweeter spirit. But we avoid the much more serious dilution in flavor that occurs in diluting the end product with clear water.

To our view, that results in a dramatically improved full flavored whiskey. And the end user is free to dilute it to taste. For larger commercial operations, the economics of doing so are brutal. Small craft distillers will get a much improved product at fairly trivial expense.

In any event, those are the variables and the economics of the matter. Cask strength is very critical to both. Finding the right flavor profile for you is pretty much a matter of experimentation. Cask strength matters.

For those who find us mad, Woodford Reserve makes an excellent, spicy Bourbon in Kentucky with a substantial rye component. They have gone to considerable expense to move to a cask strength of 110 proof and we think to absolutely superb effect – a nice, very slight sweetening to balance the pepper from the rye and very much a fully flavored dram.

MOTION

A final variable can be discussed, but not by very much. This is because essentially no one we can find does it and so results are difficult to compare. But it appears to be beneficial.

Early in the game of transporting alcohol by ship, it was learned that the motion of the ships had an additional effect unobtainable by storing barrels in warehouses. The effects of an ocean voyage in almost all cases resulted in improved flavor.

Early Bourbon producers in the Kentucky territory were delighted with the reception their products received

downriver in New Orleans. The reason they were well received was that the consumers in New Orleans seem to have been drinking better whiskey than their Kentucky counterparts. The trip down the river took several months and did age the whiskey, but apparently the motion of the boats also contributed to the event.

It rather makes sense that moving the whiskey around inside the barrel exposes different units of fluid to the barrel walls. We've heard rumors of some experiments “rocking” barrels of whiskey, generally abandoned due to expense.

And there have been recent reports of some whiskey producers actually sending their wares aboard ship for an around the world cruise. We have not experimented with motion directly.

BLENDING

Blending is an amorphous term that means different things to different people. The dark side of blending is that you can run huge amounts of raw ethanol through very efficient continuous fractionating column stills, and “blend” it with relatively small amounts of single malt barrel aged whiskeys to vastly improve the output. Indeed, most commercial Scotch and Canadian whiskeys and indeed whiskey in general are “blended” in just this fashion.

Some 90-95% of all Scottish Whiskey sold is “blended” whisky.

If you see the word “blended” on a whiskey bottle, that is generally what is meant. It has been an accepted form of adulteration for many years. And we find the entire concept abhorrent.

But there is another aspect to the term. As a small craft distiller, you will find the variables involved from batch to batch to be either overwhelming to contemplate or awe inspiring and a thing of beauty. Either way, the results tend

to be endlessly variable. If you run but a few gallons at a time, you continuously have differing whiskeys of differing ages. If your objective is to make a pure single malt Scotch whiskey, for example, in a specific fashion, control of these variables is a challenge.

On the other hand, if your mission is to make a very complex and flavorful spirit, you have all the advantages. You can age some in French Oak, and some in American Oak, and then blend the two together in variable proportions to get just the taste you like.

You can blend whiskey made from peat smoked malt that came out a bit too peatey with whiskey made from unsmoked malt that is a bit bland and by varying the proportions obtain the perfect blend.

You can blend whiskey you made 10 years ago with whiskey you made 5 years ago with whiskey you made 30 minutes ago and the result will be very different from any of the three. In blending, generally the whole is very often greater than the sum of the parts.

Indeed, essentially ALL great spirit craftsmen “blend” their whiskey, from barrel to barrel and from various age profiles to produce what they define as the flavor profile they wish to present to the world. The greatest single malts from Scotland and Cognacs from France are all purposively “blended” to achieve that flavor.

Very rarely, and generally only recently, has the concept of “single barrel” limited edition bottlings come into favor.

NOTES ON THE SOLERA

If you're looking for a seam in the zone of wine or spirit production look to Spain. There are truly some fantastic wineries there that make products that are simply beyond description. Some of these “bodegas” have been doing so for over 400 years in the same location. But they are so

execrably poor at marketing the stuff that you will rarely find a bottle over $17 or $18 and knowledge of Spanish products is almost universally poor outside of Spain.

This is heroically true of the Sherry world. There are probably six entirely different styles of wine, ranging from horrifically dry to raisiney sweet desert wines all claiming to be some incomprehensible version of Sherry – Olorosa and Fino being not even the nth part of it. It is total marketing chaos. Their story, while fascinating, is so totally garbled it is untellable.

But they also seem to be the source of the concept of the Solera.

We are enthralled by the Solera. Basically a Solera is a series of barrels with whiskey in them. Or more properly, flowing through them.

Let's say you made three eight-gallon barrels of whiskey this year. Next year you made three more. And you did this each year for five years. You would have of course 15 barrels.

Now lets' say you arranged these on the wall, in ranks of three, by year. The bottom rank would ultimately contain three barrels of eight gallons each that were five years old.

The second rank similarly but four years old. The third rank up would be similar in size but three years old. The fourth, two years old, and the top rank aged a single season.

Let's go to the bottom rank, and remove two gallons from each barrel, totaling six gallons of five year old whiskey, and let's bottle it into 30 bottles of whiskey. We drink some. We give some away.

But with evaporation, and the removal of our two gallons, each barrel now contains 5.5 gallons. Well let's top them off. But let's do it with our four year-old whiskey.

Since they are in the next rank higher, we can just siphon

from the upper barrels to the lower. While we're at it, let's cross it up and put some of EACH of the three four-year-old barrels into EACH of the lower barrels-effectively cross blending four-year-old whiskey into our five-year-old rank.

This of course leaves our rank of 4-year-old barrels a third empty. Let's top them off from the three-year-olds, again cross blending as before. Similarly, we would top off using the two-year-olds, and ultimately from the very top rank.

Let's make some new whiskey, about 7 or 8 gallons for example. And let's use it to top off the top rank.

So we drink 5-year-old whiskey for a year.

Next year, let's do exactly the same. But what we draw out of the lowest rank will be about 2/3 six-year-old whiskey by then, and of course 1/3 five-year-old. Let's top off top to bottom as before, and add our new make to the top rank.

The following year, when we go to draw whiskey, it will be partly seven-year-old, partly six-year-old, and partly five-year-old.

No matter how many years we draw from this, like successive approximations, we can never entirely empty the bottom rank of ALL of the original whiskey that was in it. And each year, some of the next year's is added – and becomes a year older.

This then is the Solera method. It is a perpetual aging cross-blending technique. Typically, you name your Solera after the year of the oldest that was ever in it. If you started in 1927, that would be a 1927 Solera, even in 2008.

Try Alveara Pedro Ximinez 1927 Solera. It's a Spanish desert sherry readily available for $16 for a 375 ml bottle and you'll find it easily comparable to any $100 Tawny Port on the market.

This might appear to be a ruse. How much 1927 product is actually in the bottle produced in 2008? Perhaps not much. But we don't think its a ruse at all and we're a huge fan of the Solera system.

The Spanish do this very well. First, it leads to a very consistent product from year to year. But I suspect there is more to it than that.

Aged spirits tend to affect younger spirits in an entirely out of proportion manner. Recall earlier that we said it was common practice for commercial distillers to blend aged small batch alembic still whiskey in small amounts, with relatively huge amounts of bulk ethanol produced in continuous fractionating columns. They do this because it more or less works. The older and much better whiskey has a profound impact on the newer and relatively tasteless ethanol.

By experiment I can tell you that mixing a small bit of older with a larger bit of younger does NOT lead to an average by volume. Something magical happens. The older has a greater effect on the younger than expected. The Solera is a way to “teach” younger whiskey to be older. But instead of teaching motor fuel to taste like whiskey, you are blending real whiskey across the years and seasons.

For large commercial operations, this would be hopelessly costly and difficult. For small craft artisans, it is both easy, and extraordinarily effective.

BARREL MATERIAL AND CONSTRUCTION

The type of barrel chosen can have a dramatic effect on the maturation of spirit in the short term, and often a more dramatic effect long term. All barrels are not created equal.

We will ignore entirely the concept of chestnut barrels, pine barrels, cyprus barrels et al in favor of oak barrels. Over the centuries, many types of wood have been tried and oak has simply dwarfed all others as the wood of choice for several reasons.

It is inexpensive. Oak trees are both hardy and aggressive. They will eventually take over any forest they grow in. And so oak is readily found on most continents in large quantities. And so it is not costly.

It is a very durable hardwood. Furniture lasting centuries is often made of oak.

It is very workable. Although a hardwood, it is readily sawn, split, and shaped – and it is quite flexible.

It is not resinous. Many trees produce products designed to stave off insect infestation. These products are poisonous at various levels and in all cases produce unpleasant flavors.

In modern cooperage, oak is the overwhelming favorite and is at this point used virtually exclusively in the beverage industry.

Today, there are essentially three choices available to mature spirits: French Oak, American Oak, and other European Oak.

FRENCH OAK BARRELS

French Oak barrels are constructed from the tree species Quercus Petraea which is known for tighter grain, high tannins and lower aromatics then its American oak counterpart. French oak typically comes from the Allier, Limousin, Nevers, Troncais, or Vosges forests.

In producing the French oak barrel, the wood is split along the grain, rather than sawn, into staves which are stacked outside and allowed to age in the elements for 10-36 months. This air drying leeches out a significant amount of

harsh tannins in the oak wood.

The staves are then “bent” over an open flame and formed into barrels using iron hoops. The flame heats the wood and makes it more pliable, but it also chars or toasts the inside of the barrel.

Barrels are available in several levels of toast, including light, medium, medium plus, and heavy.

Typically the "lighter" the toasting the more oak flavor and tannins that are imparted. Heavy toast, typical of barrels in the Burgundy region, have an added dimension from the char that medium or light toasted barrels do not impart. Heavy toasting dramatically reduces the coconut note lactones, even in American oak, but create a high carbon content that may reduce the coloring.

During the process of toasting, the furanic aldehydes in the wood reach a higher level of concentration. This produces a "roasted" aroma. The toasting also enhances the presences of vanillin and the phenol eugenol which creates smokey and spicy flavors.

AMERICAN OAK BARRELS

The species of oak typically used for American oak production is the Quercus Alba which is a white oak species that is characterized by its relatively fast growth, wider grains and lower wood tannins than the French counterpart. It is found in most of the Eastern United States but Missouri has emerged as the leader in wine barrel production with Minnesota close behind. Kentucky produces most of the American Oak whiskey barrels.

Most American barrel manufactures used kiln drying to cure the wood which is not as effective as the French air drying at removing tannins. But the American Quercus alba species is naturally less tannic than the French species.

American Oak is typically sawn, which ruptures more of the wood cells than the French splitting process, releasing somewhat more flavoring agents. American oak typically offers two to four times the “lactones” responsible for flavoring spirits.

The production process is quite similar, though American oak barrel manufacturers tend to toast a bit more heavily than the French, due to the difference in flavanoids available in the wood.

The result is that American oak tends to impart more of a sweet vanilla flavor than French oak, and is sometimes characterized as a bit of coconut flavor.

Most makers of fine wines, even in America, have traditionally shown a strong preference for French over American Oak barrels.

However, this is changing. The price disparity between French Oak Barrels ($650-$800 for 225 liter Bordeaux) and American ($300-$350 225 liter) has put enormous economic pressure on Napa Valley winemakers to experiment with American Oak.

And indeed, good wine can be made from American Oak.

More to the point, American oak cooperages have been avidly pursuing the lucrative Napa Valley wine market, and are rapidly adopting revisions to their process to make their product more appealing to these winemakers.

American coopers have made dramatic strides in recent years and continue to develop the art. They are rapidly adopting air drying techniques instead of kilning.

Silver Oak, our own personal favorite Rutherford Bench Napa Valley Cabernet Sauvignon, is famous for aging its wines a solid 30 months in oak barrels – previously French oak barrels.

After experimenting with American oak, they have more

recently acquired a 50% interest in a Missouri cooperage, and have converted wholly to American Oak barrels.

As this is written, Napa Valley wineries are in the midst of a wholesale transition to American Oak. Increasingly, the end result very closely approximates that obtained in French barrels, and the costs are typically less than half. Currently 225 liter American Oak Barrels are available at about $350, while the French counterpart runs about $650.

HUNGARIAN OAK BARRELS

In recent years, a third source of good oak barrels has emerged in Central and Eastern Europe. The forests of Hungary provided oak for shipbuilding for centuries – to the point that their forests were virtually depleted by the end of the Napoleonic Wars. Over the past 200 years a culture of replanting has developed such that even today they plant numerous oak trees for each cut down.

Hungarian Oak is quite similar to French Oak in grain and flavor profile. Two species are common, Quercus Petreae and Quercus Gorun.

Two companies/cooperatives tend to dominate good Hungarian oak barrels. The northern half of the country is dominated by Kadar Hungary while the southern half is served by Trust Hungary, a subsidiary of Trust International.

These barrels feature very strong construction and a high quality of build – noticeably thicker staves for example. They are priced higher than American Oak but typically lower than French Oak. We have actually had some very good short term experience with these barrels.

CROATIAN OAK BARRELS

The new kid on the block in barrel supply for wineries

seems to be Croatia. We've experimented with some of these small barrels – 30 liters with very encouraging results. The flavor profile is more in the French fashion, but the barrel construction is quite unusual. Very heavy, very strong, and somewhat stubby or squat in shape.

OUR TAKE

What do we do? Well, we experiment mostly and taste daily. But a couple of general themes have emerged. We generally avoid purpose-built whiskey barrels in favor of wine barrels. We think we get a better made barrel this way, and we like the toast levels made available to wine makers. Wine barrels are more readily available to small producers.

We do Bourbon in small American Oak wine barrels built with air-dryed staves and a medium toast. We think if American Bourbon makers tried this, it would be the end of heavy char.

We do our malted barley Scottish style whiskys in small French Oak wine barrels – again medium toast.

In the case of Rum and Brandy, we have pretty much gone over to the heavier stubby Croatian Barrels with a medium or medium-plus toast.

We actually age our Tequila/Mezcal in toasted oak barrels. We use small (5 gallon typically) Mexican made oak barrels to keep with the theme. Not bad. We do run a little white off for the wife's Margaritas.

For larger quantities, we love used 225 liter French Bordeaux barrels from Napa Valley Cabernet producers. You can often find these on eBay for as little as $150 shipped.

We can also highly recommend the tour of Seguin Moreau Napa Cooperage. Their facility allows you to walk the full length of the facility from an elevated walkway to

observe every step of the barrel making process. Today, they make both French and American Oak barrels.

BARREL SOURCES

The Wine Barrel Store and More
http://www.usedwinebarrels.com
8999 Elk Grove-Florin Rd
Elk Grove, CA 95624
866-752-2773

Bluegrass Cooperage
http://www.bluegrasscooperage.com
914 Booneville Hwy
Lynchburg, TN 37352
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