ALTERNATIVE WOODS for GUITAR CONSTRUCTION

and other string fretted instruments

by

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Alternative Woods

My intent tonight is to discuss what is desired in a wood to make it suitable for Instrument construction. This is from my own experimenting and research as well as discussions with other Luthiers.

In order to understand what might be desirable in alternative woods one must first understand what the properties of a traditional wood are that contribute to the acoustics of instruments. Then one might look for woods that have similar qualities to achieve similar responses.

To this end there is more than one variable, so it is important to have a clear concept of the sound one wants to achieve before you start. The other aspect you want to understand is what you are trading away, be it in sound, or structure, or aesthetics versus what you are gaining by using another wood species. Perhaps economics may also be considered in this balance. We live in an age when all musicians are not connoisseurs of resonant tone wood and want a less expensive instrument to carry on tours or play on the street. The other end of this spectrum is a collector that wants incredibly figured woods that still deliver a good tone. So be aware of the purpose of

your choice to use a wood not traditionally found on an instrument. This helps you accept any acoustic changes that might occur.

Woods can be tested with some science though many of the properties become relative to other species. This can help identify what wood might work similar to a traditional species so actually using it is not a random guess.

In 1987 I began to buy some alternative woods to use in my shop. This added another dimension to the teaching I had began. Don't be afraid of the wood, Feel it, flex it, knock on it, and learn to draw out its best qualities and reinforce its weaker ones.

Caught with money in a wood yard, one may choose to resort to the age old Tap Tone to determine the resonant quality of any given species that fits the budget. In 2001 I was at a Wood Auction and bought a number of species that sounded good to the rap of a knuckle & were more than 8" wide. I know the spread of my right hand is about 8" so I always have a measure. This experience is really what started my experimenting with alternative woods on a larger scale, prior to that I had tried a few species but not on any scale.

Timber cruisers can make a good Spruce tree vibrate with the blunt end of an axe swung as high up the trunk of a living tree as they can reach. This is the first tap tone used in tree selection. If you have ever heard a tree being cut in the forest with an axe you know the sound can ring thru the forest a long way as the vibrations travel up and down the trunk.

Two basic properties to consider, in instrument building, are Mass and Stiffness.

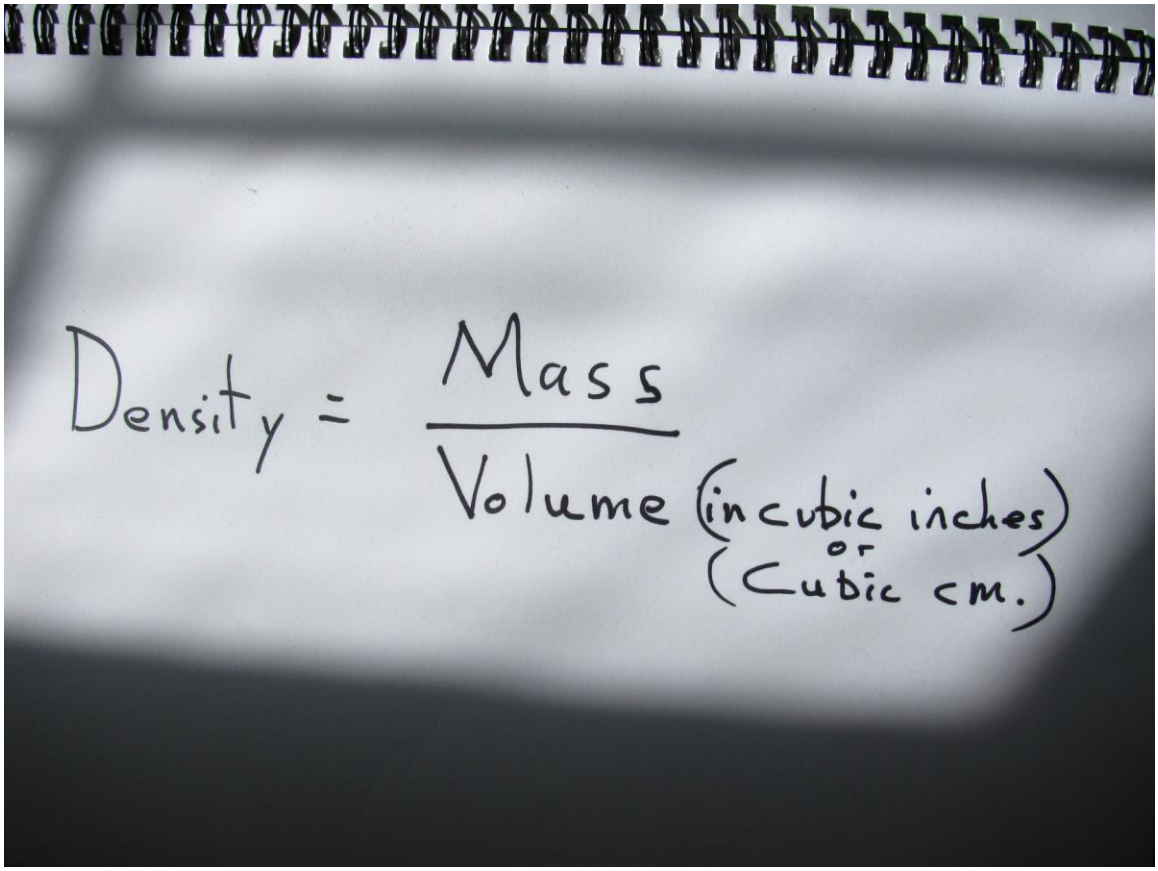
Mass is defined as; the property of a body that is a measure of its inertia, commonly taken as a measure of the material it contains & causes it to have weight in a gravitational field and … along with length & time constitutes one of the Fundamental Qualities on which all physical measurements are based.

Simpler put, the measure of the amount of matter contained. This can be thought of as Potential Energy.

More important to a luthier , the greater the mass the more force is needed to produce an acceleration or movement. Conversely, the less mass a wood has, the less string tension used to put it in motion to produce a sound. String tension when plucked is the instrument's source of Kinetic Energy.

The kinetic energy available will determine how much of the instruments wood mass or potential energy is put into motion.

Mass absorbs this kinetic energy. This is called damping. The treble response tends to damp quicker in woods with more mass. The greater inertia caused by the mass can move the plates in larger resonating arcs, favoring larger sound waves or bass sound waves. However Mass is also related to Density. Density is also related to stiffness. Wood density is mass divided by Volume.



A denser wood will have more mass, and generally be stiffer. It can be thinned to reduce mass yet maintain the desired stiffness. A less dense wood can be braced stronger to achieve desired stiffness, without accumulating too much mass. Density is another aspect to consider when selecting wood. We are looking for a balance of mass, density and stiffness in our wood selection.

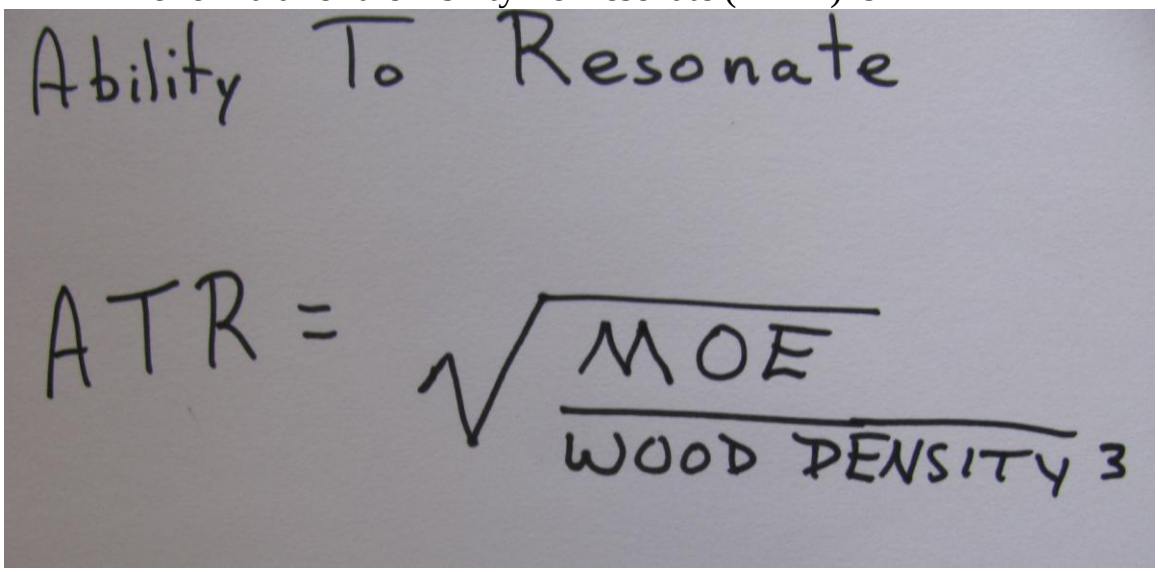
Stiffness is the other major consideration. Stiffness will allow vibration to transfer with little loss of energy. It will maintain vibration within itself as well as move it to other connected instrument pieces without major loss of energy. This is important as a stringed instrument has very

little energy input to begin with. Most of the string energy is used to vibrate the mass. The stiffness is essential to transferring & maintaining the energy so the whole instrument is in phase with itself. Stiffness will add to treble response, attack response, and sustain. Stiffness can be inherent in the tonewood used in the plates or to some extent it can be braced into the instrument. A braced plate acts as an integral unit, the bracing supporting the plate stiffness, rather than compensating for it if a piece is thinned too much, or is not inherently stiff to begin with.

The ratio of stiffness to mass will determine the resonant frequency of a wood. Greater stiffness has a higher frequency response. Greater mass will lower frequency response. An instrument tries to balance these to fit the range of frequencies it plays.

The Modulus of Elasticity is a measure of wood stiffness. Stiffness is the ability to support relative to the amount of deflection. Wood strength is the point of deflection that breaks a piece of wood, or Modulus of Rupture. Modulus of Elasticity (MOE) is used to compare stiffness. It has also been used with wood density to determine an acoustical coefficient or the ability to resonate. This can be used as a guide to select new woods that might possibly work for acoustic instruments.

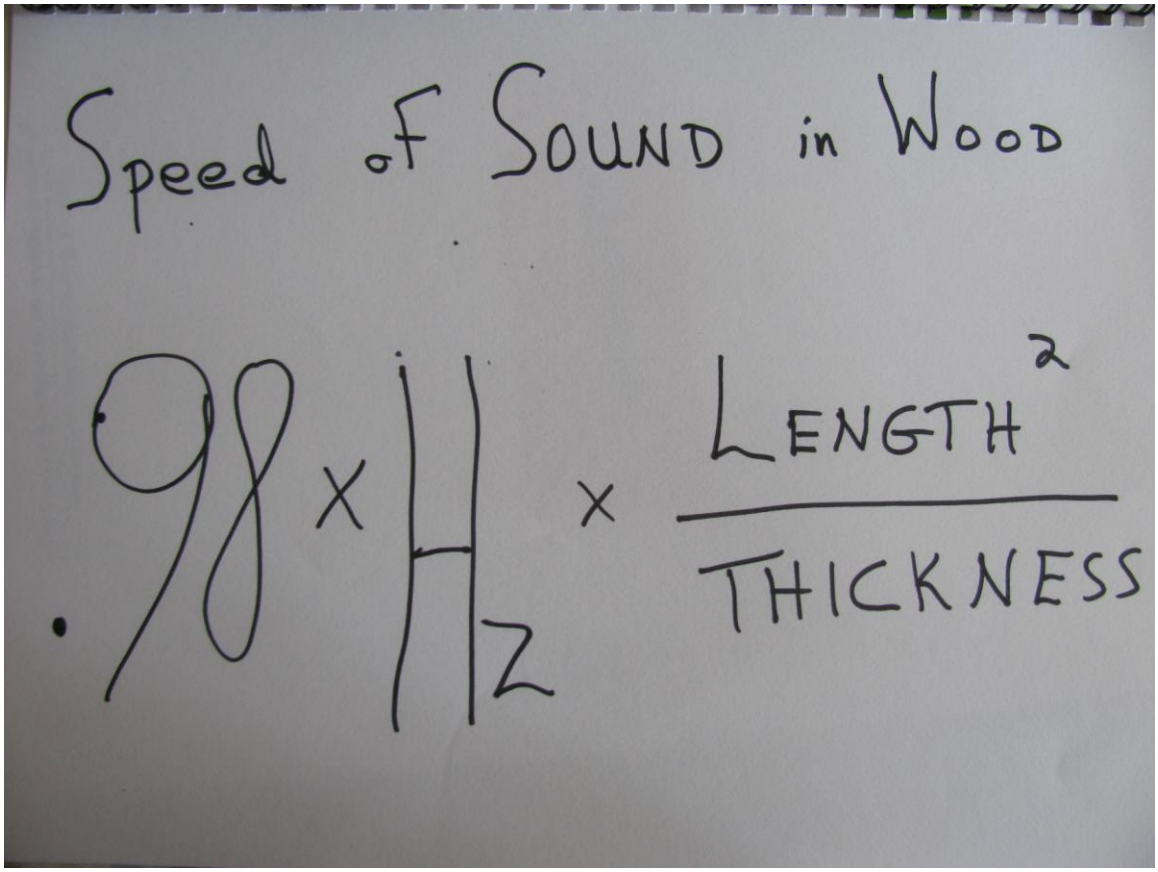
The formula for the Ability To Resonate (ATR) is



square root of (MOE divided by wood density cubed).

So you need to know the MOE which requires deflection tests of that species and that particular sample, as it varies in regions and with in trees. Density affects the stiffness of a species. Density is something we want to be aware of when picking an alternative wood or even a wood within a species as it varies a great deal even within a tree or where the tree was grown.

Density is a determining quality when assessing the speed of sound in a wood. Denser woods have a faster sound speed. A Lucci meter will read this for you or you can use a formula to work it out.



The formula for Speed of sound is ;
.98 X frequency in Hz X length squared divided by thickness.
The .98 is a correction factor for the frequency Hz.
You need to be able to measure the frequency the wood vibrates at either with a strobo scope or by ear with a tuning fork.
This can be taken into a radiation ratio for comparative assessment.
To establish a radiation ratio you divide the speed of sound in a wood by SG, specific Gravity or density . The higher the radiation ratio the denser the wood is by weight, and the faster sound will travel thru it.

{ To conduct sound, wood is resonating. In violin making the resonant frequency of the neck & finger board have a B0 factor. This is tuned by some. The density of the materials used greatly affects the frequency response. Density will increase the speed of sound. }

I don't have a Lucci Meter, seldom do I calculate the speed of sound. I assess the stiffness by flexing a wood in my hands while I am working it. I will consult charts when I am researching possible woods. I do measure the weight of wood parts as I build them to understand the ranges I am working with. This is an ongoing project since about 2009. Prior to that, I simply felt if a wood was heavy or light while I was working with it in sizes used for instrument building. Some Luthiers refer to this as intuition. I think of it as a Library of Experience in assessing wood properties.

The European woods are preferred by many builders. These set the standards in the 16th & 17th century. Living in North America I use more North American woods than European. But looking at the woods they have used helps to pick wood in this continent. Contrary to much popular belief, the variety of wood used throughout the centuries by European builders is significant.

I said in 2001 I was at an auction of a wood dealer after 22 years of business. It lasted 12 hours with 2 separate auctioneers the last 5 hours and an ongoing silent auction. I went with a budget but spent 5 times the allotted

amount. I still use some of that wood today. Some was mahogany in timber but over half was wood I was unfamiliar with. As I mentioned it resonated well to rap on, it was 8" wide for backs, or the price was too good to refuse. When I brought it all home I began to research what properties it had. Much of this wood has been used in guitar construction since then with good results.

I also have a couple of students that have become involved in sawing & re-sawing for Lumber mills and instrument construction. This has provided access to new species to use through the years. If you can't be in the right place at the right time … it is nice to know someone that is, especially when they will share it with you.

Lets start with top wood. Spruce is the most common. There is a big assortment, all with different
qualities.

European Spruce has been used for centuries & with stood the test of time. Many people still prefer it today to North American varieties. In general it seems European woods tend to be harder. **Slide6b** That would be density, coupled with stiffness. Remember Europe is a large

place so it depends if it is from the north of Italy or Norway or Hungary as to the characteristics it has.

I would caution people to use Latin Genus names whenever possible as common names are interchangeable & confusing. I will identify them and use the most common name I know in this lecture.

Englemann Spruce (picea engelmanii) is the closest North American tree to Euro spruces. It is whitest of the North American spruces. In holding it I would judge it less dense and Lighter than Sitka but I have seen tests (David Hurd; "Left Brain Lutherie) &(Les Jozsa: Stiffness, Density and Resonating Quality) that mark it denser than Sitka Spruce. The MOE is less than Sitka, so the density is not making it stiffer. The ability to resonate scores lower than other spruces, though the resonance is quite acceptable. I have used it in steel strings and classicals, finding the nylon strings can drive it sufficiently.

The fibres run longer & one must be careful not to tear out strips that can look like a knife cut. This fibre structure gives it the stiffness for resonating. The trees grow smaller which results in the sapwood and core sometimes being used to get a wide enough piece of wood for a guitar. This also means in a vertical cut, the annular rings are seldom consistent in the

span of wood, leaning over as it comes to one side. As with all the soft wood top materials, one should note where the tree was grown, as this will affect the size and quality of annular
rings.

These trees grow inland & higher up the mountains. The region of Revelstoke B.C. gets a large amount of moisture but is high enough to have slower growth periods, in severe winter weather. Here they can grow very large trees with tight annular rings.

Englemann glues well and works easily to plane. It doesn't chip or tear when cutting binding or Rosette channels. Run-out is often a problem side to side. If this is too severe it can jeopardize the soundboard's strength longitudinally. Runout also shows up after finishing, one side looks dark & the other light, a feature I have often encountered in European species. This is a case for wanting split billets instead of sawn. It does take a finish nice. It is very stable to humidity changes. Tests show it to be more stable than Red cedar and Redwood.

Humidity stability is a very desirable feature when picking a top wood. A thin wide plate is susceptible to humidity changes. Curving the top will allow it to rise and fall with changes. Thicker plates are more stable than thinner ones. Balancing this with wood stiffness and desired sound qualities

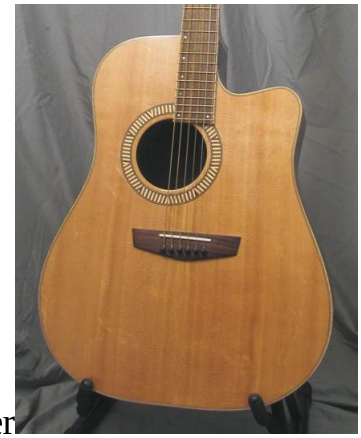
will change with different woods and building approaches. One must be aware of what you are gaining and what you are trading off in making structure decisions and sound qualities decisions.

After Adirondack spruce became endangered in the 1940's

Sitka Spruce (picea sitchensis) became the most widely used top wood. In samples done for the Wells Island Mountain Arts ToneWood Conference by Forintek Corp (Les Jozsa) in September 2000 Sitka's Ability to Resonate

is 428 the highest of the spruces tested, Engleman comes in at 373. Black spruce is 343 and White spruce (Picea Glauca) is 404. White spruce I would note is also known as Adirondack , Blue spruce, and Skunk spruce.

Adirondack has been called Red Spruce, though Douglas Fir has been called Red Spruce, hence the confusion of names.



Sitka spruce makes a fine soundboard. I prefer it for steel strings as the mass tends to be too great to properly be driven by nylon strings. If it is used for this I thin it considerably to lighten the mass but leaving it thick enough to maintain nylon string stiffness. Thinning it makes it more susceptible to humidity changes. Sitka is active to humidity changes so too thin a top can cause problems. For these reasons I use it for steel strings and harps.

Split billets can be found. Run-out is not generally a problem. It can chip-out when routing channels. Generally it works well, but it will dull tools quicker than other woods.

The trees grow very large so a good vertical cut with consistency across the grain is common.

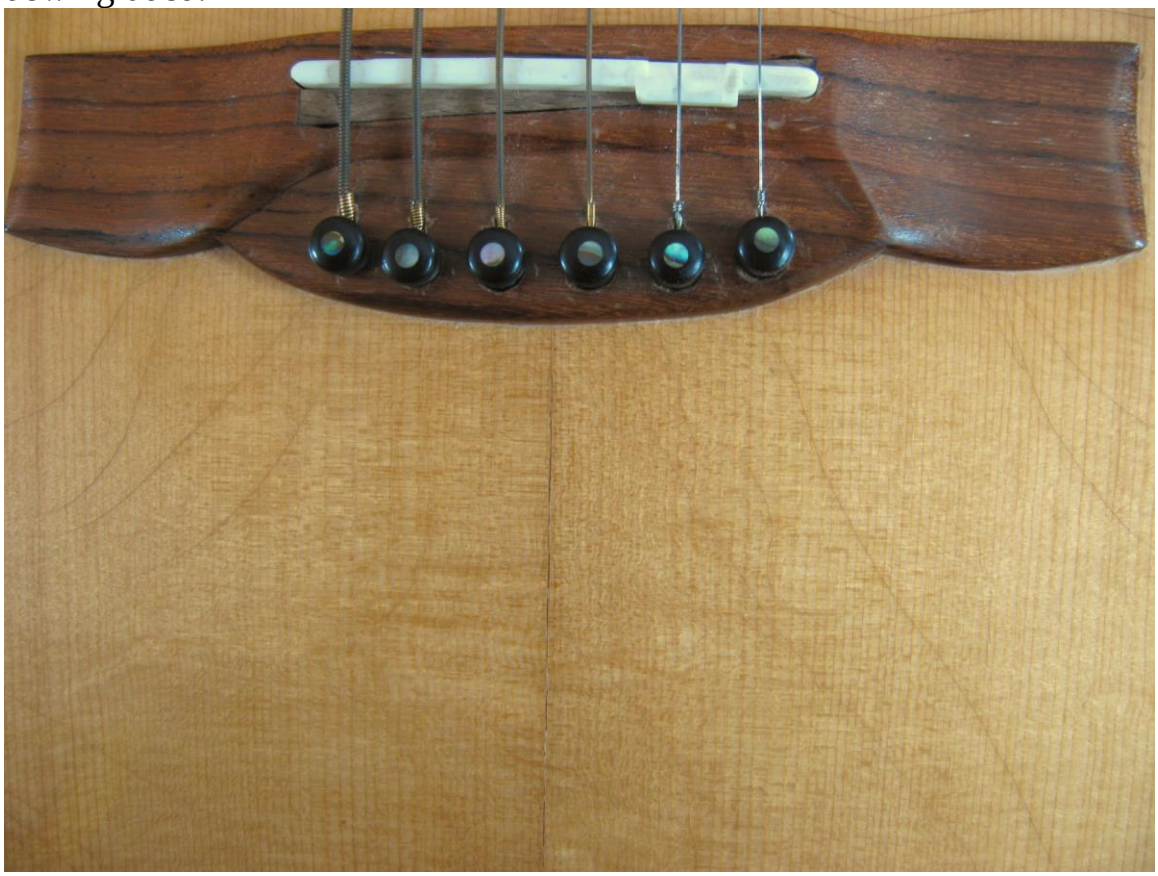
It can count up to 25 lines per inch though more common is 16 to 20. The sonic Sitka Project has up to 34 lines per inch. This is exceptional.

It can have a bear-claw figure, which affects run-out, though I have not

found it to inhibit stiffness when working or stringing it.

The redder colored wood tends to be heavier. It sometimes has very heavy sap laden late wood rings which also add mass. The latter is usually

down graded.



I would call this a standard today, while a century ago Adirondack or Red spruce (pecia rubens) was the standard. It simply became too scarce for commercial use. Good quality Adirondack has greater stiffness and mass than Sitka.

Its ability to resonate is greater and the clarity of the dynamic range responsive maintaining good overtone structure. How ever finding good quality today is difficult and expensive

It moves with humidity like Sitka so build so it can change with the weather. Its internal stiffness and strength will see it thru.

If you ever get a chance to use this wood, it is a treat. Like all master select wood the window to obtain the optimum sound qualities is narrower

than AAA grade. This is due to the extreme stiffness of master sets. Building experience with lower grade woods allows one to make mistakes without losing an acceptable sound. Once sound judgment in thicknessing sound boards has been developed, I suggest trying more difficult, or stiffer woods. Then you are less likely to over-stiffen the plate. Adirondack is stiffer by nature and requires experienced assessment when working it. The scarcity makes it more imperative to create a respectable soundboard. So try some AA grade then AAA to get acquainted with this wood's stiffness before trying the master set.

White Spruce (picea glauca) has been used for soundboards, though I personally own none. Its MOE is less than Sitka and the humidity stability is slightly more active. It is white like Engelman with a greater MOE resulting in a greater Ability To Resonate. It grows across North America. It is used extensively in lumber and pulp. It is used widely in Quebec's instrument industry.

My interest in the White Spruce is when it cross-breeds with Sitka. The result is

Lutz spruce (picea X lutzii) often considered under picea sitchensis or Sitka as a subspecies.

This Hybrid is usually white in color but has the MOE and ATR of Sitka. This makes it very attractive as a soundboard for steel strings. It works & glues well. There is a premium price paid for this wood. It does occur naturally in the wild, however some tree planting operations use it.

Western red Cedar (thuja plicata) has been used as sound boards for many years. It has less mass than the spruces, and less MOE but the ATR is higher than even Sitka.

This can be used to achieve a strong treble response, especially useful in the construction of Classical Nylon string instruments where the treble strings lack the power of the wound bass strings. By increasing the thickness which is a cubed relationship to stiffness, the stiffness hence the response can be quickened in attack as well as frequency.

Red cedar is used for steel strings as well. It can match with a back & sides that damp treble resonance like maple to balance the response spectrum. In this case it also contrasts the white maple to the dark topwood. The opposite of the standard rosewood /spruce colors.

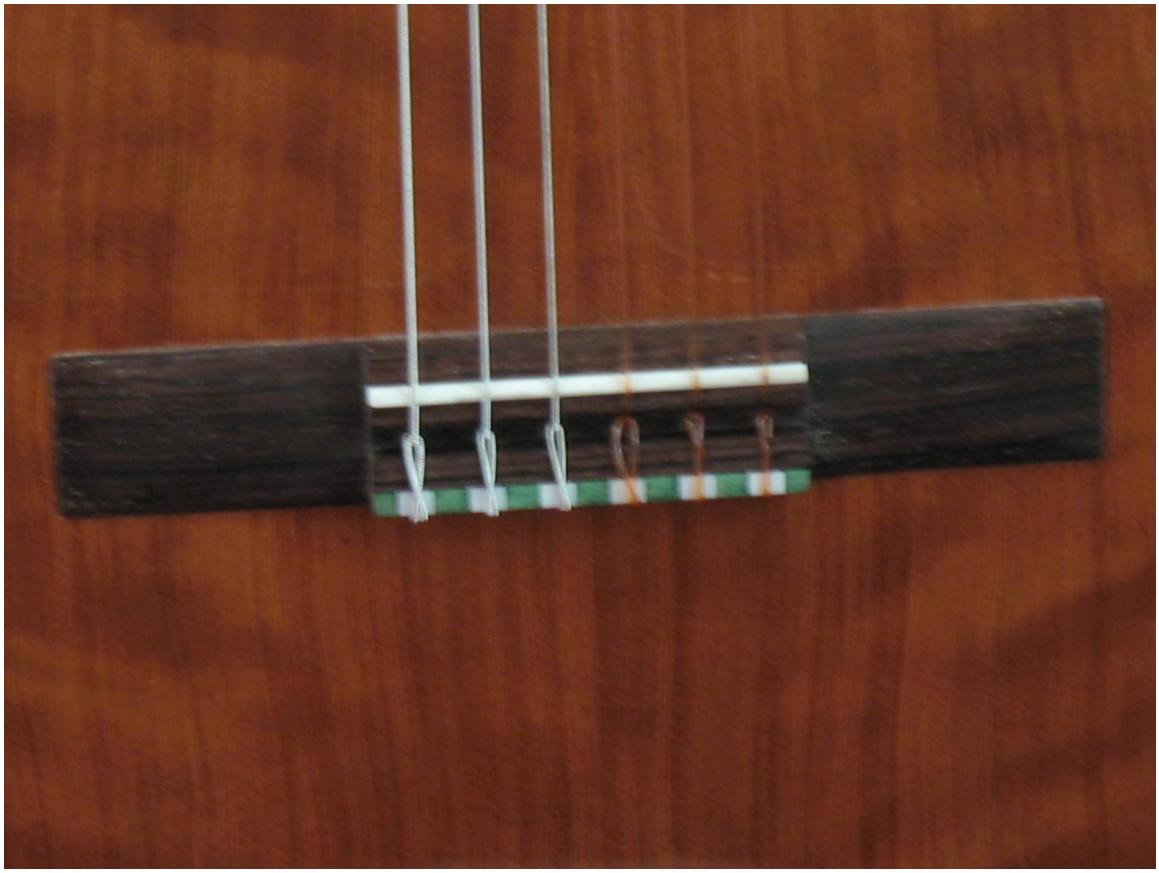
Red Cedar works well, though it is soft & care must constantly be taken to avoid marking or denting it. The color ranges from light red-brown to very dark brown. It is common to have streaks running though it of shades of brown.

The annular rings can be very tight. Up to 70 per inch I have counted, with a consistency across the span of the board. “Left Brain Lutherie’’ lists it as moving more in humidity changes than spruces , but in using it I have found it has less deformation from moisture gain or separation from excessive drying than spruces, so I would conclude it stable as a top wood. It could be the samples used in determining the movement had wider annular rings than what I generally use. The early wood absorbs more moisture than

the late wood. Thickness also adds to the ability to withstand humidity changes. My cedar tops are generally .110” to .130” thick. I have seen some that are .140”

Sequoia or California Red wood (sequoia sempervirens) has a specific gravity just below Sitka spruce. To flex it one would judge it to be much lighter. The MOE is greater than cedar but less then Sitka. This would put the ATR into an acceptable range. The annular rings can be reasonably tight, with some flame figure. The variance of softness to hardness in early wood to latewood is great, making it difficult to level. A balance between sanding and scraping is required.

The stiffness results in a strong attack response. A balance between bass, mids & treble can be attained, but left too thick the trebles will be favored, as this wood has strong internal stiffness both longitudinally and tangentially. It is not as stiff as Sitka but some samples might be equal to Engleman.



The deep red brown color is attractive and consistent. If there is figure it doesn't seem to affect the stiffness a great deal. Run-out in the figure needs to be contended with. A High flame figure is common and is worth the effort in the final appearance.

Redwood is more commonly found on nylon strung instruments. In accessing the strength & stiffness I have hesitated to use it for a steel string

instrument. I recently bought some figured Red wood that I intend to try on a steel string.

Yellow Cedar or Canadian Cypress

chamaecyparis nootkatensis) has a low stiffness and marks easily . Being a cypress I began using it as back and sides for flamenco guitars. It worked well. The ATR is also lower than cedar, adding to desirable flamenco qualities. I have since used it for tops and necks on these instruments with good success.

It heat bends well in a vertical cut. I have not used it in flat sawn at all. It planes and carves easily with little tool wear. It glues good. A finish of lacquer or French polish looks great. Like red cedar and redwood it is soft & marks easily though steaming will bring out dents.

The annular rings can be very tight, 50 to 70 lines per inch. There are species variances of Yellow cedar depending where it is grown. Port Orford cedar is known for its durability as a sound wood and is slightly different from trees grown further up the

coast.

As a neck for nylon strings it has proven longevity in maintaining trueness. The lightness adds to the flamenco quick attack and quick decay of notes.

Working it for an extended time the odor can be discomforting. It resembles turpentine. I have had it sting my eyes after carving it for a couple hours. This wood is used by Haida Gwaia

for carving totems as it works easy. Carving out doors would allow the odor to escape.

In “Stiffness, Density & Resonating Quality of interior spruce from the Wells area,” an alternative sited was Subalpine Fir

(Abies Lasiocarpa).

The size of trees growing in the Wells area are generally too small for guitar sound boards unless one was to add wings. Some trees of size can be found and this wood makes a decent sound board. It is not as lively as Sitka

spruce but the curiosity of the stiffness is it is stiffer across the annular rings than Sitka but not as stiff longitudinally. This makes it closer to being isotropic before you begin to work it! Isotropic is when stiffness is equal in all directions. It is achieved by bracing more across the grain than with it to allow the vibration to move relatively the same in all directions.

This wood is strong enough for Steel string use, yet light enough to be considered for nylon strings as well. The density runs close to that of Engleman spruce, while the ATR is above Engleman and below Sitka

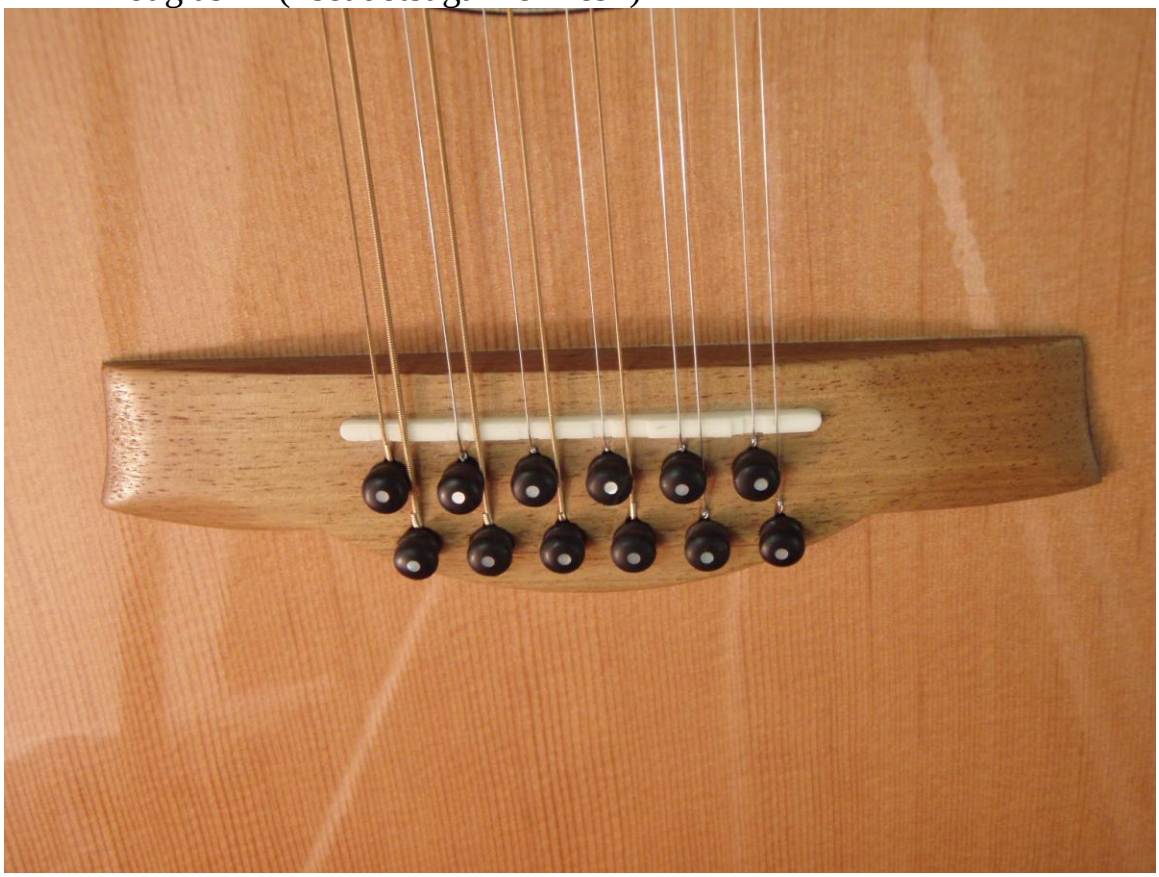
Like Yellow Cedar it has a very strong odor similar to turpentine. This can be irritating to the sinuses over time. In both these woods the color is yellow.

I haven't found any resistance to gluing in either of these species from this odor which is due to the sap content. The sap is not a problem in bleeding or seeping.

The Annular rings are not tight in the wood I have secured. They run about 16 to 20 lines per inch. This has been stiff enough to make a soundboard. It planes well and run-out is rare. Grain alignment stays even across the width. Run-out does not change as you move across the radial grain. This can happen more frequently in Englemann spruce.

The supply is sporadic as the demand is low. Larger trees are rare.

Douglas fir (Pseudotsuga menziesii)



is called Oregon Pine in Europe where it is well thought of as a tone-wood. The density is quite high compared to Sitka. And the ATR very low. Though it has a higher MOE.

I have found the flexibility across the grain to be disconcerting the first time I used it. However I made the X brace a little wider to gain cross grain stiffness and it worked fine.

Douglas fir's mass makes it a choice for Steel strings. The longitudinal stiffness is strong. This being in line with the strings it should compensate for the cross grain flex.

It does harden over 50 or 80 years to the point that you can't drive nails into a 2 x 4 with out bending the nail. What this feature will do to a guitar should it last that long is waiting to be seen. Wood that is continuously vibrating ages with that ability. The hardness could be a benefit. 

It is brittle. When routing binding and rosette channels it can chip small pieces out along the end grain which need repair. The late wood is so hard it can be difficult to carve, jumping into the softer early wood, then hitting the late wood again.

It glues well. Though some sap bleed can occur, it is rare. A wash of methylated spirits and or naptha will clean this up. It doesn't affect the finishing but rather helps the finish to hold better.

The other heavy wood I have used is Western Larch (Larix Occidentalis).

I had read Martin was trying it out & one of my suppliers had some in stock, so I acquired a sampling.

Larch is heavier, stiffer and stronger than most other softwoods. It is stiffer than both Sitka and Red spruce. It is reasonably stable once dry even in

humidity changes.

The hardness lends itself to steel string use if one is careful to avoid making it too heavy. The balance of mass & stiffness make good treble and bass response when thicknessed. A fast attack can be achieved with good sustain but the bass response is maintained.

It has a very low ATR. Considering the stiffness if you thin it more than spruces it can come up with a strong resonance. The MOE is very high. I think in all woods, you can make the soundboard too stiff and brace the resonance & sustain out of the instrument. This is true of Master grade woods if you lack experience using stiff woods. The window of resonance is much smaller with stiff woods. Larch's MOE suggests good stiffness but the ATR is misleading. Making a few instruments to assess the wood

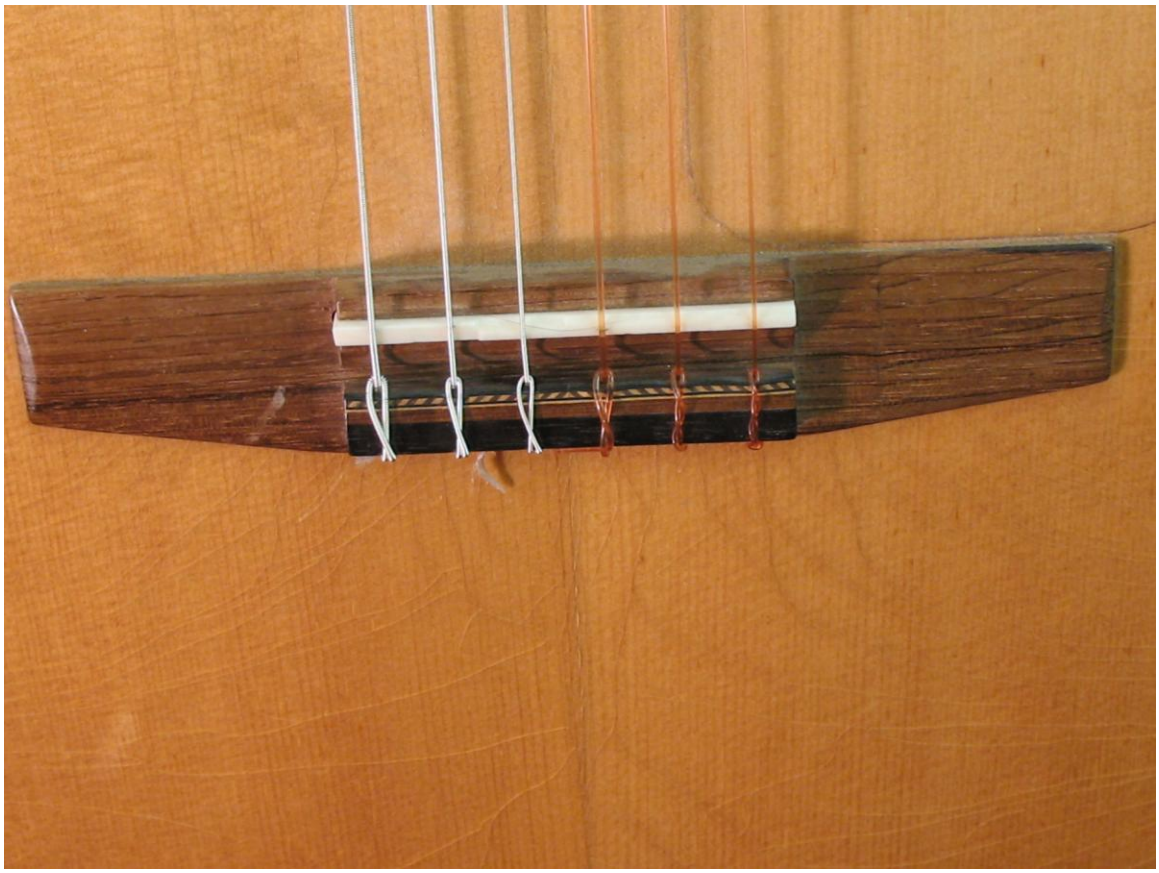
characteristics is necessary.

It planes and sands well. I didn't find it to dull tools as much as Sitka, which wears out Band saw blades rather fast. It is the resin content of the Sitka that is responsible for that.

I have read that Larch can have resin bleed but the wood I used had no problem like this. You could clean it with naptha if this was a problem. It is also reported to occasionally be stringy and can chip when routing channels. I don't recall having trouble with that either. I didn't restock for any particular reason. I would try it again, someday.

The softer end of the spectrum is White Pine.(pinus monticola).

I had read about a 17th century violin maker that used white pine, some instruments were still here being played.



I acquired a few sets & used it on a Flamenco with Yellow cedar Back & sides. It worked great . Warm sound, fast attack, & fast decay. It bled sap on the inside. I had wiped the outside with Acetone, Naptha, & Methyl Hydrate before finishing to prevent bleeding into the finish. It has proved durable

over the years.

I would use it again as a flamenco , I have not used it for a steel string thought the MOE and ATR indicate the stiffness would be enough. The ability to resonate is half way between Englemann and Sitka.

That is all the different sound board wood I have used.

The next important parts to consider is Back and sides. I will include necks and Bridge plates when

applicable.

Torres made a Paper Mache back and sides to prove the top was the most important sound producer of the instrument. This was in essence replicated when Taylor made the pallet guitar. Basically any wood could be used. Some will have better tonal qualities than others. The tonal quality and the Ability To Resonate are the main features to assess if you want to research backs. For this you need a good MOE chart , or samples to do your own testing.

Backs are a reflector of the tops initial vibration. The strings and top create the initial air vibrations, the back colors it tonally**.**

Sides require a wood that will bend without fracturing and transfer the vibration energy from the top to the back efficiently. This requires stiffness.

The act of bending wood will create stiffness but a wood's integral stiffness will affect how well it does this job. Some people use laminated sides to get this stiffness, others have gone to double sides to create stiffness trying to reduce mass**.**

Fingerboards must wear to the grinding of strings and hold frets secure over years of playing. They should be attractive as people tend to look at them on first presentation.

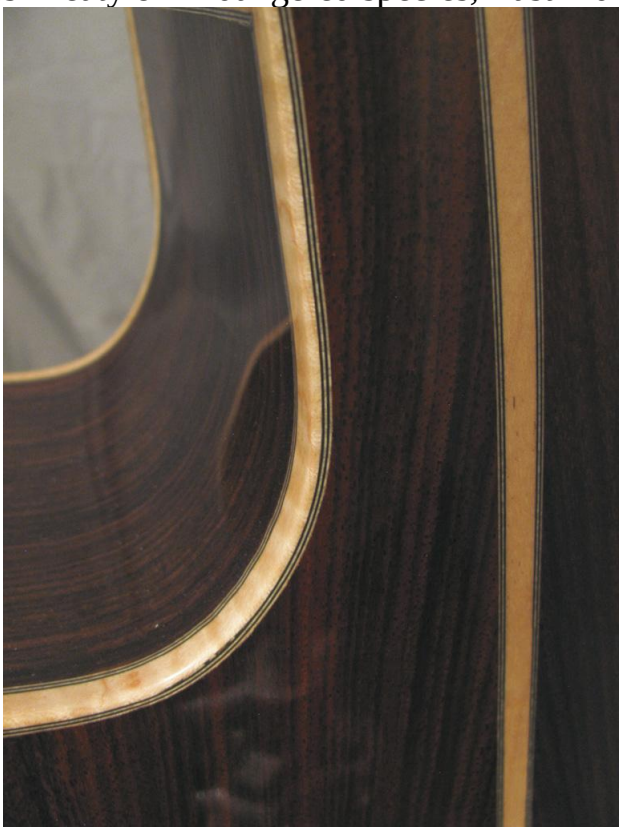
Necks must be stiff to hold straight against the constant tension of the strings. The stiffness must also transfer the vibration energy to the body, efficiently. I mentioned earlier that necks are resonating to conduct sound. I have seen discussions on the internet that try to separate resonating and transferring. I would maintain that all the parts are doing both. Ultimately, supporting each other in developing the instrument's "voice".

Bridge Plates must be a hard wood on steel strings. They secure the metal ball of the string. They must not expand under increased humidity or cause any other top distortion.

Basically, for back material, I would list two categories; woods with mass that are very stiff, and less dense, lighter woods that still maintain

significant stiffness.

Rosewoods (dalbergia) would be the first traditional wood to compare. Intially Brazilian Rosewood (dalbergia nigra) is the most treasured of tone woods. Though when Brazil put a moratorium on it & later

it went on the Cities Treaty of Endangered species, East Indian Rosewood (dalbergia latifolia**)**  might be considered traditional.

Most of the rosewoods work tonally, the problem for some of them is finding a tree that grows large enough for back material widths. One can make three piece backs. As wood gets scarcer it may become common to have multiple piece backs. Pay attention to the specific gravity, SG, some of the rosewoods go over 1. This means they sink. My experience is, woods with SG over 1 need to be thinned considerably to reduce mass or the trebles become muted. Thinning works as the stiffness of this family of wood is

very high, so they still transfer energy & vibration very well.

They all bend good except Honduras rosewood (dalbergia stevensonii) which I have found to be excessively interlocked or rowed. The interlocking makes it lurch thru the bandsaw when resawing. It is extremely hard to bend from the same grain contrariness.

The resin content of Cocabola rosewood (dalbergia retusi)

makes it gooey to bend, as the heat draws the resin out. The dust from cocabola can cause a severe skin rash reaction which some people get over sensitive to when re-exposed.

When bending there is a yellow smoke from the heat pipe which can also give you a reaction if inhaled for too long. This variety sinks so a treble muted tone can occur if it isn't thinned more than usual. The resin gums up bandsaw blade teeth after three cuts so you are either cleaning the blade or burning blue smoke in the shop. Constant cleaning of the saw blade is necessary.

One of the currently more popular is Madagascar rosewood (dalbergia baronni)  which is slightly denser than East Indian, but very close in other qualities to produce the tone. Recent unlawful sales & current restrictions on export by that government have reduced the availability of this wood. I found it to be more brittle than East Indian. As a fingerboard, it holds frets better than East Indian. The added density should make it wear better as well.

Generally, Rosewoods have a full frequency response. The attack response is quick and sustain is strong. If left too thick the resulting mass will cancel the trebles and the resulting stiffness can diminish sustain as the wood becomes too stiff to properly vibrate.

The traditional wood I would put in the less stiff and lighter category is Honduras mahogany (swietania macrophylla).

This wood is doesn't dull tools when worked, with minimal run-out problems. It is very stable to humidity changes. It delivers a sweet mellow tone. It has been used for endless woodworking applications. An ideal wood in many ways!

Unfortunately it recently went on the cities treaty 2. This means it can only be sourced from sustainable yield sources. Often this means plantations. Plantation wood is often less dense than wild grown wood as it gets fertilized for various reasons making it grow faster. Less density changes the properties luthiers are interested in. It is currently being grown in many different countries and the different climates change the wood properties again.

I have used mahogany grown in India and Fiji

with good success. The latter seems lighter but has enough stiffness to be used for steel string necks. The former has more ribbon figure than wood I have received from South America (the original location) or “ Honduras

Mahogany” Some years ago there was a Quilted Mahogany tree that had incredible figure.

Alternatives for mahogany are sapele (entandrophragma cylindricum).

Grown mainly in Africa it is denser and considerably more interlocked. This makes necks heavier which can add to sustain, but more prone to twisting or warping. It is also difficult to work as the interlocking causes splitting in contorted patterns. The color and pore size are very close to Swietania. It remains very affordable.

African mahogany (Khaya ivorensis)

is also used as a substitute. It is close in density but this can vary depending on the part of Africa it comes from. Generally it is slightly denser.

The color variance ranges from dark brown to a light-brown red, again depending on the port it is shipped from. It can have a strong ribbon figure

with great chatoyance. The pore size can also vary.

Working this wood is similar to swietania. The tonal qualities are all close as well. The ribbon figure means more run-out to contend with while working. This adds to the finished chatoyance.

Nato (Mora Excelsa or Mora Gonggrijppi) is being used by many companies as a mahogany replacement . I have not used it. The stability of use has proven over time and the accessibility for Asian production companies makes it an affordable choice.

Spanish Cedar (cedrela odorata) is a wood that looks like mahogany but is a different genus

It is from Central America. The aroma is enchanting and pleasant. Many classical builders use it for neck material. I have used it for backs & sides of flamencos. The lightness supports the decay I look for in flamenco sound. A mask is advisable as some people are allergic to this dust over time. It lacks the stiffness of Honduras Mahogany, so is not really strong enough for steel string necks.

It bends & works much easier than mahogany. It is still very affordable. Occasionally I have found a wide curl figured board.

Padauk (pterocarpus macrocarpus) from Burma, (Pterocarpus soyaussii) from Africa and (pyterocarpus dalbregoiides) from Andaman

Islands, is another wood that has mahogany like qualities.

It makes a good neck that is stable. It is like carving sapele. Runout that varies, and harder than mahogany. But it looks great with a strong orange red color.

It has ribbon figure with interlocking grain for great chatoyance. It has medium to large pores similar to mahogany. The SG is half between mahogany & rosewood so the stiffness brings acoustic results more like the latter than the former. The Burmese is the densist. The Andaman islands variety the closets to East Indian Rosewood.

The African is the most commercially available with restrictions on the other two that are both political and ecological. The African has the largest pores. Like African mahogany, the color varies depending on the port

it comes from. Color ranges from light orange to dark red-brown.

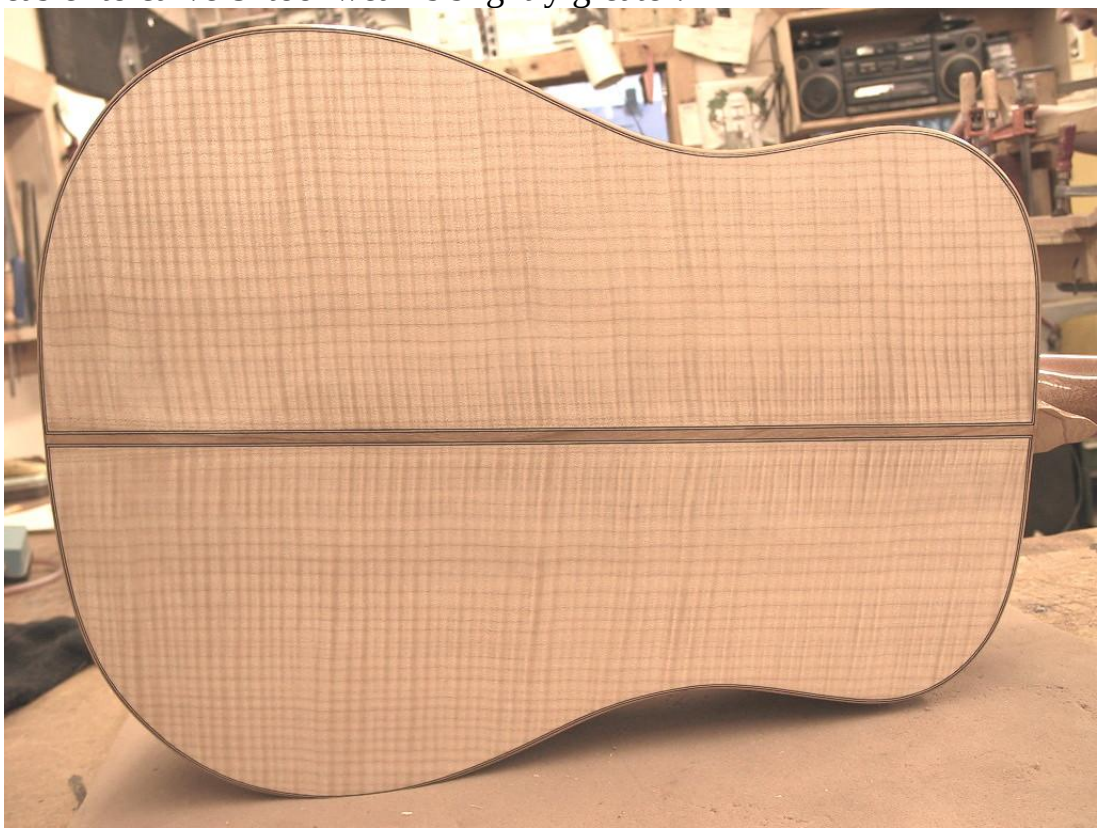
The sides don’t like to bend. It requires more heat to break down the fibres enough to get and hold the bend. It has much spring back once bent unless the extra heat has been used. It tends to work harden, getting brittle

and breaking if worked too long. It resists water. Water doesn’t always work to bend it though allowing it to get too dry makes it brittle.

The bright orange red color is unique. Over time it oxidizes to a reflective red brown, similar to rosewood.

All mahogany, true and substitutes are a good choice for neck material due to the stability and ease of working. The replacement varieties are not as

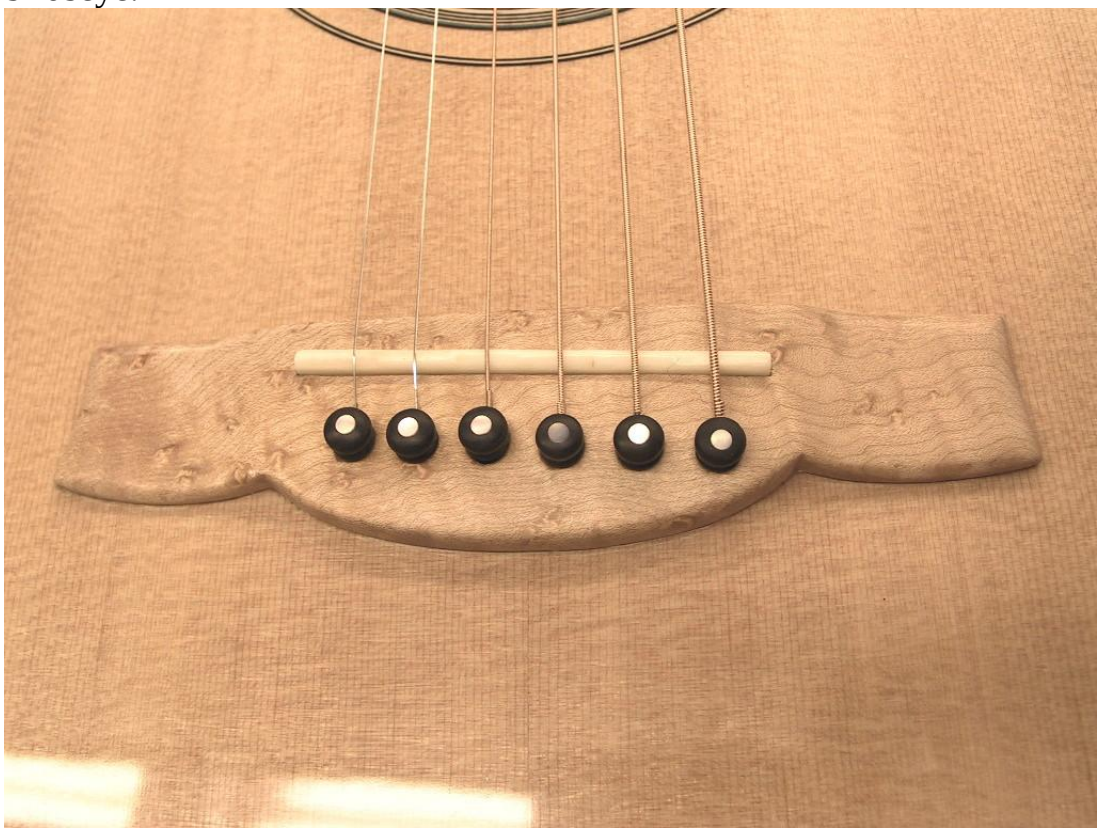
easier to carve & tool wear is slightly greater.



Hard Maple (Acer saccharum or acer nigrum) would be another traditional wood. European is harder and whiter when sourced from colder climates. North American varieties have names ranging from Sugar maple, rock maple or Hard maple.

A good curl figure is usually desired. It can vary from curl to flame to tiger strip to quilt to bees wing and

birdseye.

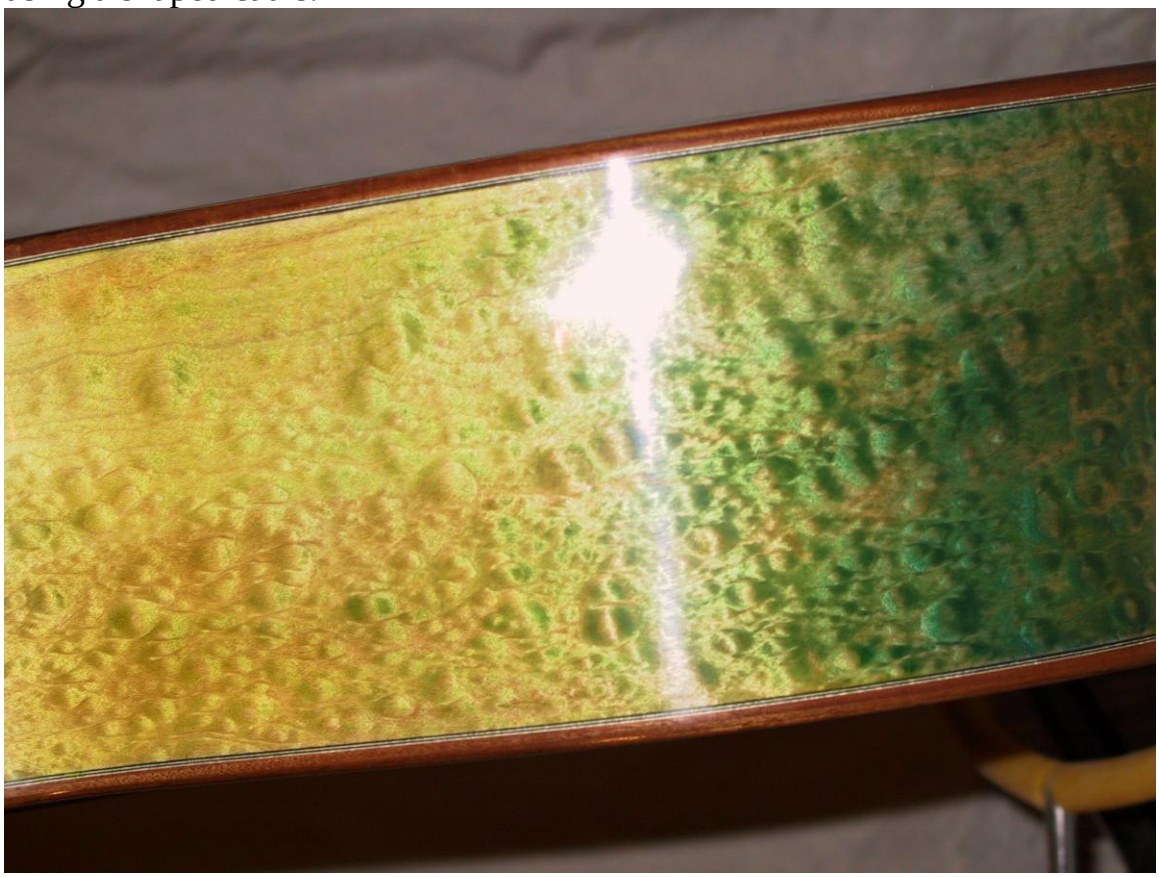


All these are variations of wood grain growth. The white background allows staining to be used to bring out the figure. Hence we have sunbursts as well as colors.

The hardness of the wood dulls tools. The same hardness and fine pore structure allows a highly polished surface to be obtained.

It bends well with water though the curl figured wood means there is run-out which can simply separate when wet and being bent. This can be reglued

using a shaped cauls.



Hard Maple is used for neck material in many applications.

It is actually stronger in a flat sawn mode than as a vertical cut. Here is a slide rule demonstration of how a curve increases a board's stiffness in one direction and less stiff if the rule is held the opposite way.

Quite common in electrics, maple is used as a one piece neck/ fingerboard.

Big leaf Maple (acer rubrum or acer saccharinum) is found on the west coast of Canada . It is about 30% less stiff than hard maple, this means about 30% less hard as well.

The figure patterns are as plentiful and vivid.

Most can be found in both vertical and flat cuts. I have never seen Birds eye in Big leaf. Birds eye only shows up on a vertical cut. The run-out can create problems in working and bending. Staining works well for this maple

too.

For necks I find it tends to lack stiffness. A truss rod needs to be used to adjust desired straightness. Laminating with other stiffer woods also works. Fingerboards as well, lack the stiffness to resist string tension and the ability to hold frets is poor.

I have resawn this wood for a week on the bandsaw without having to sharpen or replace the blade. It is tool friendly. It is easier to carve than the

hard maple if working by hand but not as easy as mahogany.

Maples sides bend well if the wood heat is reached then water is added between the bending iron and wood to create steam. The wood instantly relaxes and the bend can be made. However it needs to be held in place until dry to hold the shape. Rosewoods only need to be cooled (I have super cooled them , plunging in water) to hold the shape. Maple needs to be dried to hold the shape. This property reflects maple’s instablity to humidity changes.

Due to this tendency to movement I have stopped using any maple as bridge plates. I found they bulged my tops and I have gone to more stable woods.

The ATR of big leaf is more like that of Mahogany while the ATR of Hard Maple would be closer to Rosewoods.

Hawaiian Koa (Acacia
koa)

has been long used as a tone wood. It falls into the softer hardwoods category . The figures and color make it so attractive to use. It remains stable in use and can be used as neck stock, though the interlocking twisted grain makes carving difficult.

I have found it generally, easy to bend. About 20% is cantankerous, either cracking, splitting, or erupting, spoiling the side being bent. It can

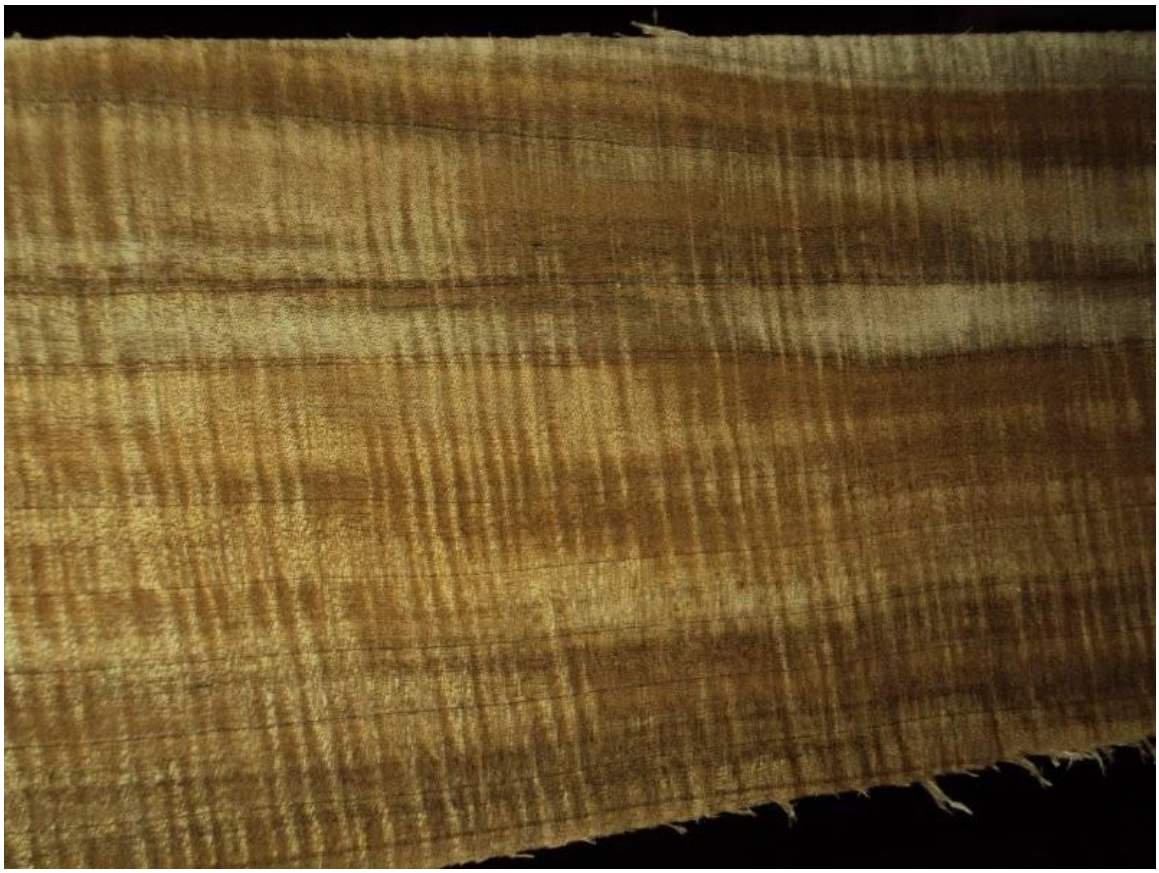
burn in the side bender if left too long. I use less heat and less time.

This wood looks great even without figure. The golden brown color is impressive. It is expensive, and availability fluctuates.

Tasmanian Blackwood (acacia melanoxylon)

is similar to Koa. It grows further south and is usually denser, and a bit darker in color the golds are more subdued. The figure can be as vibrant.

The density darkens the sound slightly more then a koa but the added stiffness takes it closer to a rosewood tonality.



I just received some blackwood from New Zealand, that was planted in the late 1970s in a paddock. I have heard some weissenborns made of

this.

It also has some run-out in the figure and knots, like koa, that need to be worked around. This creates stunning light chatoyance. The range of colors in the acacias is beautiful.

American Cherry (prunus serotina) has been used in Appalachian Dulcimers in the USA since people were in the mountains.

In working it doesn’t blunt tools as it is not as hard as hard maple but it is harder than mahogany

It is more stable to humidity changes then Maple. On this point I have begun to use it for neck stock and I like the stability it has .

It can have good curl figure. I have some spalted cherry that is still very stable.  It makes an attractive back . There is a color difference in east coast Black Cherry and west coast Black cherry the latter being much lighter in color. Other properties seem similar.

American Black Walnut (juglans nigra)

is another wood used for dulcimers for years. Guitars have been made from it but have never been highly popular. The density is above mahogany.

It is more stable than mahogany but also harder to carve dulling tools. Not as hard as hard maple, but you need to keep sharpening tools.

It makes good neck material as

well.  have used it

for bridge plates because of its stability. Yet it bends well. Holding its shape once bent.

As fingerboards it is a little soft for guitars, but has been used on mandolins and dulcimers.

I don't have a good table of MOE for these woods and it will change from region to region. You need MOE to calculate the ATR. The ATR could be argued to be less important on a back than a top. If one had this information it would be beneficial. Again I remind you different sources will yield different results in regards to ATR.

I will say walnut has the sweetness of a mahogany set with the fullness of rosewood. It can also have good curl figure.

I have some west cost Walnut that is not as dense. It is English Walnut(juglans regia). The lack of density makes it respond more like a koa

than any of the other woods. The English walnut is lighter in color and lacks the vibrant color variation of the American

Black.

Claro walnut (juglans hindsii) I will mention as many people are using it in the USA. I have not used it. The figure can be incredible. The color is more chocolate brown than American. This tree grows in Northern California and is endangered. Be aware of the reason of the source if you buy any.

Note that American walnut if air dried has wonderful array of color that is lost in kiln drying as the colors all wash together resulting in a flat grey

look.

I acquired some beech from the west coast as well. European beech (Fagus sylvatica) has been used in instruments for many years. American beech (fagus grandifolia)

coarser and denser than the European. Other wise properties are very similar. It moves medium with humidity changes. It has medium stiffness, though the SG is similar to African padauk. I had some spalting and water staining in my stock resulting in awesome design. Acoustically it falls into the softer sweeter tone woods. It does bend well, with minimal warping.

I bought some Friejo (cordial goeldiana)

at the auction. It grows in Brazil.

I only knew it was from Brazil. It was 8” wide and hard to my thumbnail. I started the bidding & no one else bid against me. They sold me both bundles. It was a steal.

It bent well. It is stable to humidity. The two bundles had slightly different colors. One was lighter brown grey. This wood was more fragile than the other. The SG is similar to mahogany**.**

The heavier darker bundle had the stiffness of mahogany. The acoustical response was definitely satisfactory

The down side was it has millions of slivers that constantly stuck in my hands.

When vertical cut it has small rays that reflect light in a wonderful contrasting way. Beech also has rays like this.

It is not really hard enough to be used as fingerboards.

Zircote (cordial dodecandra)

is in the same family. Some people have used it for back and sides. I have heard reports of its inability to handle humidity and cracking as back material. It is listed as stable once it is dry. I have used it for fingerboards with good results. It is very attractive and can be an ebony replacement.

Bocote (cordia alliodora) is another wood I bought that day. Unfortunately it was to narrow for backs. I did use it for finger boards successfully. It has a medium brown gold color. People are attracted to the color and simple figure

of this wood.

Shedua (guibortia ehie) is also called Ovangol. I have bought ovangol may years ago from a different supplier and received a very different wood. To discern the two , I cannot, that is the problem with common names.

The Shedua I had fits the description I found in “Guitar bench”. Some where, I read that it cannot be planed without tearing or splitting out. This I found to be true. I sanded and scraped it. The color is rich brown with a subtle shimmer in the light

reflection.

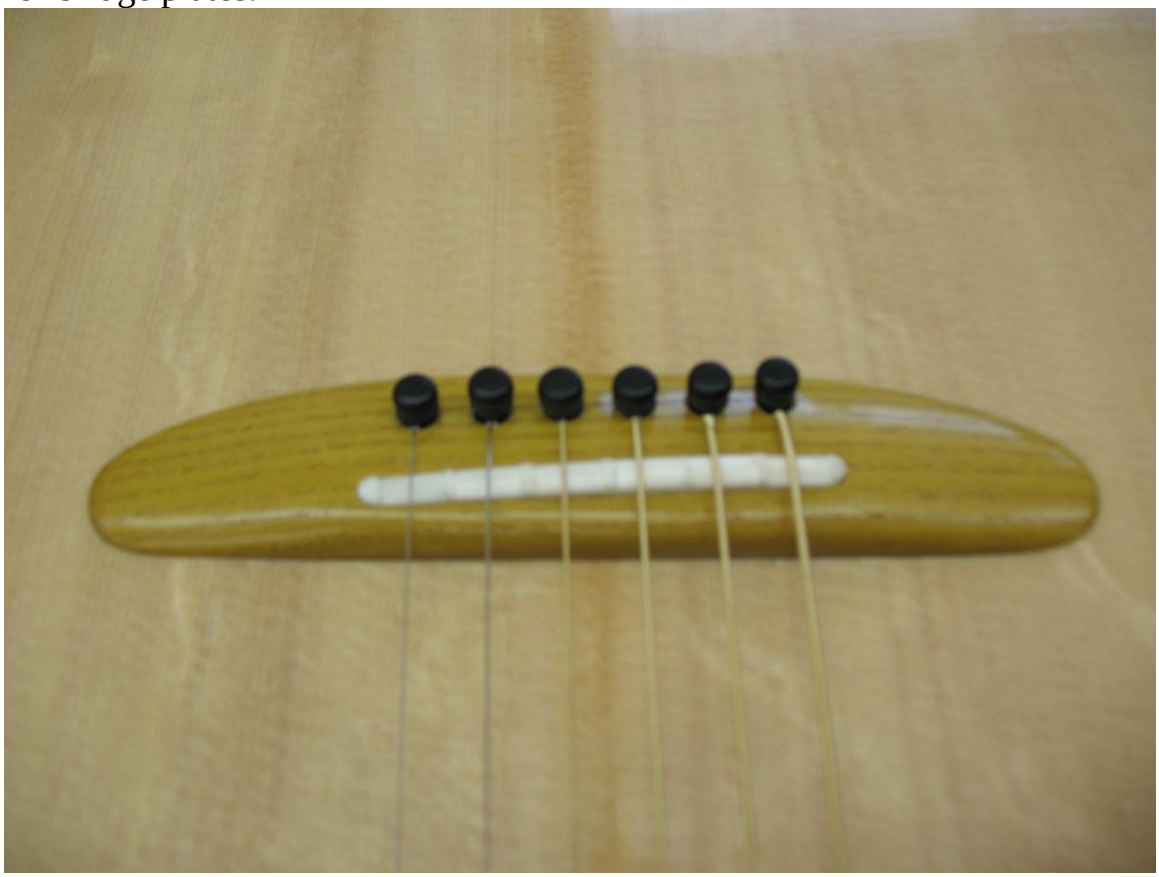
I used it for a twelve string with a one piece Douglas Fir top. The acoustical response was excellent with a full tonal response.

"Guitarbench" (an online magazine) states Lowden & Taylor are using it with good results.

Orange osage (maclura pomifera)

is a bright yellow before it oxidizes to a golden brown. The SG is close to Brazilian rosewood. It is very stable to humidity. For these reasons I use it

for bridge plates.



I have used it for fingerboards and binding. I have some sets cut but have not used them yet. Al Carruth told me he likened the properties to Brazilian Rosewood. He uses it on classical guitars. It has stiffness and density with a high MOE. It was used for archery Bows before Europeans came to this continent.

This wood also has tremendous decay resistance. Oregon apple farmers use it for fence posts as it does not rot.

A very similar wood is Pau Amarillo (Euxylophora paraensis) it is from Brazil .The SG is in the same range as Osage Orange & Brazilian Rosewood.
It has a strong yellow color that oxidizes golden brown.

The yellow has more of a green tinge to it than Osage. Osage is more vibrant.

I had a limited amount of this wood. I have built one guitar, a small O size out of it. It went to the Moosehead Craftsman Journey Contest. The

attack response was very quick. The acoustic range was full even with a small 0 size guitar. I have another set I intend to build a dreadnought with.

Both these yellow woods bend well, other than the hardness that requires sharp tools & muscle to push the plane or scraper. Occasionally

Osage Orange has divergence in the grain as it twists around a knot but both are basically straight grained for working.

As fingerboards they hold the fret and have more than enough hardness to endure future wear. They make excellent bridges as well. These

woods could be considered rosewood substitutes.

Cucumber magnolia (magnolia grandiflora) is a wood I was initially given to try out. The SG is just under mahogany. The moisture absorption is more like
maple.

It is spongy and bends best when water is applied as steam just when the

heat is up. The water relaxes the wood and it bends easily.

The name is due to the yellow green striping that runs thru the wood at all angles. I find the tonal response more like koa than mahogany.

It cuts and works well, not dulling tools excessively.

Holly (Ilex spp.) I began using for binding. The whiteness looks like ivory under a finish. One day I received boards wide enough for backs so I cut backs to try it. The tone is sweet like a mahogany with some koa attack. The SG is close to rosewood but it acts like maple in moisture stability. It absorbs moisture which can mute acoustics in a humid

environment.

It bends well if steam is applied when heat is up. It will warp. During the drying process it can discolor turning a tinged blue. This is still attractive but the ivory effect is lost. Like Koa it can burn in the side bender if left too

long.

The close grain allows a high polish and the whiteness gives a great back ground for sunbursting or staining, an artist's delight. I couldn't resist doing a sunset from my collection of pictures. This is done with aniline dye and a rag, a fan brush was used for the trees. The white is unstained holly to keep the brilliant sun effect.

Lacewood (cardwellia sublimis) caught my eye at a guitar festival so I picked it up. I read an article by someone that had used it. The figure of small rays is what makes it attractive. The softness allows it to burn easily in the side bender. Some people report it breaks easily when bending. I had no trouble with that but be wary, there is a high percentage of breaking.

The figured rays could separate when bending.
It was difficult to get level as the rays are hard and soft with extreme difference in the range. Alternate sanding and scraping needed to be done to

arrive at levelness.

It has a sweet tonal response. The SG is a little less than Mahogany, the response being similar in quality.

Staining will contrast the lace work even more as the soft wood absorbs stain, the hard wood repelling it. The wood does stand alone without

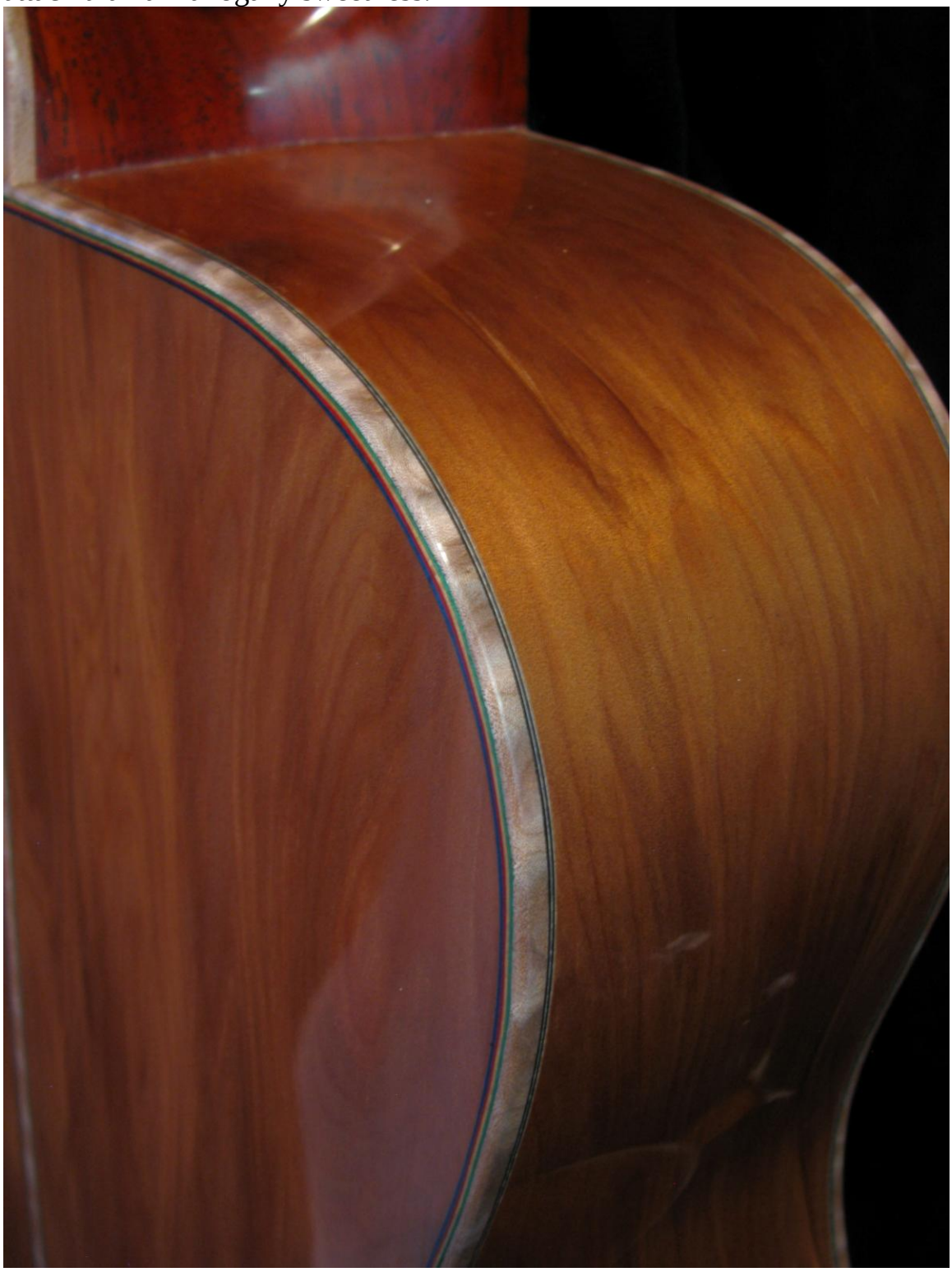
any coloring.

Ancient Kauri (agathis australis) or swamp kauri is my most recent builds. It is reportedly 45,000 years old. Buried beneath a swamp in an earth

quake it has been preserved.

It has excellent figure in long minnow shapes with wide curls crossing the grain. The run-out goes every which way requiring sanding and scraping. The wood itself is soft and absorbs CA glue causing it to stain and

blotch in a telltale way. The interlocking of the grain seems to add to the stiffness of this wood for the tone quality is closer to rosewood's full range attack than a mahogany sweetness.



It bends well with minimal warping in the run-out. The warping of run-out in highly figured backs can also occur in humidity changes. It sands and scraps ok but is softer and scrapers work better on harder woods. Leveling is not impeded by the soft and hard areas. It is consistent in the hardness.

The SG of New Zealand Kauri is .10 higher at .58 than that grown in Australia at .48. It also ranges up thru Asia. In Malaysia it is called Agathis.

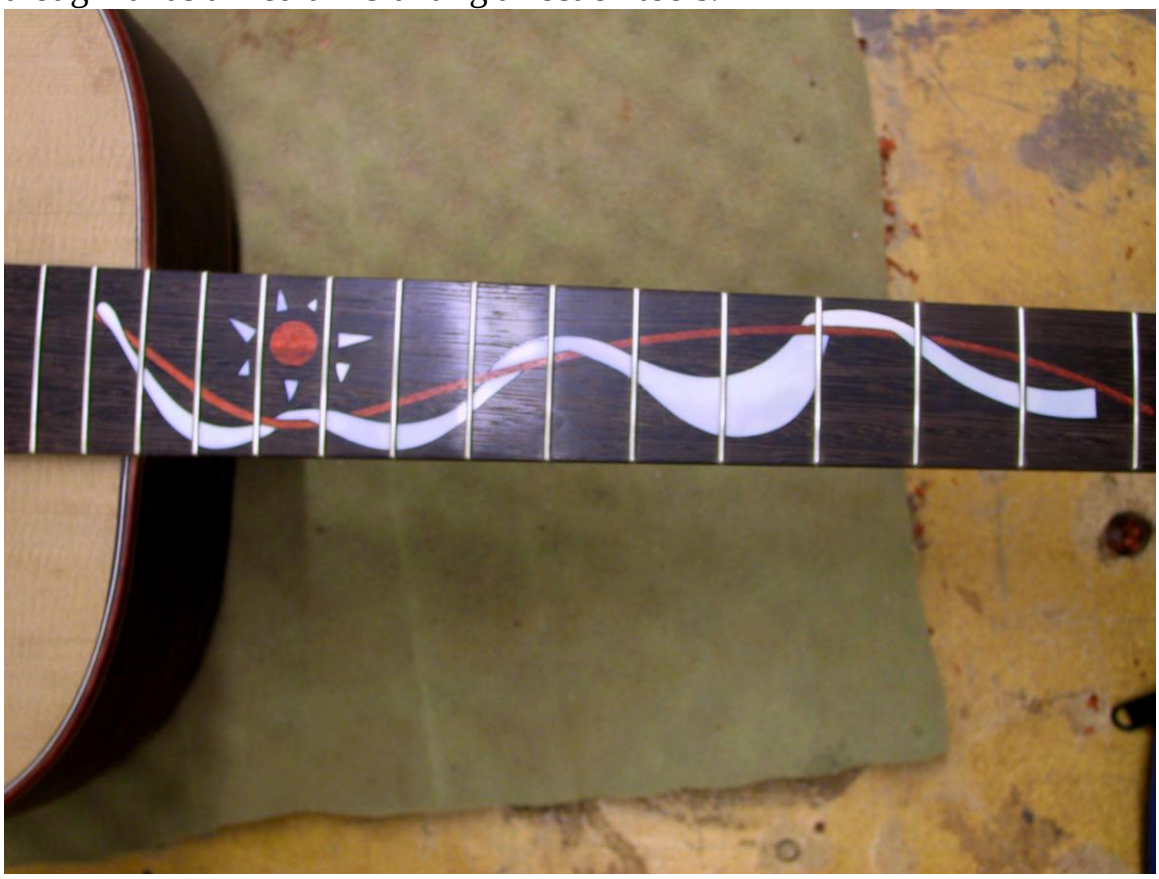
New Zealand Kauri is a protected species from over cutting in the past. The Ancient Kauri is still being dug out of the swamps and is available.

Myrtle (umbellularia californica)

is used thru the west coast of USA.

The SG is comparable to Rosewoods and the tone is acceptable. It has a softness to it when working that subdues the sound from a full on rosewood range. Like rosewoods it can have unseen cracks that show up after finishing with a humidity change. Here again, CA glue can stain the wood, leaving a blotch.

It can have some very good curl figure. The density makes it hard to work though it has a medium blunting affect on tools.



Wenge (milletia laurentia) has a SG of .88. It has medium to coarse texture which requires filling to get a smooth surface finish. The color is dark brown to black.

Some people complain it fractures and continually sends slivers into your hands while working. I find different suppliers have wood that will splinter & others don't splinter. I have found this in Purpleheart too.

It works well for fingerboards taking fret studs very securely without great resistance. It has a high bending strength but a low stiffness. This would drop the MOE which also drops the ATR. Most woods that work for

fingerboards work well for bridges too.

I had one student use it for backs and sides. Bound with Padauk it had a dramatic visual look. From Africa, the trees are not large in diameter. So

finding timber with sufficient width for backs is uncommon.

That is about all the wood I have personally used or been associated with. The list could go on with woods that people are using. In New Zealand, Rewarewa is used for backs. Purpleheart has been used. The guitars of this wood I have seen were too heavy and the treble response suffered. Unfortunately the purple color oxidizes brown over time. Pau ferro and Jarrah are other woods for fingerboards and bridges that people are using.

Exotic Wood World has acres in Peru. He told me on 2 acres there will 600 species but only 200 of them are on both acres. There are many woods yet to be tried.

In 1987, I began sourcing wood at the lumber yard where the auction was eventually held. He once advised me " most people are afraid of the wood, don't be afraid of the wood."